FALL UNDERGRADUATE **RESEARCH FAIR**

INFORMATION BOOKLET

Thursday, October 26, 2017
Jordan Hall of Science

UNIVERSITY OF NOTRE DAME
College of Science

College of Science – Fall Undergraduate Research Fair 2017

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!

Schedule and Table of Contents

Information Tables - Jordan Galleria

Advanced Diagnostics and Therapeutics (advanceddiagnostics.nd.edu)

Advanced Diagnostics & Therapeutics is a community of affiliated researchers who tackle a wide range of biomedical and environmental health through innovation, invention, and real-world applications.

Each year, AD&T awards two undergraduate Feinstein Institute for Medical Research (FIMR) - Precision Medicine Research Fellowships These fellowships are competitive awards given to highly qualified undergraduate and graduate students from Notre Dame that enable them to spend eight weeks in summer residence conducting laboratory and clinical research at the Feinstein Institute in Manhasset, New York. The fellowships are concurrent with FIMR's existing visiting scholars program, which takes place from approximately June 1 to July 31 each year. Each student receives a stipend to cover daily living expenses. The cost of transportation to and from FIMR and their home or campus is covered (within reason and subject to approval). The Feinstein Institute provides apartment housing on the institute's campus, which is a 30-minute train ride from New York City, at no cost to the fellows. These fellowships afford Notre Dame students an opportunity to experience hands-on research in a world-class setting. The summer 2018 application will open November 1st with an information session planned for Wednesday, November 8th.

Contact: Corrine Hornbeck (chornbec@nd.edu), Administrative Assistant

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)

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

ND*nano* 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, ND*nano* awards several paid fellowships to undergraduate students who spend 10 weeks of their summer engaged in a research project, mentored by an ND*nano* faculty member in science or engineering. Summer 2018 will mark the NURF program's 10th year. To date, nearly 200 students from Notre Dame and several other universities in the U.S. and abroad have participated in the program, gaining valuable research skills and experience. 2018 application information will be available in December at nano.nd.edu.

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

Eck Institute for Global Health (globalhealth.nd.edu)

The Eck Institute for Global Health (EIGH) is a university-wide enterprise that recognizes health as a fundamental human right and endeavors to promote research, training, and service to advance health standards for all people, especially people in low and middle-income countries, who are disproportionately impacted by preventable diseases. The EIGH is a cross-disciplinary group of faculty whose research and teaching are dedicated toward finding and implementing solutions to global health challenges. Over 85 faculty serve the Institute's global mission to promote research, training and service. Programs within the EIGH include the professional degree of Master of Science in Global Health, dual degree program with Indiana University School of Medicine, and the Global Health Research Associate program. The EIGH also offers funding for faculty members including graduate student fellowships, Pilot Project Grants, Building Multidisciplinary Teams Grants, Travel Grants for Research and Training, Building Institutional Partnerships Grants and an Undergraduate Research Support Program.

Contact: Sarah Craig (Craig.20@nd.edu), Communications.

FindScience Research Website (findscience.nd.edu)

FindScience is a student-run resource for students who are looking for research opportunities with current Notre Dame Professors in the College of Science. The website includes a page where students can search for research opportunities in specific subject areas, with certain professors, or for a specific semester. Each professor has a page which outlines their current research projects, their laboratory availability, and any qualifications that a student needs to participate. FindScience also includes information about different research subject areas and tips for contacting professors. The FindScience club is looking for student members to help keep the website up to date.

Contact: Claire Hagerstrom (findsci@nd.edu) Co-President of FindScience

Flatley 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 Mikala (ymikulja@nd.edu), Assistant Director of Undergraduate Research, or Jeffrey Thibert (jthibert@nd.edu), Associate Director.

First Year of Studies (fys.nd.edu)

First Year of Studies (FYS) supports and promotes research in two ways. First, through the ND Ignite Research Fellowship, 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 (swernert@nd.edu), Director of ND Ignite; Darlene Hampton (dhampto1@nd.edu), Coordinator of ND Ignite Research Initiative.

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, reducing side effects of chemotherapy, 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 comprise the main Hesburgh Library and eight campus 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 strive to meet the ever-changing needs of students in the 21st century. The Hesburgh Libraries provide critical support for your research, including access to online databases, thousands of 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, each spring semester we sponsor the Undergraduate Library Research Award

(ULRA) designed to honor students who best leverage the integrated suite of library services throughout their research process.

Learn more:
Biology, Environmental Sciences, Medicine: library.nd.edu/biology
Chemistry-Physics Library: library.nd.edu/chemistry-physics-library
O'Meara Mathematics Library: library.nd.edu/mathematics
Engineering Library: library.nd.edu/engineering
Center for Digital Scholarship: cds.library.nd.edu
Subject Librarian Guide: resources.library.nd.edu/documents/Selectors.pdf
Registration for library workshops: library.nd.edu/workshops
Undergraduate Library Research Award: library.nd.edu/ulra

Contact: Parker Ladwig (ladwig.1@nd.edu), Mathematics and Biology Librarian, or Thurston Miller (tmiller5@nd.edu), Chemistry and Physics Librarian.

IDEA Center (ideacenter.nd.edu)

Standing for **Innovation, De-Risking and Enterprise Acceleration**, the IDEA Center is the fundamental resource for all commercialization and entrepreneurial activities at the University of Notre Dame. It provides the necessary space, services and expertise for idea development, commercialization, business formation, prototyping, entrepreneurial education and student entrepreneurial efforts. It is designed to bring the best Notre Dame faculty, staff and student ideas and innovations to market.

IDEA Center initiatives support aspiring student entrepreneurs in many ways. We seek to create meaningful opportunities for you to learn and experience entrepreneurship first hand. Perhaps you want to learn more about entrepreneurship through our academic programs. You may hope to connect with startups through internships or immersive learning opportunities - outstanding opportunities exist! Perhaps you already have your own idea for a startup and are looking for help. Good news! Our resources and opportunities to engage are vast - we exist to support you and to help set you up for success!

Exciting academic programs in entrepreneurship and innovation are available at the graduate and undergraduate levels through the IDEA Center. The ESTEEM program is an innovative 1-year experiential master's degree in commercialization. By placing students with real-time startups they are able to hone and develop the mindset and skills crucial for successful launches.
Outstanding new academic programs are in the works as well, including our new cross-disciplinary minor in entrepreneurship, available to every undergraduate student on campus, will launch in 2018 - stay tuned!

Contact: Charles W. Powell (Charles.W.Powell.68@nd.edu), M.Div., Program Manager

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 medicine.iu.edu/southbend/research/research-faculty

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

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

Kellogg Institute for International Studies

The Kellogg Institute for International Studies engages an interdisciplinary community of scholars in research and education on the critical challenges of democracy and human development around the globe. Kellogg Institute student programs allow exceptional undergraduates to focus and develop their international interests and scholarly abilities. Research grants, fellowships and internships complement the Kellogg International Scholars Program, which matches students with faculty in a unique research perspective. Internships and fellowships provide undergraduates with hands on experiences in the developing world that can be transformative. Such encounters prepare students for the International Development Studies minor and for independent field research. Students can present their research at the annual Human Development Conference in the spring. More information about the Institute can be found at kellogg.nd.edu

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

Minor in Sustainability

The Minor in Sustainability is open to Notre Dame Students in all majors and include courses drawn from all five undergraduate colleges and the Law School. Through a multidisciplinary approach, the minor prepares students to serve as leaders in their communities - local, national, and international - by making constructive contributions to the development of more sustainable practices in their own personal and professional lives, the lives of others, and the lives of future generations. Through the Sustainability & Stewardship Alumni Network, we connect students with Notre Dame Alumni in a wide variety of sustainability careers and assist students in identifying internships, study abroad programs, and graduate schools that match their interests. 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.

Museum of Biodiversity (biodiversity.nd.edu)

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

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

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

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

Contact: Chris Stump (cstump@nd.edu), Student Coordinator.

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

ND Energy is a University Research Center whose mission is to build a better world by creating new energy technologies and systems and educating individuals to help solve the most critical energy challenges facing our world today. ND Energy engages undergraduate students in energy-related research and educational opportunities through programs such as the Slatt Endowment for Undergraduate Research in Energy Systems and Processes, the Energy Studies Minor, and the Student Energy Board. These programs help prepare students to become successful leaders who will understand the complexities of society's energy challenges and make a difference in the global energy economy. Learn more at energy.nd.edu.

Contact: Anne Berges Pillai (apillai@nd.edu), Education and Outreach Associate Program Director, or Barbara Villarosa (bvillaro@nd.edu), Business and Communications Program Director.

Scientia (scientia.nd.edu)

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

Contacts: Elizabeth McGough (Elizabeth.B.McGough.9@nd.edu) and Candice Park (Candice.K.Park.100@nd.edu) Editors.

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

Celebrating forty years of environmental education and research, UNDERC provides students with a unique opportunity to not only take part in hands-on field courses in environmental biology, but also the chance to gain invaluable experience in field research. UNDERC consists of two 9½ week, 3 credit summer programs. The first, UNDERC-East, is located on over 8000 acres of university-owned forest in northern Wisconsin and the Upper Peninsula of Michigan. The second summer of the program, UNDERC-West, takes place on the grasslands and montane forests of the Flathead Reservation in western Montana. Each course is composed of a set of modules (East: insect, forest, aquatic, and vertebrate ecology; West: environmental history tour, grassland/wildlife, montane, and Native American ecology) as well as an independent research project for each student mentored by a faculty member or graduate student. Admission to East is open to sophomores and above, while West requires previous participation in 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).

Contacts: Michael Cramer (mcramer@nd.edu), Assistant Director-East, David Flagel (dflagel@nd.edu), Assistant Director-West, and Gary Belovsky (belovsky.1@nd.edu), Director.

Poster Abstracts

Accessing Spirooxindole Cyclopropanes and Cyclopentenones Using a Rh^{II}-Catalyzed [4N+1]-Cycloaddition

Alexandra Bodnar
Major: Biochemistry
Advisor: Brandon Ashfeld, Dept. of Chemistry and Biochemistry, University of Notre Dame

Down Syndrome phenotypes, once thought to be untreatable, have been targeted using structural analogs of natural products to reduce and improve the phenotypic expression of genes such as DYRK1A. This gene has been shown to contribute significantly to the cognitive deficiencies characteristic of the disorder, but has the ability to be targeted and inhibited as shown in studies conducted using mice. Transition-metal catalyzed cycloadditions have proven to be powerful strategies for developing 5-membered heterocyclic rings, so this project will aim to employ a metal-catalyzed [4+1] cycloaddition to access simplified structural analogs of alkaloid natural products, in which a stereogenic carbon serves as the site of spirocyclic attachment. First, I looked at synthesizing spirooxindole cyclopropanes using a chiral rhodium catalyst via a [2+1]-cycloannulation. I conducted these experiments by reacting substituted alkenes with *N*-methyl diazooxindole. The resulting crude mixtures were initially analyzed via nuclear magnetic resonance (NMR) to determine diastereoselectivity, which revealed ratios ranging from 1:3 to 20:1. The pure spirooxindoles were tested for enantioselectivity (*ee*) using a high-throughput liquid chromatographer, and the products synthesized were obtained in up to 94% yield. A kinetic study was also performed to evaluate the ring expansion of a cyclopropyl intermediate after [2+1]-cycloannulation. Cyclopropyl spirooxindoles bearing a vinyl ketene portion can turn into a spirooxindole cyclopentenone via a ring expansion. This ring expansion is sensitive to electronic factors, so we put neutral, electron donating, and electron withdrawing groups on the vinyl ketene and the *N*-methyl diazooxindole to see how these changes would affect the spirooxindole cyclopentenone formation.

What inspired you to participate in undergraduate research?

"I took organic chemistry as a freshman and was hooked. I love being able to work closely with graduate students and people who share the same interests as I do."

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

"I have been a member of the Ashfeld Group since April of 2016. My freshman year I was awarded the Harper Cancer Research Fellowship to conduct research over the summer in this lab, and the following year the Notre Dame College of Science Summer Undergraduate Research Fellowship provided funding for my research."

Where was your research experience located?

"University of Notre Dame"

What did you get out of your research experience?

"Summer research at Notre Dame has opened my eyes to so many career opportunities. Coming to Notre Dame I was set on medical school, but then I discovered my passion for organic chemistry and how much fun it is to work in a lab."

Antibody Validation for Rare Cell Proteomic Molecular Characterization with an Imaging Mass Cytometer

Christopher Boldt
Major: Science Pre-Professional
Advisor: Erik Gerdtsson, Kuhn Lab Bridge Institute, University of Southern California

Circulating tumor cells (CTC's) have the potential to act as minimally invasive diagnostic markers to evaluate cancer prognosis and treatment efficacy, as well as track metastatic progression over time within a liquid biopsy. However, specialized techniques are required to tap into this potency. Our lab has integrated the Imaging Mass Cytometer, a tool that allows the multiplexing of heavy metal tagged antibodies, alongside the previously established High Definition Single Cell Analysis (HD-SCA) platform to study CTC's within a liquid biopsy. The HD-SCA protocol was designed to identify ultrarare CTC cells (>0.001%) from a patient liquid biopsy via immunofluorescent scanning. Next, the IMC is used to facilitate directed single-cell proteomic analysis of the CTC's through tagging with heavy metal antibodies. Seventy-two antibodies were evaluated across multiple cancer cell lines in order to validate their specific epitope binding affinity. Cells were scored with according to our developed protocol, which evaluated the mean intensity and the percentage of cells expressing a positive signal. Scored results were cross-referenced with the established literature on antigen expressivity across those cell lines to confirm validation. A number of antibodies were validated and can now be used to assess patient samples. Using the IMC and approved antibodies, this technology will allow the study of a range of biochemical properties from immune-oncology markers, EMT progression, stem-cell-like characterization using liquid biopsy.

What inspired you to participate in undergraduate research?

The opportunity to make a difference now, as an undergraduate, through applying what I have learned in an effort to improve the lives of millions who fight cancer inspired me to participate in undergraduate research.

How did you get your research position, and what preparation did you undertake for it? Networking is the key to landing a research position outside of Notre Dame. The common application process to various "Non-University" labs was simply not what I was looking to study, financially burdensome, and too far from home. I found an incredible program at the University of Southern California and did everything I could to convince them to accept a Notre Dame student.

Where was your research experience located?

University of Southern California

What did you get out of your research experience? I spent an incredible summer at the Bridge Institute at USC, where I made new friends who shared in the same zeal to beat cancer! The Bridge's paramount mission is to promote interdisciplinary research as a means of tackling a problem like cancer from every possible angle. This unique emphasis has shaped my perspective on my studies here at Notre Dame, particularly my interest in interdisciplinary classes, and has inspired me to utilize my unique skill set, in concert with scholars of other disciplines, to solve seemingly impossible problems.

Completions of Noncatenary Local Domains and UFDs

Caitlyn Booms
Major: Mathematics with Honors Concentration
Advisor: Susan Loepp, Dept. of Math and Stats, Williams College
Coauthors: Chloe I. Avery, Timothy M. Kostolansky, S. Loepp, Alex Semendinger

Commutative algebra is a field of mathematics that primarily studies the properties of abstract rings that are commutative and contain a unity element. A commutative ring is defined to be a set of elements with an addition and multiplication operation that are both associative, commutative, and distributive, that contains an additive and multiplicative identity and additive inverses, and such that adding any two ring elements or multiplying any two ring elements gives another element in the ring. For example, the set of all integers is a ring. Within the general setting of rings, we define various other structures and then study the relationships between those structures. In the research presented here, we particularly studied the relationship between the prime ideals of a local ring and the prime ideals of its completion. Specifically, we consider noncatenary local domains (a special kind of ring), which have a strange prime ideal structure. We find necessary and sufficient conditions for a complete local ring to be the completion of a noncatenary local domain, as well as necessary and sufficient conditions for it to be the completion of a noncatenary local unique factorization domain (UFD). This allows us to find a larger class of noncatenary UFDs than was previously known. We also discuss how noncatenary these rings can be.

