FALL UNDERGRADUATE **RESEARCH FAIR**

Information Booklet

Thursday, October 28, 2021
Jordan Hall of Science
University of Notre Dame

UNIVERSITY OF NOTRE DAME | SCIENCE

College of Science – Fall Undergraduate Research Fair 2021

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!

Thursday Oct 28th, 2021 | Jordan Hall of Science

Schedule | Table of Contents

6 - 7 pm | Undergraduate Research Opportunities in Chemistry (UROC) – Jordan 101

7 - 8 pm | Information Tables - Jordan Galleria

Research Poster Presentations - Jordan Galleria

Refreshments Provided

8 - 9 pm | Undergraduate Research Internship Information Night (UGRIIN) – Jordan 101

Information Tables – Jordan Galleria

Notre Dame Nanoscience and Technology (nano.nd.edu)

Notre Dame Nanoscience and Technology (NDnano) promotes collaborative research in science and engineering. The Center's 80+ affiliated faculty members work to address unsolved scientific and technical questions with an aim to promote the greater good.

Each year, NDnano awards several paid fellowships to undergraduate students who will spend 10 weeks of their summer engaged in an on-campus research project mentored by one of the Center's faculty. To date, nearly 300 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. The application process for summer 2022 fellowships will open the first day of classes in January at nano.nd.edu.

Contact: Heidi Deethardt (deethardt.1@nd.edu), NDnano Center 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. Education and training opportunities within the EIGH include the Global Health Case Competition, the Master of Science in Global Health program, and the Global Health Research Associate program. The EIGH also offers funding for research and travel for faculty and students including graduate student fellowships, Travel Grants for Research, and the Undergraduate Research Support Program.

Contact: Kelly Thomson (kthomson@nd.edu), Institute Coordinator

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

The Flatley Center for Undergraduate Scholarly Engagement, or CUSE, guides Notre Dame undergraduates in the process of scholarly discernment and advises them on how best to identify or create opportunities for experiential learning, especially research; secure University and external funding to support such opportunities; and prepare competitive applications for national fellowships, all with the aim of transforming themselves and their communities in the pursuit of human flourishing and the common good.

Contacts: Kathleen Schuler (cuse@nd.edu), Assistant Director for Student Engagement

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.

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), Associate Professor. Dr. Charles Tessier Assistant Research Professor | crtessie@iu.edu | 574-631-2519

Institute for Precision Health (https://precisionhealth.nd.edu/)

Institute for Precision Health is a community of affiliated researchers who tackle a wide range of biomedical and environmental health through innovation, invention, and real-world applications.

IPH awards two undergraduate Feinstein Institute for Medical Research (FIMR) – Precision Medicine Research Fellowships These fellowships are competitive awards given to highly qualify 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.

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

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.

Meruelo Family Center for Career Development (undergradcareers.nd.edu)

The Meruelo Family Center for Career Development provides undergraduate students with career counseling and career development services, self-assessments, workshops, 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 Handshake, to pursue postgraduate opportunities, sign up for interviews, and conduct career-related research.

Contact: Karen Manier (kmanier@nd.edu), Career Counselor | Assistant 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 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. Note that science internships should have some European policy, culture, or other aspects to be most competitive for Nanovic funding. Students are welcome to visit for advice on applications and opportunities. For more information on the Nanovic Institute and our undergraduate grant programs, please go to nanovic.nd.edu.

Contact: Anna Dolezal (adolezal@nd.edu) Student Programs Assistant Manager

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

ND Energy's 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 education programs, including the Vincent P. Slatt Fellowship for Undergraduate Research in Energy Systems and Processes, the Energy Studies Minor, and the Student Energy Board. These programs prepare students to become successful leaders who understand the complexities of society's energy challenges and 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.