What inspired you to participate in undergraduate research?

"I greatly enjoyed my math classes, but I felt like every time I understood a topic, we were moving on to the next topic. I wanted the opportunity to focus on a particular problem for a longer period of time so that I could really understand the subject area. Additionally, I wasn't certain that I wanted to pursue graduate studies in math, but I knew that doing a math research program would help indicate if that was something I should pursue."

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

"I applied for the Williams College SMALL REU program during my junior year after having taken multiple upper level proof-based math courses, including real analysis and abstract algebra. I prepared letters of recommendation from professors and wrote a personal statement about why I wanted to participate in the program. I also applied to various other summer REU programs in math to increase my chances of getting accepted to one. Each of these provided a NSF funded stipend for participating in the program."

Where was your research experience located?

"Williams College in Williamstown, MA"

What did you get out of your research experience?

"A summer filled with exciting mathematics, new friends and collaborators, and new mathematical results currently submitted for publication. My REU convinced me that I want to pursue math grad school and greatly improved my mathematical knowledge and maturity."

Antibody Purification via Affinity Membrane Chromatography Utilizing Nucleotide Binding Site Targeting

Michael Canonico
Major: Chemical Engineering
Advisor: Dr. Basar Bilgicer, Dept. of Chemical and Biomolecular Engineering, University of Notre Dame
Coauthors: Dr. Nur Mustafaoglu, Franklin Mejia

Current antibody use in therapeutics and research is increasing rapidly in both complexity and demand. Therefore, there is a constant, growing need for more efficient laboratory tools and methods to facilitate antibody engineering, production, and, in particular, purification. As of now, the predominant method of antibody purification is affinity chromatography, where the affinity molecule is Proteins A or G, proteins derived from bacteria that bind to IgG antibodies via the Fc region. This process delivers a high yield and purity, but has several drawbacks, including high cost, difficulty in isolating the affinity molecules, harsh elution steps, and leaching of the affinity molecule. Our lab has developed an alternative method. The Nucleotide Binding Site (NBS) is a conserved, underutilized binding site in the Fab variable region of the antibody. We have identified a number molecules that show moderate affinity for the NBS. For the chromatographic matrix, regenerated cellulose (RC) membranes were selected for their mechanical stability, inexpensive price, and ease of use. By conjugating our NBS ligand to the RC membranes, columns can be prepared, from a small, laboratory scale to full industrial scale. Specifically, spin columns offer unrivaled ease and efficiency for the laboratory.

What inspired you to participate in undergraduate research?

"I enjoy the collaborative aspect of the laboratory environment, and I like the satisfaction of solving problems and developing helpful technology."

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

"After browsing the faculty profiles on my department's website to get an idea of the research they do, I identified a list of potential advisors and emailed my top choice, Dr. Bilgicer. Before meeting with him, I read a few of the papers his lab had published prior."

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

"I learned the basics of the research process, how to handle data after collecting it, and how to collaborate with other researchers."

Stress in Action: Mapping and Manipulating a Central Amygdala Projection to the Substantia Nigra

Sofia Carozza
Major: Neuroscience and Behavior
Advisor: Dr. David A. Kupferschmidt, National Institute of Alcohol Abuse and Alcoholism

The substantia nigra pars compacta (SNc) is a nucleus of the basal ganglia with dopaminergic projections to the dorsal striatum (DS). Dopamine release from the SNc to the DS has been shown to modify the activity of DS medium spiny neurons, and could therefore influence action sequencing, initiation, selection, learning, and memory. The central nucleus of the amgydala (CeA) is an inhibitory structure that innervates the SNc. By modifying the activity of the SNc, the CeA could indirectly influence the DS and modulate these aspects of movement and memory. To this end, Cre transgenic mouse lines were injected with a Cre dependent viral vector to selectively express ChR2-YFP in the bilateral CeA or DS. Immunohistochemical methods were then employed to identify the anatomy of the projection from the CeA to the SNc. On the basis of these preliminary results, an optogenetic construct was developed for *in vivo* manipulation of SST+ neurons of the CeA that innervate the SNc. Behavioral tests in the open field and elevated plus maze (EPM) were then performed to identify various effects of activating this projection in freely moving mice. Statistical analyses show significant effects of optogenetic manipulation on the patterning of movement and exploratory behavior.

What inspired you to participate in undergraduate research?

I have always wanted to pursue cutting-edge neuroscience research, but do not have the time to do so during the academic year. Summer is a perfect time to gain new skills, explore post-graduate possibilities, and learn from distinguished scholars in the field.

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

I applied to the nationally-competitive Amgen Scholars Program and won a fellowship for 10 weeks of research and training at the National Institutes of Health. The program matched me with a faculty mentor in the Lab for Integrative Neuroscience.
I was prepared for this experience through extensive coursework in biology and neuroscience, as well as my familiarity with the existing literature in this area of neuroscience.

Where was your research experience located?

National Institutes of Health in Rockville, Maryland

What did you get out of your research experience?

Overall, I gained confidence in my research and laboratory skills, and fell in love with neuroscience research; I am now planning to pursue a PhD in neuroscience after graduation. I also learned about discrepancies in public health among minority and underprivileged populations, and was trained in the use of social policy to address these disparities.

Novel dual EGFR/PI3K inhibitors exhibit greater potency than clinically relevant mono inhibitors in glioblastoma

Trever Carter
Major: Biochemistry, Spanish
Advisor: Dr. Joya Chandra, PhD. Department of Pediatric Research, MD Anderson Cancer Center, Houston, TX.
Coauthors: Cavan Bailey, Christopher Whitehead, Judith S. Sebolt-Leopold, and Joya Chandra

Glioblastoma multiforme (GBM) is the most prevalent and aggressive malignant glioma, with a dismal five year survival of less than 10%. A 57% mutation rate of epidermal growth factor receptor (EGFR)--which controls cellular responses such as proliferation, survival, migration and tumorigenesis--and a 15% mutation rate in downstream phosphoinositide 3-kinase (PI3K) makes them tempting targets for intervention in GBM. To this end, a series of novel, small-molecule inhibitors were designed to dually inhibit both the EGFR and PI3K pathways. Our goal was to verify their mechanism of action using adult, human derived GBM cell lines SNB19 and U251. SNB19 and U251 cells differentially express PI3K. Inhibitor MTX 216 shows higher cytotoxic potency than its respective mono inhibitors, and GBM shows a rebound in viability at high doses of drug. Seahorse data shows significant decrease in glycolytic reserve function in MTX treated cells compared to EGF treated controls, suggesting successful inhibition of EGFR.

What inspired you to participate in undergraduate research?

My hope is to pursue a career as a practicing clinician in pediatric oncology. A full time summer experience was a great way for me to get immersed in the research side of medicine, which I had never experienced but very much wanted to. I also have had close relations treated at MDA, and knew I wanted to work there.

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

I applied directly to the MDA-UND joint program. As I had never done research before, I consumed a lot of scientific literature prior to my start date that was related to what my lab worked on.

Where was your research experience located?

MD Anderson Cancer Center in Houston, TX

What did you get out of your research experience?

I learned a lot about the research side of medicine, made a lot of great connections, and discerned my future career path.

Intercellular Signaling and Transport in Arabidopsis thaliana by AtRRP44A

Patrick Cunniff
Major: Biochemistry
Advisors: David Jackson and Munenori Kitagawa, Cold Spring Harbor Laboratory

Plasmodesmata play a key role in both the active and selective transport of macromolecules between cells in plants. Their role is especially important during the growth and development of plants, as the presence, or lack thereof, of certain transcription factors is important for cell fate determination. In our lab, Arabidopsis is used as a model organism as we are able to isolate mutants where transport through plasmodesmata is defective through a "Trichrome rescue system." One gene responsible for the transport through plamodesmata has already been identified, and encodes CCT8, a chaperone subunit of the palsmodesmata. Two further mutant Arabidopsis candidates have been identified, MKS-140 and the RB31, and next generation sequencing (NGS) and genotyping of the chromosome have determined that the gene responsible for both of these mutants is the At2g17510 gene. Further tests are needed to determine how mutation to this gene is responsible for the mutation, and reinsertion of the wild type gene for both the CCT8 and the new gene into mutant plasmodesmata, as well as tagging of the mutant RNA in the mutant Arabidopsis through Gateway cloning should allow for determination if the lack of these genes is the sole reason for the mutant, and how the mutation affects transport during growth and development.

What inspired you to participate in undergraduate research?

"I have loved everything about my undergraduate science classes and really wanted to opportunity to further my passion for science through extracurricular research. For this opportunity specifically, the chance to do research at such a prestigious institution as Cold Spring Harbor was one that I could not possible turn down."

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

"I applied for the position at Cold Spring Harbor, as well as to another of other summer research positions, over winter break last year, and heard that I got an offer to do research there this past summer in mid-March. To prepare I read a number of scientific papers about the topics that I would be researching and looked through a presentation that my post-doc put together on the prior research he had been doing to get a good feel for the background for the research."

Where was your research located?

"Cold Spring Harbor Laboratory"

What did you get out of your research experience?

"An amazing summer of doing research at an awesome laboratory, as well as opportunities to meet some people I really look up to in terms of their science like James Watson and Bruce Stillman. The summer also prepared me for what I will experience in graduate school and doing research even beyond that.

Synthesis and Characterization of Platinum (II) Carbene Complexes

Anthony P. Deziel
Major: Chemistry
Advisor: Vlad M. Iluc, Dept. of Chemistry and Biochemistry, University of Notre Dame

Metal carbene complexes have become an area of great interest in catalysis and small molecule activation. A square planar platinum(II) carbene complex [{PC(sp^2)P}^{H}PtPMe$_3$] ([PC(sp^3)H$_2$P]^{H} = (bis[2-(di-isopropylphosphino)phenyl]methane) was synthesized through the dehydrohalogenation of [{PC(sp^3)HP}^{H}PtCl] in a microwave reactor. An analogous complex, [{PC(sp^2)P}^{tBu}PtPMe$_3$] ([PC(sp^2)P]^{tBu} = bis[4-(tert-butyl)-2-(di-isopropylphosphaneyl)phenyl]methylene) was synthesized via the analogous route. The nucleophilic nature of the carbonic carbon was determined through DFT calculations and further reactivity studies are currently being conducted to confirm this.

What inspired you to participate in undergraduate research?

"I wanted to become more active in the chemistry community at Notre Dame, to get a taste of what graduate school would be like, and to get a unique experience of lab research that you cannot get from a lab course."

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

"I became a member of the Iluc Group in the spring of 2017. I chose the Iluc Group after reviewing recent publications and finding that the chemistry done by the group was interesting and exciting. I sent an e-mail to Dr. Iluc and we discussed whether the group would be the right fit for me, and if I was the right fit for the group."

Where was your research experience located?

"University of Notre Dame"

What did you get out of your research experience?

"I got a much deeper understanding of chemistry, and also made some new friends! I learned more about the process of research, how to write scientifically, and what graduate school would be like."

Linking the Oral Microbiome and Gut Parasites in Macaca fascicularis from Singapore

Bailee Egan
Major: Biological Sciences
Advisor: Hope Hollocher, Dept. of Biological Sciences, University of Notre Dame

Previous studies have associated the oral microbiome with changes in the host's health, but little is known about how chronic infections influence the oral microbiome. Parasites have been shown to alter the population dynamics of other infective agents and therefore may be able to influence the development of the oral microbiome, but the interactions between parasites and oral microbiome remain unexplored. Microbiome literature suggests that healthy individuals may have lower microbiome diversity while studies on helminth immune suppression suggest that healthy individuals may have higher diversity. *Macaca fascicularis* (long-tailed macaques) provide an excellent model for studying the oral microbiome in a natural environment given that they share similar microbiota and parasites as humans and may be more representative of primates as a whole. Here, we use Illumina sequencing to characterize the bacterial and archaeal communities in the mouths of macaques from Singapore and relate their oral microbiomes to data on parasite richness and abundance within individual macaques. We discuss our research in the context of existing literature both on microbiomes and health and on parasites and immune function.

What inspired you to participate in undergraduate research?

The field of microbiome research is rapidly growing, and that our macaques are wild, we can address some of the key questions about the microbiome in natural environments. Moreover, I plan to go into bioinformatics, and so I also see my research experience as an opportunity to learn about the toolsets used in this field.

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

I've worked in the Hollocher lab since fall 2016 after applying for the position as a freshman. I worked on a research proposal that would fits in well with my lab's work and submitted it to the Notre Dame COS-SURF for funding.

Where was your research experience located?

I worked on the University of Notre Dame campus.

What did you get out of your research experience?

I enjoyed doing full-time research this summer, which involved working towards a goal, honing lab skills, and finally presenting my work at the end of the summer. It was also lot of fun to spend time with people with so much knowledge because I learned something new almost every day.

Optimization and quantification of UV cleavable peptide exchange in peptide Major Histocompatibility Complex

Richard Felli
Major: Biochemistry
Advisor: Brian M. Baker, Dept. Chemistry and Biochemistry, University of Notre Dame

The peptide Major Histocompatibility Complex (pMHC) is composed of a heavy chain, responsible for most of the molecule's structure, the light chain (Beta-2-Microglobulin), and a 9 amino acid long peptide bound within the binding groove of the MHC's heavy chain and presents a surface for recognition by T-cell receptors (TCRs). The peptide plays an essential role in conferring the disease state of the cell, which TCRs can recognize. To refold an array of different peptides bound to their MHCs, researchers have to refold each pMHC one peptide at a time, which is not only time inefficient but also labor-intensive. The UV cleavable peptide (KILGFVFJL) uses UV light to catalyze a cleavage reaction via a modified phenylalanine residue (J) to cleave the peptide and destabilize the pMHC to allow for another peptide to replace the cleaved peptide. From a single refold, researchers can generate different peptide-MHCs, saving them both time and labor. This project attempts to: first, exchange peptides to compare the binding of two different TCRs to the newly formed complexes, (Rodenko et al.); second, modify the published procedure (Rodenko et al.) to increase the peptide exchange efficiency of peptides that bind weakly to the MHC's major groove; and third, create a fluorescence assay to measure the peptide exchange efficiency. So far, our group has screened for various destabilizing conditions, peptide efficiencies. Thermal melt measurements show the most ideal conditions to destabilize UV peptide pMHC is 44 mM dipeptide with 20% DMSO. Additionally, our group has developed an assay, using fluorescently tagged peptides to qualitatively measure peptide exchange efficiency.

What inspired you to participate in undergraduate research?

"Eventually I want to become a physician, who like a researcher, needs the ability to critically think, and trouble shoot problems. Participating in research is a great way for me to get my feet wet and prepare myself how to think critically for medical school"

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

"I have been in the Baker lab ever since second semester sophomore year. Once I received my funding from the College of Science, I was ready to start my summer research. "

Where was your research experience located?

"Harper Hall, University of Notre Dame"

What did you get out of your research experience?

"My summer research has pushed me beyond the limits of what I thought I could do. Through my summer experience I have become a more mature person overall who not only thinks more critically about the world but who has also adopted a more positive outlook when it comes to failure in research and in life."

References(1) Rodenko, B.; Toebes, M.; Hadrup, S. R.; van Esch, W.,J.E.; Molenaar, A. M.; Schumacher, T. N. M.; Ovaa, H. Generation of peptide-MHC class I complexes through UV-mediated ligand exchange. *Nat. Protocols* **2006***, 1*, 1120-1132.

TRIM24 is essential for proliferation of Breast Cancer-derived cells

Triana Fernandez
Major: Chemical Engineering
Mentors: Abhinav Jain and Michelle Barton, Department of Epigenetics & Molecular Carcinogenesis, The UT MD Anderson Cancer Center, Houston, TX

TRIM24 is a multi-functional protein that was identified as an oncogene in breast cancer. The RING domain of TRIM24 acts as a E3-ubiquitin ligase to suppress levels of tumor suppressor, p53. A tandem PHD/bromodomain module of TRIM24 reads a combinatorial histone mark H3K4me0/H3K23ac that facilitates its localization to chromatin. TRIM24 acts as a transcription co-regulator to either promote or prevent transcription. It was previously thought that if binding of TRIM24's bromodomain to the histone tail was prevented, the cell growth would be hindered. However, it was discovered that bromodomain inhibitors such as IACS-9571 was not sufficient in preventing growth of breast cancer-derived cells, suggesting oncogenic functions of TRIM24 do not completely rely on its bromodomain. Therefore, we determined if eliminating TRIM24 from cells would affect their proliferation. Our results indicate that introducing small interfering RNA (siRNA) targeting TRIM24 in breast cancer derived cells that prevents the generation of TRIM24, effectively reducing total TRIM24 levels, and cell proliferation. These preliminary studies show that strategies to eliminate total TRIM24 may be more effective in treating TRIM24-dependent breast cancers.

What inspired you to participate in undergraduate research?

"I wanted to contribute to the advancement of medicine by helping to find better treatments for diseases, such as cancer. I also wanted to learn about the methods and processes required for these discoveries."

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

"I applied to the program (MD Anderson Cancer Center- University of Notre Dame Summer Undergraduate Research Program) and I had done a similar program at MD Anderson the previous summer which helped me prepare. I also read about the research interests of Barton Lab, the lab I would be working in."

Where was your research experience located?

"Houston, TX, at MD Anderson Cancer Center"

What did you get out of your research experience?

"I learned how to apply the things I'd learned about in my classes to scientific research. I also spent time in Houston with other Notre Dame students, experienced working in the Texas Medical Center, and became good friends with the lab members I worked with."

A distinct population of sensory neuron-associated oligodendrocytes are non-myelinating

Robert Gallant
Majors: Science-Business and Psychology
Advisor: Dr. Cody J. Smith, Dept. of Biological Sciences, University of Notre Dame
Coauthors: Lauren A. Green, Cody J. Smith

Oligodendrocytes represent the myelinating cell of the central nervous system. In the packed brain and spinal cord, distinct profiles of oligodendrocytes are present, but the diversity of these cells is less understood. To study this, we used *in vivo* time-lapse imaging in the developing zebrafish spinal cord. We identified a sensory neuron-associated oligodendrocyte with a specific molecular and sheath profile, a unique migratory pattern, and distinct interaction with sub-type specific neurons compared to more traditionally described oligodendrocytes. Unique to other oligodendrocyte populations, our data is consistent with the hypothesis that these oligodendrocytes do not myelinate; they display a distinct non-myelinating ensheathment and molecular profile that remains stable over days of development. Our data shows their oligodendrocyte progenitor cells (OPCs) migrate directly to the sensory neurons during a critical window of synaptic stabilization in sensory neurons and remain stagnant upon arrival while continuing to produce dynamic cellular extensions and retractions to the sensory axons. Stable synapses that colocalized with sensory OPCs exhibited greater synaptic marker intensity, suggesting these non-myelinating oligodendrocytes contribute to both synaptic stabilization and function. Together our data uncovers a greater level of oligodendrocyte morphological and functional diversity that assembles into a fully functional nervous system.

What inspired you to participate in undergraduate research?

I thoroughly enjoyed my classroom biology labs and became even more fascinated with research when I took a one credit seminar that met once a week in which we heard from several Notre Dame biology faculty about their work.

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

During summer 2016 I found Dr. Smith's lab on the Biology Department's website and read one of his papers from his postdoc then emailed him a few questions I had about the paper and his current work. I then met with him a few weeks later and joined the lab!

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

My experience in the Smith Lab over the past year has been the greatest factor in redirecting my career path from pursuing an MD to pursuing a PhD. This past summer I have grown in

Analysis of Diel Vertical Migration in Various Plankton Species in Sea Grass Bed

Madeleine Girgis
Major: Biology
Advisor: Laura Kloepper, Department of Biology, Saint Mary's College
Coauthors: Shelby Compton

Plankton are marine organisms that drift in ocean currents. Microscopic zooplankton form the base of the marine food web and phytoplankton are vital contributors to the Earth's oxygen production. Diel vertical migration is a behavior that plankton display to avoid predation and ultraviolet exposure. The purpose of this study was to determine if the species composition of plankton differs throughout the day in a seagrass bed near South Water Caye, Belize. Plankton were collected at 7:30 am, at noon, and at 8:00 pm using a plankton tow, and then were analyzed under a microscope to determine the species. The average number of plankton collected in the morning was 23.5, 8 at midday, and 35 at night. The data trended towards a higher number of plankton at night and in the morning than at midday. However, the significance value for this set of data was 0.421, signifying that time of day has no effect on the species composition of plankton. Individual species groups were also analyzed, and most did not have significant results except for crab zoea ($p = 0.021$). This data suggests that further research can be done to better understand plankton behavior and support diel vertical migration in plankton.

What inspired you to participate in undergraduate research?

"When I decided to enroll in the marine biology course with a field work research component, marine biology was a potential professional interest of mine and I took advantage of the opportunity to gain field experience right off the bat."

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

"Fortunately for me, this was an optional course available to all students who had taken biology that included a research component. To prepare for our field work, I did extensive prior research on my experiment to better understand what I would be finding."

Where was your research experience located?

"South Water Caye Marine Reserve, through Saint Mary's College"

What did you get out of your research experience?

"I determined what I wanted to pursue! I found a passion for the ocean that I would not have known if not for undertaking this research opportunity. In addition, I developed friendships with my fellow researchers and a sense for what marine field work entails."

Synergistic regulation of calcium signaling by the goliaths of cell communication: TRPM7 and CRAC

Melissa Malia Gozun
Major: Biology
Advisor: Andrea Fleig, The Queen's Center for Biomedical Research, The Queen's Medical Center

CRAC channels and TRPM7 are vital to maintaining proper calcium levels within cells. Both have been implicated in a variety diseases, making them ideal pharmaceutical targets. While much is known about the two separately, little work has been done on how they operate together. Recent research has shown that decreased TRPM7 activity, induced either by mutation or pharmacological inhibition, affects CRAC channel activity. This current study, through calcium based Fura-2am imaging, aimed to determine if and how TRPM7 modulators affect CRAC channel function. While all of the TRPM7 inhibitors and agonist affected calcium release, only two of the modulators significantly affected store operated calcium entry. As a result, more experimentation is needed. However, the initial results suggest some link between the two and could lead to new paths for treatment.

What inspired you to participate in undergraduate research?

"During my Intro Bio lab last year, we learned how we can diagnose illnesses or find new solutions to problems through research. I loved the idea of solving problems in this way, particularly in the context of biomedical research and healthcare."

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

"My research position was a part of the Summer Research Internship at the Queen's Medical Center in Honolulu, HI. I applied for the internship in early February and heard back in late March. After being offered the position, I familiarized myself with my PI's previous work."

Where was your research experience located?

"The Queen's Center for Biomedical Research, The Queen's Medical Center; Honolulu, HI"

What did you get out of your research experience?

I am so grateful for my research experience! I learned so much about the research process and the lab environment. My internship was also integrated with the local hospital and medical school, which allowed me to consider how research and clinical care go hand-in hand.

Creating Tunable Substrates for 2D Bilayer Silica through Epitaxial Growth

Taylor Hernandez
Majors: Physics, Mathematics
Advisor: Eric I. Altman, Dept. of Chemical Engineering, Yale University

The development of thin films are of both practical importance in everyday applications and fundamental interest in order to study materials and their unique properties. The structure of these two-dimensional (2D) materials can be manipulated by altering the lattice strain. An epitaxial alloy system has been successfully developed which allows for continuous variation of the strain hence making it a tunable substrate. In growing 2D silica (SiO_2) on top of this substrate, we have seen a limitation in the strain which we are able to impart. Knowing that the strain is limited by the strength of the thin film-substrate interaction, we have introduced an additional interfacial reactive layer of the late transition metal ruthenium (Ru) to enhance the interaction. Theory predicts that when the tensile strain is greater than approximately two percent, we will induce phase transitions in the 2D van der Waals SiO_2 and observe new structures. The thin films were grown through molecular beam epitaxy (MBE) under ultra-high vacuum (UHV). Measurements to verify the crystal structure of the substrate are obtained through X-ray diffraction (XRD). Auger electron spectroscopy (AES) is used to obtain the composition and low-energy electron diffraction (LEED) patterns are taken to verify the surface order of the crystal. Following this we proceed with growth of the 2D bilayer and imaging using scanning tunneling microscopy (STM).

What inspired you to participate in undergraduate research?

It's just what you're expected to do if you are a physics major, so it's a good thing I enjoy it!

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

I assume it was based on my previous research experience the summer after my first year at Notre Dame and my research experience in Ken Gomes' condensed matter research lab here at Notre Dame, and grades probably mattered, too. I applied online for NSF REU's at different colleges and heard back from Yale in February, which was very exciting. I attribute my success to Ken Gomes who prepares me for all things.

Where was your research experience located?

Yale University, New Haven CT

What did you get out of your research experience?

I was challenged on several occasions and given a lot of responsibility, which was frightening but a good look into what a PhD in physics will entail. I was given the chance to give an oral presentation at a National Symposium at the end of the program, and that in particular forced me to reflect on my accomplishments. This experience also confirmed my previous belief that I should go to graduate school. Truthfully, it was just really fun.

B7-H3 as a potential marker of aggressive ductal carcinoma in situ

Sarah Herzog
Major: Biochemistry
PI: Helen Piwnica-Worms, PhD
Mentor: Vidya Sinha, PhD
Institution: MD Anderson Cancer Center

Ductal carcinoma in situ (DCIS) is an early stage of breast cancer characterized by the expansion of malignant cells within the mammary duct. A subset of aggressive DCIS will invade the surrounding mammary tissue, progressing to invasive breast cancer (IBC), which is associated with metastases and poor patient prognosis. A potential marker of invasive potential of DCIS is the immune checkpoint marker B7-H3. Expression of B7-H3 may be associated with immune inhibition, allowing tumors to avoid detection by the immune system. In this experiment, tumors were grown in wildtype female mice injected with lentiviral particles expressing the activated ErbB2 oncogene. Using immunohistochemistry, tumor lesions in mouse mammary glands were analyzed for B7-H3 expression and measured for invasion and size. Positive correlations between B7-H3 expression and size/invasion were found in 2 of 3 mice ($p<.001$). In addition, smaller and less invasive lesions exhibited B7-H3 expression constrained to the periphery of the lesion. This study suggests B7-H3 in conjunction with other aggressive DCIS markers could serve as one prognostic marker for the likelihood of progression to invasive breast cancer. Further studies require generalizing results to larger populations and evaluating human patient sample B7-H3 expression and cancer outcome.

What inspired you to participate in undergraduate research?

After my experience caring for my grandmother who had Stage IV breast cancer I developed an interest in cancer research. I fell in love with benchtop work and have wanted to pursue graduate school and research ever since!

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

This research position I applied for through the MD Anderson-Notre Dame joint program for the summer. I had been working in the Hummon lab for 3 semesters and received a research grant to do work at ND in the summer of 2016. I wanted to experience multiple types of cancer research labs (I do analytical chemistry here at Notre Dame) and made that clear in my application.

Where was your research experience located?

MD Anderson Cancer Center in Houston, TX

What did you get out of your research experience?

I learned how much I love the idea of studying the immune system from my summer research. I also experienced what it is like to research at a medical center compared to an academic institution. The work done in the Piwnica-Worms lab involves doctors, PhDs and graduate students. The research projects are incredibly collaborative. Many different perspectives on the team are necessary to have any chance of your benchtop work making it to treatment.

Stability of RNA•DNA-DNA Triple Helices with Varied Base Triple Composition

Sarah Hickman
Major: Science-Business
Advisor: Jessica A. Brown, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Charlotte N. Kunkler

Triple helix formation is one of the many possible mechanisms explaining the function of long noncoding RNAs (lncRNAs). LncRNAs are a recently discovered class of RNAs whose functions are largely unknown but have been found to be important in the regulation of gene expression. One intriguing mechanism proposed to regulate gene expression is the formation of a triple helix or triplex. LncRNAs are thought to interact with genomic DNA to form an RNA•DNA-DNA (R•D-D) triplex. This proposal is based on computational programs designed to predict where in the genome a specific lncRNA will bind. However, these programs are based on findings using DNA•DNA-DNA (D•D-D) triplexes, which have different chemical and physical properties than R•D-D triplexes. In this study, we measured the equilibrium dissociation constants (K_d) for sixteen different base triples at a single position (Z•X-Y) within an R•D-D triplex using native gel-shift assays. At position Z•X-Y, Z represents the RNA strand (U, A, G, or C) and X-Y represents the dsDNA Watson-Crick base pair (A-T, T-A, C-G, or G-C). The K_d values for each base triple were ranked and compared to the relative stability of pure DNA and RNA triplexes. Both canonical base triples, U•A-T and C•G-C, provide the greatest stability, while A•A-T, C•A-T, and G•A-T inhibited triplex formation. The relative stability of base triples in R•D-D, D•D-D, and R•R-R triplexes have distinctly different profiles, demonstrating that the stabilities of pure DNA triplexes do not accurately predict the stability of R•D-D triplexes.

What inspired you to participate in undergraduate research?

I was interested in developing my skills as a scientist and as a researcher. I had always enjoyed the hands-on experience in classroom labs, and I wanted the opportunity to extend my knowledge further by working in a more independent setting.

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

I have been a member of the Brown Lab since April 2017. As a new faculty member, Dr. Brown had positions available for undergraduate researchers and my biochemistry course inspired me to pursue scientific research. After looking into Dr. Brown's previous research, I decided that working with her was an opportunity I could not pass up.

Where was your research experience located?

Stepan Chemistry Hall at the University of Notre Dame

What did you get out of your research experience?

This research experience has helped me to develop my problem solving skills, my reading comprehension of primary literature, and how to successfully design experiments and to conduct collaborative science while still growing as an independent scientist.

The Role of the Fibrinolytic System in Hypertensive Renal Injury

Kristina Hollkamp
Major: Biochemistry
Advisor: Victoria A. Ploplis, Dept. of Chemistry and Biochemistry, University of Notre Dame

Hypertension is a prevalent health issue in the United States and around the world. Approximately 75 million American adults, nearly one third of the U.S. population, suffer from hypertension. Despite these numbers, the effect of the fibrinolytic system in hypertensive renal injury is still poorly understood. This study investigates the effect of the fibrinolytic system in hypertensive renal injury, specifically the roles of plasminogen activator inhibitor-1 (PAI-1) and of urokinase **(**uPA) and its receptor (uPAR). The study utilized a mouse model in which hypertension was induced by the infusion of angiotensin II (AngII) and aldosterone (Ald). There were four mice genotypes in the study: wildtype (WT), PAI-1 deficient (PAI-$1^{-/-}$), uPA deficient ($uPA^{-/-}$), and uPA mutant (uPA^{m}) in which uPA's ability to bind to uPA receptor (uPAR) was impaired. The harvested mouse kidney specimens were harvested after 4 weeks, fixed in 4% paraformaldehyde, embedded in paraffin, and cut into 4 μm sections. To assess general morphology, the sections were stained with hematoxylin & eosin and were assigned kidney injury scores by an investigator blinded to the genotype and experimental conditions. The amount of collagen deposition in the kidneys was assessed through picro-Sirius Red staining, fibrino(ogen) deposition and kidney injury molecule-1 (KIM-1) expression were evaluated by immunohistochemistry, and gene expression was assessed by quantitative Real-Time Polymerase Chain Reaction (qRT-PCR). ELISA experiments were performed to see the expression of proteins associated with renal inflammation. The data indicate that hypertensive uPA deficient mice have higher levels of renal injury compared to hypertensive wildtype mice. The protective effect of uPA is independent of its interaction with uPAR and of the activation of transforming growth factor-beta (TGF-β).

What inspired you to participate in undergraduate research?

"I enjoy seeking answers to scientific questions and learning about the amazingly complex systems in the body. Undergraduate research allows me to apply the ideas that I learn in class to solve real-world problems."

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

"I have been a member of Dr. Castellino's research group since fall 2015. After submitting a proposal based on an extension of my research during the academic-year, College of Science Summer Undergraduate Research Fellowship provided funding for my summer research."

Where was your research experience located?

"W.M. Keck Center for Transgene Research at University of Notre Dame"

What did you get out of your research experience?

"The opportunity to research full time during the summer was a wonderful learning experience that allowed me to make significant progress on my research project. It challenged with a different kind of learning in which the answers are often unknown."

Randomness Of Play Calling In College Football

Gretchen Hopkirk
Majors: Film, Television and Theatre & Spanish
Advisor: Annette Pilkington, Dept. of Mathematics, University of Notre Dame
Coauthors: Brian Curley and Ryan Lokhorst

Our research is focused on randomness of play calling in college football. In our data there are two options for play calls: run or pass. Due to game theory, one would expect that a team with more randomness in play calling would have better results, such as more wins, fewer sacks, and fewer interceptions. To test our hypothesis, we used R Programming to analyze data on all college football games played from 2005 to 2013. We used the Wald-Wolfowitz test to give us a measure of randomness. However, our findings about randomness in play calling do not match the game theory based hypothesis. The results indicate a significant but weak correlation between randomness in play calling and point differential as well as other critical statistics. However, when we created a model of wins and losses using a logistic regression, we found that the pattern of play on third down was a significant low impact factor.

What inspired you to participate in undergraduate research?

"I enjoyed learning about game theory and wanted to further explore its presence in sports statistics. Research provides me the opportunity to continue my learning experience from Finite Mathematics and Mathematics in Sports."

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

"I reached out to Professor Pilkington following the completion of both *Finite Mathematics* and *Mathematics in Sports* and expressed interest in assisting in a larger project. Aside from taking those two classes, I completed outside readings regarding the Wald-Wolfowitz test."

Where was your research experience located?

"University of Notre Dame"

What did you get out of your research experience?

"I have gained an increased understanding of the utility of statistics in analyzing sports as well as knowledge about conducting independent projects. Additionally, I have further developed my relationship with both Professor Pilkington and the other researchers on our team."

Finding a Sensor for Cortisol in the Microbiome

Allison Huffman
Major: Neuroscience and Behavior
Advisor: Dr. Michael Goodson, 711th Human Performance Wing, Wright Patterson Air Force Base

The microbiome, or the makeup of gut bacteria, is closely related to mental health, especially levels of stress and awareness. If the gut bacteria is altered in any way, the disruption can cause negative side effects which hinder a person's abilities to perform, especially in the case of an airman who needs to be highly alert and at peak health. The Air Force has recently teamed with the Army and Navy in order to engineer gut bacteria to sense chemicals, such as cortisol, and respond with a different chemical output, such as tryptamine, in order to decrease stress levels and increase alertness. Cortisol is an indicator of stress while tryptamine causes the release of serotonin which lowers stress and anxiety levels. At the moment, there is no known cortisol sensor. The objective of my summer research project was to determine if a repressor protein, BreR, could function as a sensor for cortisol. The goal of the project was to construct three plasmids, a reporter, repressor, and control plasmid, and test these with and without BreR to determine if the repressor protein could sense the cortisol based on the production of green fluorescent protein (GFP). Two out of the three plasmids were constructed. The project is ongoing to develop the last plasmid in order to test the BreR repressor protein as a sensor for cortisol.

What inspired you to participate in undergraduate research?

I have always had a love for molecular biology and really wanted to see what it was like to work in a lab so that I could determine if it was what I wanted to do with my future. I was lucky enough to be offered the internship at a young age and continue to work with my boss for two more summers, learning more and more each summer.

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

I participated in a high school program which provided high school students with the opportunity to work as a research intern in a lab at Wright Patterson Air Force Base. I enjoyed my first summer with my mentor and have returned the past two summers to work with him. My biology and chemistry classes prepared me to do the research and the position has led me to be able to work in Dr. Champion's lab at Notre Dame.

Where was your research experience located?

Wright Patterson Air Force Base in Dayton, Ohio

What did you get out of your research experience?

I learned a lot about the microbiome and how complicated the cellular mechanisms within the microbiome are. I was taught valuable lessons about dealing with unexpected results and troubleshooting the research plan in order to get the desired outcome.

Evaluating the effectiveness of ET cocaine esterase (CocE) in reducing abuse-related and toxic effects of cocaine

Karen Jimenez
Major: Neuroscience and Behavior
Advisor: Gregory T. Collins, Dept. of Pharmacology, University of Texas Health Science Center at San Antonio

Cocaine abuse continues to be a problem in the United States that has taken the lives of many people over the past years. While there are currently no approved therapies for treating cocaine abuse, recent discoveries and further mutagenesis of an enzyme that can metabolize cocaine much faster than natural metabolization by butyrylcholinesterase has shown promising results in reducing the abuse-related effects of cocaine. Previous mutagenesis studies dramatically improved the thermostability, resulting in a 500-fold improvement in the *in vivo* duration of action of CocE . The version of the enzyme, cocaine esterase(CocE) used in this study is a novel mutant known as ET CocE. Mutations to the enzyme are related to its catalytic site which allow for an improvement in its affinity towards cocaine. Therefore, combined with the previous and new mutations we hypothesize that ET CocE will reduce the abuse-related effects of cocaine in rats by improving the enzyme's overall efficiency in metabolizing cocaine. The goal of this study is to characterize the effectiveness of ET CocE in rats by examining the reinforcing and discriminative stimulus effects through dose-response curves produced from self-administration and discrimination experiments. After rats were trained to self-administer cocaine, they were given a pretreatment of ET CocE and then dose-response curves were obtained in a single session using a multiple component schedule. Similarly for discrimination studies, rats are being trained to discriminate a stimulant and in the future, a pretreatment of vehicle or ET CocE will be administered before a cocaine dose-response curve will be determined. Two doses of ET CocE (0.1 and 0.32 mg/kg) produced rightward shifts in dose response curves for self-administration studies, indicative of a reduction of the reinforcing effects of cocaine. Together with in vitro data demonstrating the increased catalytic efficiency of ET CocE in metabolizing cocaine, these data will provide strong evidence supporting the development of ET CocE for treatment of cocaine abuse in humans.

What inspired you to participate in undergraduate research?

"As a high school student, I was part of a research program at the same institution that introduced me to the field of animal behavior and neuroscience. After doing gaining an interest in this field and doing research for several years I found myself wanting to ask more questions and try different fields of behavior. Plus, I just love rats."

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

"Because I had been conducting research at the same institution for several years already, I had heard about the program from another faculty member there and decided to apply to continue my research with another mentor. Some people helped with recommendation letters and editing of my personal statement which was part of the application process."

Where was your research experience located?
"At the University of Texas Health Science Center in San Antonio through the Pharmacology Summer Undergraduate Research Fellowship"

What did you get out of your research experience?
"An intriguing and fun summer that allowed me to gain new skills and learn about different areas of research I had not been exposed to. Along with the program, I took classes about the field of pharmacology taught by faculty members and I also gained many friends within the lab and the program."

Inhibition of Autophagy Increases Radiation-induced Cell Killing in Pancreatic Cancer

David Kronenberger
Major: Pre-Professional
Advisor: Marc S. Mendonca, Professor & Director of Radiation and Cancer Biology, Depts. of Radiation Oncology & Medical and Molecular Genetics, Indiana University School of Medicine
Coauthors: William Tyler Turchan, Helen Chin-Sinex, and Marc S. Mendonca

High levels of c-Ki-ras activity in pancreatic cancer have been shown to both increase free radical production and pro-survival NF-kB activity, as well as drive aerobic glycolysis, i.e. Warburg metabolism. High levels of NF-kB and ras activity have also been shown to induce resistance to chemotherapy and X-ray-induced cell death. In addition, data suggest that Ras-transformed pancreatic tumors actively scavenge/recycle intracellular nutrients though autophagy (self-eating) and this process is essential for pancreatic cancer cell survival. We have shown that treating pancreatic cancer cells with Dimethylamino-parthenolide (DMAPT) an NF-κB inhibitor in combination with Dichloroacetate (DCA), a pyruvate dehydrogenase kinase inhibitor, is cytotoxic to human pancreatic cancer cells and increases their X-ray-induced cell killing in vitro. Our data suggest that the toxicity and enhancement of radiation-induced cell killing by DMAPT and DCA may involve inhibition of autophagy. To test this hypothesis, we investigated whether inhibition of autophagy with the well-known autophagy inhibitor chloroquine induced cytotoxicity and increases radiation induced cell killing in pancreatic cancer cells. Our data shows the treatment of pancreatic cancer cells with chloroquine induces both cytotoxicity and increase x-ray-induced cell killing. We propose that autophagic inhibition is a promising approach to increase pancreatic tumor response to X-rays.

What inspired you to participate in undergraduate research?

"Cancer has been present through multiple generations of my family and therefore cancer research is of personal interest to me. I wanted to learn more about cancer metastasis and how different therapies worked to treat cancer."

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

"My advisor is a colleague of my fathers and I reached out to him to see if there were any undergraduate positions open in his lab over the summer. To prepare for my summer of research, I read multiple papers submitted by the lab in which I would be conducting my research along with part of a textbook containing information concerning radiation oncology."

Where was your research experience located?

"Indiana University School of Medicine, Indianapolis, IN"

What did you get out of your research experience?

"I gained a greater appreciation for the work conducted in laboratories. Being in the lab environment, I realized how many variables went into proposing grants, researching transduction pathways, and conducting all the necessary information. I was also able to better understand lab protocols and the mechanisms of planning and conducting research."

Experimental Investigation on Magnetohydrodynamic Power Generation Using Pre-Ionized Argon Flow

Tommy Krug
Major: Physics, Russian
Advisor: Steven F. Adams, Primary Investigator, RQQE Air Force Research Laboratories
Coauthors: Alex Myers, Boyd Tolson, Jared Miles

This report details an experimental setup which is used to investigate the properties of magnetohydrodynamic (MHD) electric power generation using a pre-ionized argon pulsed flow. Argon flow in a quartz tube is excited in a microwave discharge and passed downstream between two permanent magnets. The magnets create a Lorentz force on the flowing charges which are collected as an induced electromotive force (emf) by electrodes perpendicular to the magnets. For this experiment, the static argon pressure in the discharge tube is held at 0.5 Torr and a pulsed valve with a pressure differential of 2000 Torr is opened for 10 ms to create a local pressure wave through the discharge which carries the ionized gas downstream through the magnetic field. By varying the load resistance, the local emf voltage and current characteristics were measured. The average conductivity of the plasma is calculated to be roughly 0.056 S/m based on local voltage and current characteristics. The load factor k reaches its optimal value (0.5) when system load resistance approaches 14kΩ, which matches the internal resistance of the Argon plasma itself. This load resistance yields the investigation's maximal power density, found to be around 400 W/m^3. Finally, the effect of load resistance on power density of the MHD generator is analyzed.

What inspired you to participate in undergraduate research?

"I plan on doing high-energy and cosmological physics research later in my career, and the chance to explore new plasma physics for the Air Force was hard to turn down!"

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

"I worked for AFRL after graduating from high school, and made connections through the same program to find my current position in RQQE, the Electric Power & Control division."

Where was your research experience located?

"Wright-Patterson Air Force Base, Dayton, OH"

What did you get out of your research experience?

"A ton of lab hardware and software experience, a pending research paper in Supersonic MHD research, and a lot of life lessons and new collaborators and connections. I got to peruse a few research papers in French and Spanish, and became very familiarized with fluid dynamics."

Homeostasis in Biological Systems

Patrick LeBlanc
Major: Mathematics
Advisor: Janet Best, the Ohio State University; Marty Golubitsky, the Ohio State University, Michael Reed, Duke University

Common biological motifs, systems, and existing models were investigated to look for homeostatic and physiological behavior. In particular, the Feed-Forward Excitation Motif was investigated. A sensitivity analysis was performed which found that varying parameters did not cause emergent behavior. An additional input was added to the feed-forward motif in such a way that a double homeostasis point was found, and this model was subjected to a sensitivity analysis. Moreover, the Feed-Forward Excitation Motif was modified to use Michaelis-Menten kinetics, and the conditions under which this system would have a homeostasis and chair point were derived. Brian Topp's βIG model of glucose regulation was investigated for homeostatic behavior. It was found that neither the fast nor slow subsystems of the model exhibited homeostatic behavior with respect to any parameter. Moreover, it was found that neither the time-evolution of the fast subsystem nor the time-evolution of the slow subsystem matched experimental data. Efforts were made to improve the βIG model and correct these behaviors by introducing terms for glucose in the liver and glycogen, but these efforts are ongoing.

What inspired you to participate in undergraduate research?
I wished to perform research in mathematical biology which could have beneficial public health outcomes.

How did you get your research position, and what preparation did you undertake for it?
I participated in a Research Experience for Undergraduates at the Mathematical Biosciences Institute at the Ohio State University. Class work and previous research experiences prepared me for this research position.

Where was your research experience located?
The Ohio State University.

What did you get out of your research experience?
I learned how to perform research in mathematical biology, as well as a more well-defined idea of what paths I wish to tread following my undergraduate career.

Interfering RNA larvicides using engineered yeast to control Dengue and Zika

Alexandra Lesnik
Major: Neuroscience
Advisor: Molly Duman-Scheel, Dept. of Medical and Molecular Genetics, Indiana University School of Medicine South Bend & Dept. of Biological Sciences, University of Notre Dame
Coauthors: Limb Haparai, Keshava Mysore,Ying-Ying Chen, David W. Severson, Na Wei, and Molly Duman Scheel

The *Aedes aegypti* mosquito transmits multiple diseases including dengue and Zika. In the absence of vaccines, disruption of virus transmission primarily relies on vector control using chemical pesticides. An increasing number of studies show resistance to chemical pesticide of *Ae. aegypti* and environmental concerns of non-target species. Development of new biorational larvicides RNA interference (RNAi) allows for recognition and silencing of genes expression in *Ae. aegypti* only, thus addressing both insecticide resistance and negative effects on non-target organisms. We engineered *Saccharomyces cerevisiae* to produce and propagate short hairpin RNAs corresponding to *AAEL007292* and *AAEL007548* larval lethal genes. Feeding *A. aegypti* larvae with engineered yeast killed larvae by silencing target gene expression and disrupting neural development. We developed and characterized larvicide yeasts granules that have been heat inactivated for semi-field and field experiments.

What inspired you to participate in undergraduate research?

I think it is a really great experience to do hands-on research and see what it is like to work in a lab. This has been really helpful towards my career exploration.

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

I emailed a few professors whose biographies I read online and whose work interested me. I talked to a few and chose the one that was the best for me. For the summer research I participated in, I applied for a grant through the Glynn Family Honors Program and the College of Science.

Where was your research experience located?

Indiana University School of Medicine, South Bend

What did you get out of your research experience?

This summer, I learned a lot about what a full time career in research would be like. This was an experience I could not have gotten during the semester while taking classes full time. I also met some really great mentors who are great models of research scientists.

Serotonin Receptor: Targeted for Insecticide Design

Zoe Loh
Major: Chemistry
Advisor: MaryAnn McDowell, Department of Biology, University of Notre Dame

Zika and Dengue are infectious diseases that are transmitted by the vector mosquito Aedes aegypti. The spread of the diseases has increased the need for containment and eradication. Current insecticidal compounds are becoming unsatisfactory due to the increased resistance of disease carrying vectors. New techniques of vector control and disease prevention look to G Protein Coupled Receptors, GPCR's, as insecticide targets. GPCRs play a huge role in transducing extracellular stimuli into intracellular signals that are part of signaling pathways affecting many physiological events in mosquitoes. Serotonin receptors are one of the identified GPCRs that are important in insect physiology. Serotonin, a neurotransmitter, involved in feeding and behavior related physiological events, acts as a neuromodulator in the brain participating in multiple cellular pathways. This research focuses specifically on compounds that act effect serotonin receptors, serotonin an agonist, and methiothepin an antagonist. We also looked at compounds that affect the serotonin levels in the animal, PCPA and alpha methyl tryptophan, which disrupt serotonin synthesis, and fluoxetine, which alters reuptake of the ligand. Compounds are injected into the mosquito, after which a blood-feeding assay or flight assay is performed. The studies are ongoing to determine the pathways serotonin receptors affect and viable compounds for insecticide development.

What inspired you to participate in undergraduate research?
I am a curious person by nature, research was a natural choice for me in that it allows for me to ask questions and experimentally try to find the answers.

How did you get your research position, and what preparation did you undertake for it?
I joined the McDowell Group my junior year in 2016 after emailing Professor McDowell. While I did not have many skills coming into the lab, besides prior classroom lab experience, I have learnt a lot in my time there and continue to build on my knowledge and technique.

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

What did you get out of your research experience?
My research experience has given me a solid basis for graduate school and has also given me valuable friendships with great people!

Identification of unique DNA markers across the genus Castanea through the use of chloroplast sequencing

Aaron Long
Major: Biological Sciences
Advisors: Warren Chatwin, Dept. of Biological Sciences, University of Notre Dame; Jeanne Romero-Severson, Dept. of Biological Sciences, University of Notre Dame

There are eight extant species of chestnut under the genus *Castanea*, all of which can hybridize. The morphological nuances of the hybrids cannot be distinguished physically. In addition, due to a lack of historical records, chestnut breeders are unable to track the ancestry of their trees. The ability to differentiate species as well as track the ancestry of chestnuts is vital in restoration efforts such as the restoration of the American Chestnut (*Castanea crenata*), which became ecologically extinct in the 20th century due to a fungal blight. Before a blight resistant chestnut can be introduced, there must be certainty in its ancestry and identity. Identifying and validating ancestry informative genetic markers is thereby the primary focus of this experiment. Thirty-seven samples from all eight *Castanea* species were gathered and their DNA was extracted and isolated. Six specific regions of the chloroplast were selected, PCR amplified, and sequenced. We predict that through the comparisons of the sequences from all species, unique and meaningful allelic combinations will be ascertained. These combinations will then allow for the identification of species with more than 95% confidence.

What inspired you to participate in undergraduate research?

"As a student going into college with an interest in biology and no real idea of what he wanted to do with his life, I sought out valuable experiences that could help direct my studies. This lead me to seek undergraduate research as a way to become as much a part of the scientific community as possible and learn how research functions at the graduate and post-graduate levels."

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

"After many long, introspective nights, I narrowed down my general interest in biology to specific interests in the fields of ecology and evolutionary biology. Driven by this realization, I contacted several labs that combined these areas of biology and set up meetings and lab tours with those that would take on an undergraduate researcher. After hearing Warren describe his research, I knew that I had found a good fit. In preparation, I learned the various lab protocols and began learning coding for data analysis."

Where was your research experience located?

"In the Romero-Severson lab at the University of Notre Dame."

What did you get out of your research experience?

"I continue to gain insight into research as a whole. I am learning how it is conducted, how it is reported, and everything in between. In addition, I am gaining a lot of experience in the field of plant-based genetics. Of course, it is also a lot of fun, and I'm meeting and interacting with some great scientists."

The Effect of Nutrient Inputs and Stem Boring Insects on Salt Marsh Dieback

Edward Lopez
Major: Biology
Advisor: Gina M. Wimp, Dept. of Biological Sciences, Georgetown University

Smooth cordgrass (*Spartina alterniflora*) serves as a foundation plant species in Atlantic coastal salt marshes, and performs critical ecosystem services, such as coastal protection, waste treatment, fisheries maintenance, carbon storage, and heavy metal and nutrient filtration which prevent eutrophication in nearby estuaries. However, these ecosystem services are threatened by human impacts, including, sea level rise, eutrophication, and most devastating, plant dieback. While proposed explanations for dieback differ tremendously according to geographic location, previous research in our lab demonstrates that while short-term pulses of nitrogen dramatically increase plant biomass, multi-year nitrogen inputs (a nutrient press) lead to a dynamic cycle of increased plant biomass in one year and dieback in the subsequent year. This may be due to a feedback cycle whereby fertilized plants suffer more frequent attacks from stem boring insects, resulting in dieback. **This study examines the relationship between nutrient levels, nutrient input frequency, and *Spartina* dieback.** To examine this relationship, we performed a nutrient addition experiment and examined the effects on aboveground living and dead biomass, along with stem borer herbivory. We found that: 1) level of fertilization affected stem borer herbivory and dieback in a non-linear fashion, 2) stem borer density explained 90% of the variation in dieback, even after accounting for nutrient level, and 3) stem borer activity continued in fertilized plots for years after fertilization treatments ceased. These results demonstrate that feedbacks between nutrients and herbivory can increase plant dieback in this critical salt marsh foundation species.

What inspired you to participate in undergraduate research?

Ever since I visited my first National park, I knew that I wanted to do something related to environmental research. I knew that undergraduate research would be the best away to answer many of the questions I had involving ecology and begin exploring different ways to help preserve the environment. Also field and lab work was always very appealing to me.

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

I began researching for REUs early into the beginning of the spring semester through the NSFs website. I found different environmental based programs that interested and began filling out applications. I prepared by asking for letters of recommendations from my mentors and professors and began preparing a personal statement. I also prepared a resume that outlined my research experience and qualifications.

Where was your research experience located?

Georgetown University

What did you get out of your research experience?

It was my very first time in D.C. and it was one of the best summers that I have ever had! I also made a ton of new friends, saw some amazing sites and met so many other potential mentors. The different workshops put on by the program has prepared me in writing/researching grants, how to write a paper, publishing, applying for graduate school and so much more. It really was everything and more I could ask for in a summer.

Investigating Organ Pipe Structural Differences Produced by Sand, Cloth, and Hammer Casting Techniques

Sarah Maazouz
Major: Chemistry
Advisor: Jon P. Camden, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Chaoxiong Ma

Organ pipes are individually crafted to produce the best possible sound. To create the ideal organ pipe, the best metal alloy must be used to produce a high-quality sound, while maintaining a long-lasting structure. For centuries, organ craftsmen have worked to produce this perfect balance, but it has remained unknown whether methods of organ pipe creation influence the metal alloy chemical structure, which may or may not result in longer-lasting, better sounding pipes. In this study, three uniquely cast metal alloys provided by the Paul Fritts and Company organ makers will be analyzed for difference is elemental and chemical structure. The three common methods of organ pipe casting being analyzed include, sand-cast, sand-cast hammered, and cloth-cast. Each organ pipe sample contains differing elemental composition, of which were reported by Paul Fritts & Company. Preliminary observation was obtained through optical microscopy. Further investigation of specific elemental differences was performed using Scanning Electron Microscopy (SEM) coupled with X-Ray Diffraction Spectroscopy (SEM-EDX). Differences within organ pipes will provide a basis for organ- pipe makers to adjust techniques to obtain higher-quality pipes.

What inspired you to participate in undergraduate research?

"Growing up, I broke almost every toy I owned. I always wanted to know why they worked the way they did. That same curiosity led me to do some independent research in high-school. It's a general love for hands-on experiential learning that inspires me to continue throughout my time as an undergrad here."

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

"First semester of my freshman year, I was extremely eager to take advantage of the research opportunities available at Notre Dame. I had spent plenty of time reading faculty profiles to find projects that interested me, and met with a few of those professors. In the end, I decided to join the group whose professor was already a great mentor to me, and whom I trusted would challenge me the most both in and out of the lab."

Where was your research experience located?

"University of Notre Dame"

What did you get out of your research experience?

"The group community I worked with was such a pleasure to be around. Although many of the graduate students and post-docs have left to new jobs, I know I will be able to contact them for any advice in the future. Since it was my freshman year, I was able to build a foundation of lab techniques and scientific knowledge pertaining to my future studies."

[Re]Evaluating the Cost of Electricity in Hospitals with Unreliable Energy - VSL/E Metric

Brady McLaughlin
Major: Physics-in-Medicine
Advisor: Dr. Abigail Mechtenberg, Dept. of Physics + ND Energy, Energy & Sustainable Development Research Group
Coauthors: Moses Musaazi, Makerere University Fr. John Makanda, Dr. Lydia Nanjura, College of Engineering, Design, Art, and Technology, Dr. Mark Shrime, Harvard Medical School, Ugandan Martyrs University and Mountains of the Moon University, Business

This research defines a new term called VSL/E based on value of a statistical life (VSL-$USD) and energy failutre based on electricity capacity shortages (kWh). Building upon four peer reviewed articles that highlight either a health care facilities' published optimal energy design simulation or actual measured failure rates, we modeled nine VSLs based on three elasticities for four countries: Iraq, Ghana, Uganda, and Bangladesh. VSL/Es were also proposed based on each of those VSLs. Additional VSL/Es were obtained from research over Summer 2017 from in-person research travel to Fort Portal, Uganda and evaluation of hospitals and power failures there. Results suggest that health care electricity costs should include not only typical levelized cost of electricity (LCOE: $0.03-3.00 kWh) but this new VSL/E ($5-$500,000 kWh) analysis which is orders of magnitude larger and should not be ignored.

What inspired you to participate in undergraduate research?

I was inspired to do undergraduate research by the ability to make a lasting contribution to human knowledge and make a positive difference in the world the way that I best know how.

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

When I was looking for research positions, I emailed Dr. Mechtenberg asking for a research position, and it worked. To prepare, I continued to pay attention in physics class so that I would show up with some knowledge, and ask Dr. Mechtenberg what I could do to get up to speed so that I could be a more useful research assistant. This involved reading many research papers in the area of energy and health, including many of Dr. Mechtenberg's papers.

Where was your research experience located?

Over the summer, my research experience was located in Fort Portal, Uganda, at Ugandan Martyrs University, and back at the University of Notre Dame.

What did you get out of your research experience?

What I got from my research experience was an incredible experience in Uganda, where I was able to see just how incredibly capable some of our co-workers there are, and how amazing the country and the people in it are. I also got to learn how to think on my feet, and how design works as a process, going from what's available to something that works for the end goal.

Effects of Concussion on a Computerized Visual Working Memory Task

Margaret Meserve
Major: Neuroscience and Behavior
Advisor: Dr. Nathan Rose, Dept of Psychology, University of Notre Dame

Although the long term effects of concussion and mild traumatic brain injury on standard neuropsychological tests may be negligible, it is unclear whether there are any lingering effects that are potentially detectable on more sensitive measures of psychophysiology or working memory. The purpose of this study was to examine associations between self-reported concussion history and visual working memory. Participant's pupil size was continuously measured while they performed a visuospatial working memory task requiring recall of a series of 3-9 locations presented one at a time on a 4 x 5 grid. The results did not show a significant difference between participants who had never experienced a concussion (n= 37, M=0.87, SD =0.042) and those participants who had reported experience at least one concussion (n=17, M=0.85, SD=0.060). Although there was no significant difference in pupil sizes between groups, there was overall effects of set size and experiment phase. The results suggest that visuospatial working memory is not sensitive to lingering effects of concussions experienced between 2012-2016. Future analyses will focus on patterns of eye-movements during visual working memory performance, and future study will compare these effects before and after participation in a contact sport (boxing).

What inspired you to participate in undergraduate research?

I really enjoyed my time in Intro Biology Lab and wanted to look more into research experiences around campus. Mostly, I wanted to see if academic research was a career that I would be interested in pursuing.

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

I have been working in the Rose Lab for a full school year after a recommendation from an upperclassman who needed help on his thesis. I asked my professor to stay on during the summer since I knew that we had a lot of work to do to make advancements in our projects. I got a job as a summer RA on campus to pay for my room and board.

Where was your research experience located?

The University of Notre Dame

What did you get out of your research experience?

Besides spending an amazing summer at Notre Dame, I learned so much this summer. Mostly, I worked on learning different computer programming skills in order to analyze large quantities of data efficiently and several different statistics pathways. This experience definitely influenced my career plans and interest in research.

The Role of Iron in Neuronal Development

Saam Mojtahed
Major: Neuroscience and Behavior
Advisor: Dr. Charles R. Tessier, Indiana University School of Medicine – South Bend
Coauthors: Samuel Rudisill

Autism spectrum disorders (ASDs) are mental illnesses characterized by impairment in various cognitive skills including communication, forming relationships, and understanding language and abstract ideas. Over the years, multiple reports have shown that deficiencies in certain trace metals are associated with autistic patients. In particular, low maternal iron during pregnancy was found to be a risk factor for the disorder. Iron is well known to be required for proper neuronal development, however it has not been determined whether iron affects the brain directly. We are therefore studying the role of iron in neuronal development in the well-characterized Drosophila model of Fragile X Syndrome (FXS). FXS is an ASD and is caused by the silencing of the fragile X mental retardation (FMR1) gene. We are investigating the synaptic development of the Drosophila small ventral lateral neurons, which comprise a circuit involved in regulation of circadian activity. We are analyzing the role of iron by manipulating dietary levels of this metal via supplementation or chelation to determine how changes in iron content affect the structure of this system. This study intends to improve our understanding of the mechanisms underlying FXS and neural development to create opportunities for more innovative therapeutic targeting and pharmacological development.

What inspired you to participate in undergraduate research?

"I was driven by my scientific curiosity and passion for learning to go beyond my neuroscience courses and creatively apply the material I had been learning in my classes."

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

"I reached out to Dr. Tessier in the summer following my freshman year after searching for opportunities to engage neuroscience research and finding his work on Fragile X Syndrome to be particularly interesting. During my various undergraduate lab courses, I gained some of the skills and familiarity with scholarly literature necessary to perform research in a lab."

Where was your research experience located?

"Harper Cancer Research Institute – University of Notre Dame and Indiana University School of Medicine – South Bend"

What did you get out of your research experience?

"From my time in the Tessier Lab, I have continually become better able to articulate my thoughts and formulate my ideas in a research setting. Furthermore, I have learned various laboratory techniques that I believe will help me throughout my career and in future research experiences. In the process, I have explored and cultivated my interest in neurodevelopmental disorders and the pursuit of better treatments and cures.

Microglia exit the spinal cord and bring debris into the CNS

Lauren A. Green[1,2], **Julia C. Nebiolo[1]**, and Cody J. Smith[1,2]
Degree: Neuroscience and Behavior
Research Mentor: Dr. Cody J. Smith[1,2]
Affiliation: Department of Biological Sciences[1] and The Center for Stem Cells and Regenerative Medicine[2] at the University of Notre Dame, Notre Dame, IN.
Timeline of Research: November 2016-Present

Regeneration of nerves requires the clearance of debris. Microglia and macrophages are the cells responsible for phagocytizing debris in the CNS and PNS respectively. Their phagocytic ability within their CNS and PNS domains are well characterized. During some injury cases, macrophages can leave the PNS and enter the CNS, however the ability for microglia to leave the CNS and enter the PNS is poorly understood. To address this, we use confocal time-lapse imaging coupled with laser ablation to create injuries in PNS-located sensory nerves of transgenic zebrafish. We observed microglia leaving the CNS to phagocytize peripheral debris, bringing debris back into the CNS, and carrying it throughout the animal. Additionally, microglia appear to be deterred by the presence of macrophages. To investigate this further, we singly ablated macrophages and observed immediate microglial response. We compared microglial response time to injury between animals with and without macrophages and determined that microglia respond faster in the absence of macrophages. This further suggests that debris clearance is more efficient in the absence of macrophages and supports the hypothesis that microglia leave the CNS to phagocytize PNS debris. We seek to further investigate this hypothesis and the implications this could have towards axonal regeneration.

What inspired you to participate in undergraduate research?
"I've always had a passion for asking questions. In this capacity, I can gain experience and tools to answer my questions."

How did you get your research position, and what preparation did you undertake for it?
"I narrowed down what kind of research I was interested in and investigated where such research was taking place. I read the work of professors then I reached out to them and indicated my interest in joining their lab."

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

What did you get of your research experience?
"I've been awarded with incredible lab experience and mentorship. My experience gave me new friends and opportunities to learn how to conduct research, write abstracts, and present results."

The Design Brain

Leslie Omeeboh
Major: Neuroscience and Behavior; French Language and Culture; Pre-Health
Co- Advisors: Dr.Abigail Mechtenberg, Dept. of Physics, Nancy Michael Director of Undergraduate Studies, Neuroscience and Behavior, University of Notre Dame

Imperialism and Colonialism are prevalent in international sociological discourse. The mechanism of physical and psychological violence via language, religion, industry - among other issues-and the legacy, of so-called underdevelopment, have had notable implications on the lives of formerly colonized African states. However, few researchers outside of sociology are listening. Meanwhile, in the US, there has been recent compelling neuroscience research that suggests that low SES status, one of the legacies of colonialism, is correlated to shifts in brain development due to early life stress. Furthermore, several brain areas, notably the HPA axis, have been implicated in the transgenerational effects of violence- again, another legacy of colonialism. Interestingly, the psychological fracture that has permeated all aspects of post-colonial life have engendered the paramount need for hope in the future and abilities of Africans whose colonial history has proliferated the unfortunate belief that Africans are not capable of creating new knowledge axioms. However, with physical, sustainable design -which marries art and science design- one may see a resurgence of hope. This means a relationship between hope and design that can have consequences implicated beyond the realm of science. There are two neuroscience-sociology-psychology transdisciplinary methodologies that have been generated to begin the attempt at capturing approaches to measure various aspects of moving from, oppression to empowerment, in which oppression is manifested in the problematic, This Is Africa(TIA)1 -(Afropessimism) and empowerment is designated as TIA2 (This Is Africa hope). One methodology looks at a re-designed stroop measure, using pre-existing algorithms to record reaction time, which will be utilized to detect hope amongst energy designers in Uganda. The second methodology uses a fMRI scan to compare neural activity between energy designers and traditional energy technicians, followed by regressions that analyzes the relationship of a) hope to design, b) hope to brain activity and c) design to brain activity. The regressions aim to determine whether or not a statistical difference exists in brain activity of those impacted by hope, via energy design and those not exposed to energy design. Due to the methodological approach, there are no claims but the results will inform further research. Preliminary methodologies will be presented and discussed in detail.

What inspired you to participate in undergraduate research?

I am fortunate to have many passions and I wanted, needed, to explore them. Traditional classroom experiences seemed insufficient for that ordeal but research proved a great way to synthesize and further develop and explore my passions. It also allows great hands-on learning that emphasizes the importance of outside classroom experiences, to which I am testament.

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

After hearing my physics II lab professor and present the end of the year project, in connection to her research, I was fascinated- as it immediately resonated with the current research I was pursuing at the time. I approached her, post-lab, to discuss the research, and my interest, and the discussion culminated in her inviting me into her lab group. My preparations for the lab included my two prior research- in psychology and, independent, psycho-historical trans disciplinary research. Furthermore, the academic labs played a tremendous role in preparing me for the research undertaking.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

I was reminded of the art of science, the importance of perseverance and tenacity, the beauty in failure, the grace of not knowing and the joy in learning and pursuing passions. In addition to my past research, I learned grant writing, honed my public speaking, and became more comfortable with discussing research with people, and experts, from different disciplines. Research has definitely impacted the development of my intellectual virtues and has paved the path for future studies.

Comparing hydraulic resistance to drought of tree species in the Northern temperate deciduous forest

Angela Pantell
Major: Environmental Science
Advisor: Ben Castro, Pontificia Universidad Católica de Chile

This study aimed to compare the hydraulic drought resistance capabilities of different tree species in the Northern temperate deciduous forest. Species differ in the ability of their xylem to resist embolism and hydraulic failure caused by the dramatic decreases in water potential during droughts. Climate change is predicted to increase the frequency of droughts in these areas of the Northern hemisphere, so having an understanding of the ability of individual species to resist drought is essential for anticipating how these forest communities could change in the future. We sampled three gymnosperm species and three angiosperm species using a vacuum apparatus to measure embolism and a pressure chamber to measure water potential. These measurements were used to construct xylem vulnerability curves to compare the water potential at which 50% of hydraulic conductivity was lost (Ψ_{50}) as well as the range between 50% and 88% loss of conductivity (hydraulic safety margins) of these species. We found that, contrary to our original hypotheses, the angiosperms had more negative Ψ_{50} points and larger hydraulic safety margins than the gymnosperms. This suggests that the gymnosperms could be at higher risk to drought-induced mortality caused by climate change than the angiosperms. This information can be used to ensure that the Northern temperate deciduous forest is managed in a way that protects threatened species and preserves the unique communities of these forests.

What inspired you to participate in undergraduate research?

I have always loved being involved in research and being able to ask and answer meaningful questions. I was very excited to perform this research to learn how a unique forest type is at risk due to climate change.

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

I applied to UNDERC through the standard application released every Fall. We had a one-credit class in the Spring semester to prepare for our summer research.

Where was your research experience located?

University of Notre Dame Environmental Research Center – East

What did you get out of your research experience?

I learned a lot about plant physiology and how this knowledge can be applied to understand human impacts on unique ecosystems. I got better at scientific writing and research as well.

Determination of Cold Tolerance in Switchgrass (Panicum virgatum L.) Varietiesand Plant Breeding Lines

Henry Perry
Major: Science Pre-professional
Advisor: Alan G. Taylor, School of Integrative Plant Science – Horticulture Section, Cornell University

Biofuels comprise an important sustainable energy source. Grasses, especially switchgrass, are renewable biofuel primary materials that are easy to grow, process, and store. Research on switchgrass for use in biofuel production has experienced resurgence in recent years as an alternative to fossil fuels. The main goal of this project was to compare germination rates via laboratory germination tests in order to select for cold tolerance in switchgrass breeding lines for biofuel production. In the first experiment, treatments included seeds from commercial cultivars, "Cave-in-Rock," "Carthage," "Shelter," and "Kanlow," that were moderately sensitive to low temperatures and obtained from a nursery in Ithaca, NY and from commercial seedlots. Experiment 1 also included seeds from seedlings through 3 generations of selection and from those selected for cold tolerance and rapid germination from the USDA Plant Conservation Center in Big Flats, NY. Experiment 2 included treatments organized by groups of breeding lines that were also previously selected for cold tolerance and fast germination. Experiment 2 was conducted to further select for decreased dormancy and increased cold tolerance in groups of switchgrass breeding lines. Treatments were identified by row, individual plant number, and the year in which the nursery was established (e.g. 115-13-2009). The results demonstrated very successful selection for cold tolerance in breeding lines of switchgrass, as seen especially in the nursery-grown plants of commercial cultivars, CiR and Carthage. These results allow for agricultural expansion of biofuel primary materials to cold climates and areas with relatively short growing seasons.

What inspired you to participate in undergraduate research?

I love agriculture and have been pretty convinced from early in my undergrad days that I wanted to go to graduate school in Agricultural Sciences. I knew that I should do some research in the field to find out if I liked it, and I did!

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

I took a Seed Science course at Cornell and the teacher mentioned that he was looking for an undergraduate to work on a research project the next semester. So I talked to him, committed, and did it. In retrospect, if he hadn't said anything in class, I would have asked him and every other ag science teacher until I found something.

Where was your research experience located?

Cornell University, School of Integrative Plant Science, Horticulture Section

What did you get out of your research experience?

This was my first research experience, so everything was educational. It was a lot more real than just doing a science class lab. I learned the importance of keeping a research schedule, seeking out collaboration with grad students and techs in other labs, and that it was OK to speak up when experiments didn't go as planned. I'm glad I did this before grad school because it gave me skills that I think I'm really going to use.

"Localization Patterns of a Chimeric RNA Containing Animal and Vegetal Localization Elements"

Will Phillips
Major: Biochemistry
Advisor: Dr. Paul Huber, Dept. of Chemistry and Biochemistry, University of Notre Dame

RNA localization is a vital process in cell development that controls the spatial and temporal distribution of RNAs and proteins. In particular, RNA localization has important roles in neuron development; mis-localized RNA transcripts are implicated in neurodegenerative diseases like spinal muscular atrophy. However, the mechanisms of localization and the proteins that control this process are not well understood. In order to investigate the mechanisms of RNA localization, experiments were carried out using *Xenopus laevis* oocytes; these cells contain well-characterized RNAs called Vg1 and An1 that localize to the vegetal and animal poles, respectively. The identity of the proteins that determine the directionality of localization is currently unknown. To pursue this question, a chimeric plasmid containing localization elements from both Vg1 and An1 was synthesized. This plasmid was transcribed to digoxigenin-labeled and fluorescently tagged RNA transcripts. These chimeric transcripts were then microinjected into oocytes; the localization patterns of these oocytes were compared to oocytes injected with An1, Vg1, or a nonspecific RNA synthesized from a Bluescript plasmid, as a negative control. The preliminary results revealed that the chimeric RNA exhibits a localization pattern similar to Vg1. These findings support a working model in which two proteins, hnRNP U and Staufen, determine movement to the vegetal, as opposed to the animal, pole.

What inspired you to participate in undergraduate research?

I love learning about the mechanisms behind biological processes in class, but taking part in undergraduate research made these concepts real. Instead of simply learning, I am able to work through problems and carry out experiments that contribute to our understanding of processes that have implications in human biology and medicine.

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

I have been working on projects related to RNA localization in the Huber lab since the spring of 2016. Based on data from experiments during the academic year, I crafted a proposal for summer research. I received funding from the College of Science Summer Undergraduate Research Fellowship.

Where was your research experience located?

University of Notre Dame, Stepan Hall of Chemistry and Biochemistry

What did you get out of your research experience?

I learned a lot: I improved my laboratory skills, read the relevant literature, and gained experience in experimental design and troubleshooting. I also gained valuable experience to guide me in my career decisions post-graduation. Finally, I was able to spend a summer with other undergraduates conducting

MRI Pilot Study: Investigation of Infant Brain Growth with Exposure to Anesthesia and Prolonged Sedation

Samuel Rudisill
Major: Neuroscience and Behavior
Advisor: Dusica Bajic, MD, PhD, Department of Anesthesiology, Perioperative and Pain Medicine, Boston Children's Hospital, Boston, MA
Coauthors: Chandler R. L. Mongerson, Russell W. Jennings, Patricia E. Grant, Dusica Bajic

Some infants undergo anesthesia and prolonged sedation early in life. The effects of such treatment on the developing brain remain largely unknown. We utilized Magnetic Resonance Imaging (MRI) to evaluate brain growth in *full-term* infants younger than 12 months undergoing numerous procedures and prolonged sedation. In this study, we evaluated efficiency of a novel automated segmentation tool, Morphologically Adaptive Neonatal Tissue Segmentation (MANTiS), in infants younger than 12 months of age (both *full-term* and *premature*). We also hypothesized repeated exposure to anesthetics and prolonged sedation is associated with delayed brain growth in *full-term* infants. Evaluation of MANTiS efficiency in segmenting the infant brain for estimation of *total intracranial* and *cerebrospinal fluid* (CSF) volumes, and subsequent calculation of *total brain volume*, was done using T2-weighted infant MRI images. We extended preprocessing steps to include: (1) simple watershed scalping to remove skull tissue, (2) FAST Bias Field Correction to normalize tissue intensity and ensure proper registration, and (3) alignment on the center of mass to orient the image to the neonatal template. MANTiS automated segmentation masks for intracranial space and cerebrospinal fluid were compared to manually edited and/or thresholded segmentations to determine classification accuracy and subsequent volumes. Final estimated volumes were compared between f*ull-term* patients and controls to determine the effects of anesthesia and prolonged sedation on brain development. MANTiS underestimated intracranial volumes by only 2.35±2.88%. There was no difference in accuracy between infants younger and older than 6 months. However, MANTiS overestimated CSF volume by 46.23±25.54%. Application of a 20% threshold reduced this error to an underestimation of 3.46±3.40%. Quantification of *absolute* intracranial, CSF, and total brain volumes were shown to have a positive relationship with age in both full-term patients and controls, with the exception of CSF in patients. Furthermore, averaged *normalized* CSF volumes in *full-term* patients showed a 4.16% greater proportion of intracranial space than controls at the expense of total brain volume. One should take into consideration possible minor errors in segmentation when applying MANTiS to larger groups. Our data also report increased CSF volume in full-term infants exposed to anesthesia and prolonged sedation. Although this data implicates attenuated brain growth with such treatment, future studies with larger patient samples are needed. Whether these changes are global or region-specific also remains to be investigated.

What inspired you to participate in undergraduate research?

"Although I enjoyed learning in the classroom, I sought the opportunity to apply those lessons to real world questions in hopes of making tangible strides in science as an undergraduate. Participating in undergraduate research is a great way to dive into a specific field and work to answer novel scientific questions."

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

"Google is a wonderful tool. I submitted a short personal statement in addition to my transcript and CV, and I was offered an interview. With my research background, there was not much preparation to do other than to read publications pertaining to the field of pediatric anesthesia prior to beginning the internship."

Where was your research experience located?

"Dept. of Anesthesiology, Perioperative and Pain Medicine, Boston Children's Hospital, Harvard Medical School, Boston, MA"

What did you get out of your research experience?

"I had the opportunity to work alongside some of the brightest minds in medicine to take on an issue that affects one of the most vulnerable patient populations. This ten-week internship pushed me in ways I have never been challenged before, and I was very excited to obtain results that led to an award-winning poster presentation at a national medical student conference."

A Case Series Examining the Effects of Anesthesia and Prolonged Sedation on Premature Infant Brain Growth: Is There Reason for Concern?

Samuel Rudisill
Major: Neuroscience and Behavior
Advisor: Dusica Bajic, MD, PhD, Department of Anesthesiology, Perioperative and Pain Medicine, Boston Children's Hospital, Boston, MA
Coauthors: Chandler R. L. Mongerson, Russell W. Jennings, Patricia E. Grant, Dusica Bajic

Premature birth (gestational age <37 weeks) has been associated with decreased tissue volumes in various parts of the brain, resulting in cognitive impairment. In addition, preterm infants show a higher incidence of complication and pathology, sometimes requiring surgical intervention. Long gap esophageal atresia (LGEA) is a birth defect in which a portion of the esophagus is missing, proving lethal when left untreated. The Foker Procedure for LGEA repair is complex and time-consuming. In addition to perioperative anesthesia, infants are routinely administered opioids and benzodiazepines for pain and sedation management throughout the Foker Process. This series case study seeks to characterize and display the effects of exposure to anesthesia and prolonged sedation on the developing brain of three preterm infants by quantifying brain volumes before and after treatment. 3 premature infants underwent brain MRI scans (1) prior to treatment and (2) following surgical repair of LGEA requiring anesthesia and prolonged sedation (≥5 days). Brain tissue classification was performed using Morphologically Adaptive Neonatal Tissue Segmentation (MANTiS) with manual editing of tissue masks. Absolute and normalized cerebrospinal fluid and total brain volumes were compared before and after treatment to analyze effects on brain development. Former preterm patients experienced 8±5 anesthesia events, totaling 34.49±19.56 hours of exposure between pre- and post-treatment scans. Further, patients were sedated with morphine and/or midazolam for 71.67±48.68 days between scans. Although *absolute* cerebrospinal fluid and total brain volumes were each found to increase between scans with near significance, *normalized* volumetric analysis of the total brain showed a 6.68±4.64% decrease in size as a proportion of intracranial volume. No significant correlation was found between anesthesia events, anesthesia exposure, or sedation exposure with reduction of normalized brain volume. Normalized brain volume is decreased in premature infants exposed to anesthesia and prolonged sedation, implicating attenuated brain growth. However, because no significant correlation was found between anesthesia events, anesthesia exposure, or sedation exposure with this decrease, the presence and severity of pathologies in the brain may also play a role. Further study will require more infants to undergo brain MR imaging for a more precise determination of the relationship between brain growth and anesthesia and sedation exposure.

What inspired you to participate in undergraduate research?

"Although I enjoyed learning in the classroom, I sought the opportunity to apply those lessons to real world questions in hopes of making tangible strides in science as an undergraduate. Participating in undergraduate research is a great way to dive into a specific field and work to answer novel scientific questions."

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

"Google is a wonderful tool. I submitted a short personal statement in addition to my transcript and CV, and I was offered an interview. With my research background, there was not much preparation to do other than to read publications pertaining to the field of pediatric anesthesia prior to beginning the internship."

Where was your research experience located?

"Dept. of Anesthesiology, Perioperative and Pain Medicine, Boston Children's Hospital, Harvard Medical School, Boston, MA"

What did you get out of your research experience?

"I had the opportunity to work alongside some of the brightest minds in medicine to take on an issue that affects one of the most vulnerable patient populations. This ten-week internship pushed me in ways I have never been challenged before, molding me into a stronger researcher and medical school applicant."

Systems Genetics Analysis to Identify Gene Candidates Associated with Axon Death in Optic Nerve and Glaucoma

Eric Sah
Major: Applied and Computational Mathematics and Statistics
Advisor: Monica M. Jablonski, Dept. of Ophthalmology, Hamilton Eye Institute

Glaucoma is a multifactorial disease that causes irreversible blindness. Loss of retinal ganglion cells (RGCs) is indicative of retinal neurodegenerative diseases with glaucoma being one of them. Intraocular pressure (IOP) is another leading factor in glaucoma. However, not all cases of glaucoma show elevated IOP. Because axon death in retinal ganglion cells lead to vision loss, retinal ganglion cell axon necrosis was studied as a possible factor for glaucoma. Systems genetics analysis was used to examine optic nerves of strains belonging to BXD family to identify gene variants associated with glaucoma. Using GeneNetwork, positional candidates were narrowed down under seven criteria using QTL mapping, Pearson correlation, and single nucleotide polymorphisms (SNP). Four gene candidates *Apopt1*, *Cdc42bpb*, *Klc1*, and *Tmem179* were identified as genes that modulate axon death in RGCs.

What inspired you to participate in undergraduate research?

"I hope to become a physician someday. I believe that a physician must be able to see a problem and find a way to solve it by thinking critically and independently. Participating in undergraduate research is a way to improve those skillsets."

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

"I became interested in retinal neurodegenerative diseases during my second semester of sophomore year. I sent Dr. Jablonski an email explaining who I was and why I am passionate about glaucoma specifically. She offered me an interview and then an intern position in her lab for the summer. My previous research experiences at Indiana University School of Medicine - South Bend and reading her publications helped me transition into her research lab."

Where was your research experience located?

"Hamilton Eye Institute"

What did you get out of your research experience?

"I had a chance to work with massive amounts of data during my summer. This was quite different from my previous wet lab experiences at Indiana University School of Medicine – South Bend. I learned how important it is to be able to interpret data in a useful way."

Application of Machine Learning Techniques to Study ttH Events

Kaitlin Salyer
Major: Honors Physics and French
Advisor: Kevin Lannon, Dept. of Physics, University of Notre Dame

At the Large Hadron Collider in Geneva, Switzerland, protons and heavy ions are collided at speeds just shy of the speed of light in order to find answers about the most fundamental building blocks of the universe. One of the many possibilities that can result is the production of ttH events, or the production of a Higgs Boson with a top quark-antiquark pair. These are very rare events, especially in cases where these particles decay leptonically, in which we are particularly interested as they may hold important information that will help us better understand Higgs Bosons and top quarks individually as well as how they interact together. The rarity of these events necessitates the usage of machine learning (ML) algorithms to maximize the accuracy of separating ttH events from a huge amount of very similar-looking events. The strength of the ML algorithms is determined by how well they are trained, which requires feeding the computer large amounts of simulated information and a collection of variables for the computer to use as guidelines for analysis. Past and current investigations focus on pushing the limits of these algorithms with the intention of making the computer better at selecting out the most interesting events to study these particularly rare and exciting events.

What inspired you to participate in undergraduate research?

Research in Notre Dame's High Energy Physics department is one of the experiences I have loved most about my time as an undergraduate student. I have really enjoyed learning more about what it means to be a scientist and to feel like I can help answer some of the most exciting questions of our time. I spent last semester and summer fully immersing myself in the field when I studied abroad in Geneva and worked on this project at CERN.

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

Doing research was a required portion of my study abroad program, but I prepared for it by beginning to learn about this project in the semester before leaving the United States.

Where was you experience located?

Previously, CERN, Geneva, Switzerland; currently, the University of Notre Dame

What did you get out of your research experience?

Through conducting this research, I strengthened my skills in computer programming and science communication. Participating in this research continuously reminded me how exciting it is to do science and that my identity as an undergraduate does not restrict my ability to help find answers to important questions.

Relating Cut and Paste Invariants and Topological Quantum Field Theories

Matthew Schoenbauer
Major: Honors Mathematics
Advisor: Carmen Rovi, Department of Mathematics, Indiana University, Bloomington

In this presentation we shall be concerned with a relation between topological quantum field theories (TQFTs) and cut and paste invariants. These cut and paste invariants, or *SK* invariants, are functions on the set of smooth manifolds that are invariant under the cutting and pasting operation. There are also weaker invariants, called *SKK* invariants, whose values on a manifold depend on both the cut and paste class and the gluing diffeomorphism. Here we investigate a surprisingly natural group homomorphism between the group of invertible TQFTs and the group of *SKK* invariants and describe how these groups fit into an exact sequence. We conclude in particular that all positive real-valued *SKK* invariants can be realized as restrictions of invertible TQFTs.

What inspired you to participate in undergraduate research?

"I've always loved mathematics, and I couldn't have imagined a better way to spend my summer than learning a lot of topology and using it to come up with an awesome connection between two previously unrelated ideas."

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

"I applied to a number of REU's and got into the Indiana University, Bloomington, REU soon in the process. To prepare, I worked individually with Professor Frank Connolly on general and algebraic topology throughout all of last year, and did a good amount of reading on my own the first weeks of summer.

Where was your research experience located?

"Indiana University, Bloomington"

What did you get out of your research experience?

"I got the best summer of my life. I enjoyed every minute of the research, and in addition I got both a plethora of knowledge in the subjects of algebraic and differential topology and a publishable paper."

Quantifying Diacetyl in Commercial Products with Paper Analytical Device

Caroline Sherry
Science Preprofessional Studies and Theology
Science, Technology, and Values
Advisor: Marya Lieberman Dept. of Chemistry and Biochemistry, University of Notre Dame

The usage and concentration of unnecessary chemicals and carcinogens are often hidden under general classifications such as “food additive” or “natural flavoring”. One such chemical is diacetyl (2,3-butanedione), which is linked to neurodegenerative diseases and is a direct cause of pulmonary diseases. It is added with minimal regulation as butter flavoring in everyday products including food, beverages, cooking sprays, gum, and electronic cigarettes. Chronic exposure to diacetyl puts individuals at significant risk for lung disease and cancer. Developing an inexpensive, accessible paper analytical device (PAD) that qualitatively tests the concentration of this carcinogen can help address this public health issue, which has significant financial and medical consequences. Preliminary methods involved synthesizing a byproduct whose color intensity indicated the relative product formation. Creatinine and its precursor creatine were independently tested with permutations of diacetyl, α-naphthol, and potassium hydroxide. The reaction was successfully adapted from an aqueous environment to dry-chemistry: rapid, vivid color transformation confirmed strong product formation. Product formation was evaluated qualitatively and with graphical analysis to construct a sensitive standard curve to qualitatively evaluate diacetyl concentration based on pigmentation. Further experiments are needed to increase replicability of the reaction with different forms of diacetyl samples.

What inspired you to participate in undergraduate research?

My experiences participating in semester group projects on antibiotic resistance and ecological evolution in biology labs motivated me to become more involved with a long term project that would engage my passion and curiosity for science and ethics.

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

I did significant background research on synthetic chemistry before applying for a summer research grant from the Reilly Center for Science, Technology, and Values. Through the department’s support I was able to begin summer research with Dr. Lieberman’s lab in 2016.

Where was your research experience located?

Our lab is located on campus in Stepan Chemistry Hall.

What did you get out of your research experience?

My research experiences over the summer and school year have developed my creativity, critical thinking, and scientific writing skills, especially in overcoming errors and unexpected data. reasoning my way through inconsistent results has made me aware of not automatically accepting correlation as causation. This experience has shown me how ethics and public health intersect with chemistry and research, while also providing a realistic understanding, appreciation, and passion for the time and effort required for progress in research.

Inhibition of the Androgen Receptor N-Terminal Domain in Castration Resistant Prostate Cancer

Helen Streff
Major: Biological Sciences
Advisor: Dr. Scott Dehm, Department of Laboratory Medicine and Pathology,
University of Minnesota, Twin Cities

Prostate cancer claims 26,000 American lives each year despite its 99% 5-year survival rate. The androgen receptor (AR) is an important transcription factor in prostate cancer. Thus, therapies for metastatic prostate cancer typically aim to inhibit the AR through chemical androgen deprivation. However, this is not curative, because prostate cancer cells can become resistant to such therapies and progress to castration resistant prostate cancer (CRPC). In CRPC, AR alternative splicing occurs, giving rise to AR variants that lack the ligand binding domain (LBD). Because these AR variants retain the transcriptionally active N-terminal domain (NTD), inhibiting the AR NTD may be a more promising approach for developing new therapeutics. A high-throughput screen of 100,353 compounds led to the identification of four potential inhibitors of the AR NTD. Cell growth inhibition by these compounds was tested using a crystal violet assay on two prostate cancer cell lines which are driven by the AR or AR splice variants (LNCaP and 22Rv1, respectively), and as controls, we tested two prostate cancer cell lines that lack expression of the AR (PC-3 and DU145). The results indicate that three compounds successfully target the AR. Additional studies are warranted to characterize the AR NTD specificity of these compounds, which could lead to new therapies that improve the lives of men with advanced CRPC.

What inspired you to participate in undergraduate research?

I love trying to solve the questions that seem unanswerable and impossible. My older sister started doing organic chemistry research two years before I decided to start research, and her positive experience further inspired me to join a research lab.

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

I knew I wanted to return to Minnesota for the summer, so I did internet searches of programs at the University of Minnesota, and the Life Sciences Summer Undergraduate Research Program (LSSURP) fit all the criteria I was looking for in a program. To prepare for the summer, I read literature, contacted my PI, wrote a biography for the other students in the program, and attended a weekend orientation in northern Minnesota.

Where was your research experience located?

University of Minnesota, Twin Cities

What did you get out of your research experience?

I got a super fun summer that was filled with meeting new people from around the country, learning new lab techniques, becoming more competent working independently on a research project, and exploring the Twin Cities. The program provided a lot of information regarding graduate school and helped me discern what I want to do after graduation.

FFT Analysis in Energy Systems for Smart Grid Control using Multiple Storage Devices

Robert Stiller
Major: Physics
Advisor: Dr. Abigail Mechtenberg, Dept. of Physics, University of Notre Dame
Coauthors: Dr. Abigail Mechtenberg

A FFT analysis of yearly power loads and sources data results in unexpected key frequencies. These unique frequencies correspond to specific storage devices. This analysis demonstrates the need for hybridization of energy storage devices for optimal control of a smart grid. Furthermore, the juxtaposition of the FFT analysis of energy sources and loads yields a straightforward discussion about the disconnect between loads, storages, and sources. Unlike other research focusing on energy sources and/or power loads with one or two storage devices, this research demonstrates the superiority of an energy systems based approach to storage over a component-based approach. Future smart grids must include hybridization of storage to deal with noise versus vital system behavior and this FFT analysis seems promising moving forward.

What inspired you to participate in undergraduate research?
"I love solving problems—especially ones that haven't been solved yet."

How did you get your research position, and what preparation did you undertake for it?
"I heard Dr. Mechtenberg give a talk to sophomore physics majors and reached out to her."

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

What did you get out of your research experience?
"I learned how to conduct interdisciplinary research, write grants, and publish results. My research experience with Dr. Mechtenberg has provided a solid basis for my future graduate studies."

Groundwater's influence on agricultural ditch biogeochemical cycling

Audrey Thellman
Major: Environmental Science
Concentration: Earth Science
Advisor: Jennifer L. Tank, Dept. of Biological Sciences, University of Notre Dame
Additional Mentor: Martha Dee, PhD Candidate, Dept. of Biological Sciences, University of Notre Dame

Land use change in the Midwestern US and the subsequent application of fertilizer to agricultural fields has altered the fates of dissolved bioavailable nutrients, notably nitrate-nitrogen (NO_3-N), soluble reactive phosphorous (SRP), and ammonium-nitrogen (NH_4^+-N). To mitigate excess nutrient efflux, agricultural best management practices (BMPs) have been developed to increase permanent removal or assimilation of nutrients. To establish nutrient inputs from groundwater on an agricultural ditch located in Mentone, IN, I designed and installed groundwater wells located in two BMPs (two-stage ditch and forested reach) and a control trapezoidal ditch. Overall, groundwater inputs of NO_3-N, SRP, NH_4^+-N were minimal compared to other sources. For NO_3-N and SRP, tile drains remained the dominant source whereas the hyporheic zone contained the most NH_4^+-N. Among sites, there were no clear differences in nutrient concentrations. Wetlands and the saturated areas near streams are an important "last" biogeochemical environment for nutrient retention and expression. Studying these critical areas is an important part of reach-scale nutrient dynamics which can evaluate the potential for the mitigation of nutrient pollution from agriculture.

What inspired you to participate in undergraduate research?

"As an innately curious individual, I have always wanted to learn about how natural processes function. Additionally, I am passionate about protecting our world's water resources. The opportunity to participate in research this summer gave me a chance to contribute to my lab's goal of preserving water resources in the Midwest, US."

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

"I have been a member of the #streamteam (Tank Lab) since the spring of 2015. Upon returning from a summer spent designing my own research project at the University of Notre Dame Environmental Research Center (UNDERC), I was ready to undertake my own project in the lab. After receiving funding from the College of Science Summer Undergraduate Research Fellowship Program, I had the opportunity to take this project from concept to completion (while having a lot of fun)."

Where was your research experience located?

"University of Notre Dame and our field station in Mentone, Indiana"

What did you get out of your research experience?

"This project restated my love for the scientific method and for asking interesting ecological questions. I also learned how to write a proposal for a grant, design and execute a large-scale research project, and collaborate with other researchers on an otherwise understudied component of biogeochemical cycling and agricultural stream ecology"

Higher Levels of Heme Oxygenase-1 in Bone Marrow Mononuclear Cells in a Unique Tolerant Rat Strain that Lives Longer

Tiffany Toni
Major: Biochemistry
Advisor: John E. Repine, MD, Webb-Waring Professor, University of Colorado

Acute Respiratory Distress Syndrome (ARDS) is a severe disease associated with lung inflammation and edema. The full mechanism of ARDS is unknown, but the condition is associated with an influx into the lung of neutrophils that release reactive oxygen species and subsequent oxidative stress. A novel "tolerant" rat was discovered that resists ARDS development. A stable tolerant strain was created from this initial variant through multiple generations of cross-breeding. Tolerant rats survive after 66 hours of hyperoxia while all control rats die. Tolerant rats also live longer than control rats in non-hypoxic conditions and have many beneficial characteristics including a greater exercise capacity and weight gain resistance. It is currently unknown what induces the increased survival and fitness observed in tolerant rats.

My work investigated the levels of Heme Oxygenase-1 (HO-1) in bone marrow mononuclear (BMM) cells isolated from control and tolerant rats of both genders. HO-1 is an anti-inflammatory, antioxidant enzyme that we hypothesized would be elevated in the tolerant rats. HO-1 levels were tested using an ELISA assay. Our results illustrated that tolerant rats express more HO-1 in BMM cells than control rats. Furthermore, both control and tolerant female rats express more HO-1 in BMM cells than corresponding male rats. These results correlate with the observed increased life spans of tolerant rats, suggesting that HO-1 could be involved in the aging process or be applied as a predictive marker for a lengthened life span. Future directions include increasing the sample size, testing other rat strains, analyzing HO-1 at different time points in the aging process, looking at HO-1 levels post-hyperoxia, and investigating whether a similar relationship exists in humans. The latter could initially be addressed by measuring HO-1 levels in BMM of aging individuals.

What inspired you to participate in undergraduate research?

"I wanted to learn beyond the classroom, and once I started, I enjoyed it so much that I couldn't stop."

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

"I obtained my research position through the Colorado Undergraduate Summer Program (CUSP), which was an opportunity advertised by the Pre-Professional Office at Notre Dame. After submitting a research proposal based on the work I planned to undertake, the Notre Dame College of Science and the North Foundation generously provided funding for my research."

Where was your research experience located?

"Webb-Waring Center at the University of Colorado Anschutz Medical Center"

What did you get out of your research experience?

"My summer experience as part of CUSP allowed me to explore an avenue of research that is very different from my research on campus. From this experience, I was able to learn about how research is conducted in a different scientific field and also in a different part of the county. Additionally, this program included a clinical experience in the morning that exposed me to many areas of modern day medicine. Overall, this opportunity provided me with a way to integrate my clinical and research interests within the beautiful city of Denver, Colorado."

Effect of PTK7 Knockdown on Breast Cancer Cell Growth

Katie Uhler
Major: Science-Business
Advisor: Dr. Powel Brown, Department of Clinical Cancer Prevention, MD Anderson Cancer Center
Coauthors: Yanxia Ma, Lakshmi Bollu, William Tahaney, and Abhijit Mazumdar, Department of Clinical Cancer Prevention, MD Anderson Cancer Center

Triple-negative breast cancer (TNBC) is a subtype of breast cancer that does not express estrogen receptor, progesterone receptor, or HER2 receptor. An aggressive disease that affects a younger patient population, TNBC is difficult to treat due to its lack of receptor proteins. This project explored protein tyrosine kinase-7 (PTK7), a pseudokinase involved in the noncanonical Wnt pathway, as a possible target in treating TNBC. Initial analysis of data from Oncomine™ was conducted to confirm the elevated expression of PTK7 in TNBC cells. Next, PTK7 expression was knocked down in TNBC and non-TNBC cells so that these cells could be used in a cell growth assay to determine the effect of PTK7 expression on breast cancer cell growth. Kaplan-Meier survival curves were constructed to analyze the impact of triple negative status and relative PTK7 expression on the overall survival and cancer-related survival of patients. The results from this study indicate that PTK7 knockdown suppressed cell growth in both TNBC and non-TNBC cells but did so to a lesser extent in non-TNBC cells. Survival curve analysis shows that high PTK7 expression denotes lower overall survival for breast cancer patients. Future studies need to find downstream pathways affected by the knockdown of PTK7 in order to understand PTK7's mechanism of action and develop targeted treatments.

What inspired you to participate in undergraduate research?

"I wanted to apply the knowledge I gained in the classroom to explore a medical issue that could improve the lives of breast cancer patients."

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

"I applied for and was accepted to the MD Anderson Summer Undergraduate Research Program during the spring semester of 2017. Thanks to the generous contribution of a donor at Notre Dame, I was able to spend the summer in Houston doing triple negative breast cancer research at one of the most prestigious cancer centers in the world. I was able to meet the high expectations of my lab at MDA thanks to the training I received through completing introductory biology lab courses and working in Professor Mary Ann McDowell's lab at Notre Dame."

Where was your research experience located?

"MD Anderson Cancer Center in Houston, TX"

What did you get out of your research experience?

"Spending my summer at MD Anderson opened my eyes to the incredible world of cancer research. I vastly expanded my knowledge of cancer biology and repertoire of lab techniques. The work I did in lab gave me a new appreciation for the complexities of the scientific method and the power of statistics. Outside of the lab, I attended lectures given by renowned cancer researchers and shadowed physician scientists who apply their research in their clinics."

What types of books are Chilean parents of low SES reading to their children?

Brigid Walsh
Major: Neuroscience and Behavior
Advisor: Sarah Mustillo, Dept. Chair of Sociology, University of Notre Dame

Countless studies have shown the major role that development of early literacy plays on academic success later in life. In Chile, early literacy is just as important as in the US, but there is less of a culture of reading in the household and less access to books, especially for low SES families. To gather data on early literacy environment, in an effort to plan the best intervention, a program called "Un Buen Comienzo" gathered a large sample of data on early literacy environment in the classroom and at home in Chilean preschools and kindergartens. In this thesis, I look specifically at the types of book that parents of Chilean children of low socioeconomic status read to their children. After coding questionnaire responses from parents about the types of books they read to their preschoolers, and creating categories based on use, theme, genre and accessibility, I plan to look at correlations between types of books and socioeconomic status. Then I will relate the different types of books to later achievement. I am hopeful that knowledge of the types of books—or lack there of—that parents of low SES in Chile are reading to their children can help provide the best intervention and improvement of early literacy development.

What inspired you to participate in undergraduate research?

"I am very interested in early child development and knew that I wanted it to be the subject of my senior thesis. In talking with my research advisor, she helped me find a fit with my interests in practicing Spanish and researching in early literacy."

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

"I contacted Professor Mustillo (now my thesis advisor) and brainstormed about my research interests and desire to travel. She put me in contact with a professor at Universidad Católica whose research aligned with my passions. There was a long process of emailing back and forth, skype calls and proposal drafts, but I was lucky enough to get a grant from the Glynn Family Honors program to fund my travel and summer experience in Chile.

Where was your research experience located?

"Universidad Católica de Chile in Santiago, Chile"

What did you get out of your research experience?

"An amazing summer in Santiago, Chile right under the Andes Mountains. I got to form friendships with my Advisor and research team there and practice my Spanish in the process. I got to live with a host family, take the metro every day to UC's beautiful campus and experience a new culture that I grew to love."

History and Medicine: The Application of Pre-Modern Tuberculosis Treatments to Mycobacterium Smegmatis

Morgan Williams
Major: Science PreProfessional
Advisor: Evan Ragland, Dept. of History, University of Notre Dame and Kristin Lewis, Dept. of Biology, University of Notre Dame

Tuberculosis has long been a major cause of death in humans. In the past, it was a universal sickness that affected many, but today it mainly affects those living in developing countries. Unfortunately, its longevity as a disease has allowed it to develop significant resistance to multiple strains of antibiotics. This is making it significantly harder to treat effectively. This research looked to treatments done early in the history of medicine for a possible solution. There are two main schools of historical thought regarding antique medical treatments – that no historical treatments are worth investigating, or that all of them should be thoroughly tested for any efficacy. This research falls in the middle, in that an algorithm for choosing cures to actually test was developed in order to weed out cures that were less likely to work. Nine pre-modern sources were analyzed, taking a tally of each ingredient mentioned in treatments for "consumption", "phthisis", or "phthisicks". After determining the most common ingredients used and analyzing their chemical properties, six cures were chosen that had high proportions of the ingredients deemed most likely to have an impact. The cures were tested on *Mycobacterium smegmatis* using a disc assay, with gentamicin as the positive control.

What inspired you to participate in undergraduate research?

"I wanted to investigate something that combined two of my passions – medicine and history. I love learning about how things were done in the past, and the idea that something from history could help cure a disease today was very exciting."

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

"I came up with the project with the guidance of my advisor, Dr. Ragland, and applied for a DaVinci grant to complete the research."

Where was your research experience located?

"University of Notre Dame"

What did you get out of your research experience?

"I learned a lot more about career path I want to take, nominally that I want to work with people rather than do research. I loved doing my research and having the opportunity to problem solve on my own, but I prefer working with people. I also learned the importance of being flexible to new and unexpected challenges."

Dengue Vaccination by Pre-Vaccination Diagnostic Testing: An Epidemiological Evaluation

Yutong Yao
Major: Science Business
Advisor: Dr. Alex Perkins, Guido Camargo Ph.D., Dept. of Biology, University of Notre Dame

Dengvaxia® from Sanofi Pasteur has been recognized as the first licensed dengue vaccine recommended for selected countries by WHO. However, the population-level impact of this vaccine may be limited, particularly in low-transmission settings. Results from clinical trials indicate that vaccination of individuals with no prior dengue virus infection could elevate their risk of symptomatic or severe infection. A hypothetical pre-vaccination test has been suggested to assess whether potential vaccines have experienced a prior dengue virus infection, with the aim of relieving the elevated burden caused by unnecessary vaccination in low-transmission settings. In this study, I performed simulations of vaccination campaigns with and without the hypothetical test under various transmission intensity settings to determine the possible added benefit of this test. The transmission intensity under these scenarios were controlled by varying three major parameters within a stochastic, individual-based computational model that simulates dengue transmission dynamics in Iquitos, Peru. With another two parameters, sensitivity and specificity, the pre-vaccination test was added to the simulations and evaluated by calculating averted symptomatic and hospitalized cases relative to a scenario with no vaccination or with vaccination in the absence of the test. The primary results suggest that (1) high specificity of the test is more critical than high sensitivity in low-transmission settings, whereas the reverse is true for high transmission settings; (2) the pre-vaccination test could potentially nullify the negative effects of vaccination in low-transmission settings. These results suggest that a coupling of diagnostic testing and vaccination could be a promising dengue prevention strategy but that the properties of tests ideal for different settings may vary.

What inspired you to participate in undergraduate research?

"I am always looking for opportunities to learn beyond the curriculum. It is a great opportunity to explore something you have been interested in but never done before by applying what you have known."

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

"Interested in disease forecasting, I found Dr. Perkins and emailed him about research opportunities for undergraduates in his lab. I was in the lab for one year learning some basics of modeling and finishing a historical project before I started this research project.

Where was your research experience located?

"University of Notre Dame."

What did you get out of your research experience?

"The skills to read codes, analyze data and be efficient in experimental design. The cool opportunities to start from nothing and end up with novel discoveries. I also get opportunities to cooperate with peers as well as people from a wide range of background."

Comparison of Zebrafish Liver Histopathology after Acute Ethanol and Fructose Treatments

Wen Zhong
Major: Neuroscience and Behavior
Advisor: Chunyue Yin, Division of Gastroenterology, Hepatology, and Nutrition, Cincinnati Children's Hospital Medical Center
Coauthors: Jillian Ellis and Chunyue Yin

Hepatic steatosis, or fatty liver disease, is characterized by the accumulation of excess lipid within hepatocytes and can be classified as Alcoholic Liver Disease (ALD) or Nonalcoholic Fatty Liver Disease (NAFLD). The prevalence of both types of fatty liver disease has been increasing due to acute and chronic alcohol abuse as well as increased fructose consumption. Previous studies have shown that both ethanol and fructose exposure can injure the liver and induce steatosis in zebrafish larvae. Acute ethanol exposure has been shown to cause the activation of hepatic stellate cells (HSCs), which is the key cell type responsible for liver fibrosis. However, little is known about the effect of fructose exposure on HSCs. For this study, double transgenic zebrafish larvae, *Tg(hand2: EGFP; kdrl:ras-mCherry)*, were used to mark the HSCs and the intrahepatic vasculature, respectively. For the ethanol treatment, we treated the zebrafish larvae with 2% ethanol and compared their HSCs and liver morphology with their age-matched controls. For the fructose treatment, we treated the zebrafish larvae with 4% fructose or 4% glucose, which served as a calorie-matched control. When we compared the liver histology of the treated zebrafish with their respective controls, we found lipid accumulation in the hepatocytes of both fructose-treated and ethanol-treated livers, but not the control livers. By analyzing the average number of HSCs per liver, we suspect that HSC activation is less evident in fructose-treated livers when compared with ethanol-treated livers. This suggests that HSCs respond differently to the two insults.

What inspired you to participate in undergraduate research?

I wanted to get involved in research because I wanted to apply the skills I had learned in my lab classes at Notre Dame to solve problems in the real world.

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

I obtained my research position by applying to the Summer Undergraduate Research Fellowship program at Cincinnati Children's Hospital Medical Center during winter break.

Where was your research experience located?

Cincinnati Children's Hospital Medical Center

What did you get out of your research experience?

This was my first bench research experience and I really enjoyed getting to see how my project unfolded throughout the summer. The experiments were challenging and exciting and the project helped me better understand current health issues. My research experience at a hospital also gave me the opportunity to see how scientists, doctors, and health professionals work together as a team to improve the lives of people throughout the Cincinnati area and beyond.

Undergraduate Research Internship Information Night 2017 - Jordan 101

Plenary speaker is Lily Spatz, (Biological Sciences 2018), participated in the Summer Undergraduate Research Program (SURP) at the University of Iowa (genetics.grad.uiowa.edu/program/surp) within the Department of Genetics. The program consists of about 20 students, 5 specifically in genetics). Lily worked in Dr. Diane Slusarski's (https://biology.uiowa.edu/people/diane-slusarski) Zebrafish Lab, and looked at congenital visual disorders, specifically cataracts. During her talk, Lily will also provide students with information about how and where to search for internships; types of internship programs; and how to increase the chance of landing a great internship. Lily is currently conducting undergrad research in the Vaughan Lab (Notre Dame) studying combinatorial drug treatments for breast cancer. She plans to attend graduate school with the ultimate goal of working as either a clinical researcher or a genetic counselor.

Helen Streff (Biological Sciences 2020), took part in the University of Minnesota Life Sciences Summer Undergraduate Research Program (LSSURP) where she was part of the CREATE program (Cancer Research Education and Training Program). In the program, 60 students from around the country were placed in unique labs across the campus. She was in Scott Dehm's prostate cancer lab in the Masonic Cancer Center. (https://www.cancer.umn.edu/bio/cell-signaling-program/scott-dehm). Helen is interested in going onto graduate school with the goal of entering the pharmaceutical or biotech industry.

Kieran Phelan, (Biological Sciences 2019), conducted internships through the Cincinnati Children's Summer Undergraduate Research Fellowship (https://www.cincinnatichildrens.org/education/research/surf), where he worked in the gastroenterology department developing a model system for progressive familial intrahepatic cholestasis type II. He utilized human iPSCs to develop mature hepatocytes, with the goal of using patient cells to recreate diseased hepatocytes (http://dev.biologists.org/content/144/6/1056.long); in a later internship, he used CRISPR/Cas9 to create the disease phenotype in zebrafish, and tested the efficacy of this model.