Notre Dame Integrated Imaging Facility (NDIIF)

The Notre Dame Integrated Imaging Facility (NDIIF) is a state-of-the-art research core facility within Notre Dame Research that consolidates the University's imaging capacity and augments it with powerful new imaging modalities. The NDIIF creates an interactive network of research groups who are connected by their interest in imaging technology and allows them to cross-fertilize ideas and form interdisciplinary collaborations. The Imaging Facility makes available to the Notre Dame science and engineering community an integrated suite of sophisticated microscopes and imaging stations that enable expert users to attack the most complex modern research problems and, equally important, resident professional staff (technicians and research specialists) to guide the non-expert users and allow them to conduct experiments that were previously beyond their limits. The NDIIF brings together two conceptually different groups of science and engineering researchers, the inventors who design new materials and techniques and seek research problems that will test their inventions, and the discoverers who are always looking for improved technologies that can better test their hypotheses of how things work. Learn more at imaging.nd.edu/

Contacts: Sarah Chapman VanHouten (Sarah.Chapman@nd.edu)

Scientia (scientia.nd.edu)

Scientia, ND's own student-run Undergraduate Journal of Scientific Research, is looking for student reviewers and news writers for this year's publication. Reviewers should have some research experience and be interested in reading, critiquing, and commenting on student research 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: Abigail Abikoye <aabikoye@nd.edu>, Andrew Langford <alangfor@nd.edu>.

Undergraduate Research Opportunity Program (urop.nd.edu)

The Undergraduate Research Opportunity Program (UROP) provides grants to students who wish to pursue independent research or creative projects. Together with the College of Science and College of Engineering, UROP also offers the DaVinci Multidisciplinary 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.

Contact: Karla Cruise (kcruise@nd.edu), Director of Student Programs.

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

Celebrating over 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 provides two opportunities to promote understanding of field biology and how field research is conducted through 10 weeks in the wilds. Our Track 1 opportunity is designed for students wanting to gain initial experience in field biology where they can gain an introduction to the concepts and methodology while conducting a collaborative research project with other students in the program. Our Track 2 opportunity is designed for undergraduates with prior research experience at UNDERC (including Track 1) or elsewhere that would like to conduct an independent research project under the mentorship of UNDERC scientists. Each Track would include housing, travel between the Notre Dame campus and UNDERC, and a stipend ($5000). Apply by November 10 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.

Plenary Talks

6:00pm-7:00pm Undergraduate Research Opportunities in Chemistry (UROC) – Jordan 101 Steven Wietstock, Teaching Professor, Department of Chemistry & Biochemistry

8:00pm- 9:00pm Undergraduate Research Internship Information Night (URIIN) – Jordan 101 T. Mark Olsen, Associate Teaching Professor, Department of Biological Sciences
Students: Joseph Gentine, Brian Villa, Isabella Rodriguez

Brian Villa, bvilla@nd.edu, plenary speaker

Brian, a Senior Biology Major and medical school intent will talk about types of research opportunities, internship strategy (searching, applying, etc.) as well as his diverse range of internship experiences (IU School of Medicine and Scripps Florida) that have culminated in co-authorships in several peer-reviewed scientific journals.

Isabella Rodriguez, irodrig4@nd.edu

Isabella, a Senior Biology Major and medical school intent will discuss her molecular and computational research with Dr. Neil Lobo that focused on the malaria epidemic in Bangladesh, molecular species identification and preventative measures in malaria mitigation. While working in the Lobo lab, Isabella contributed to the writing of a soon-to-be published peer-reviewed journal article.

Joseph Gentine, jgentin2@nd.edu

Joe, a Senior Environmental Sciences and Economics Major and graduate school intent, has worked in the Stream and Wetland Ecology Laboratory with Dr. Gary Lamberti on an independent research project exploring algal growth in Great Lakes coastal wetlands. His work is now in final stages with a manuscript in preparation for publication. Joe's diverse array of experiences include Great Lakes coastal wetland monitoring with an EPA funded program and participation in Notre Dame's 2021 summer UNDERC-East Program (Land O'Lakes, Wisconsin), where students take ecology classes and work on independent research projects.

Poster Abstracts

Brain Tissue Clearing while maintaining Antigen Signal Presence

Lauren Aucoin
Major: Neuroscience and Behavior
Minor: Poverty Studies
Mentors: Samantha Golomb, BS; Siyuan Zhang, M.D. Ph.D., Dept. of Biology, University of Notre Dame

Abstract

Obtaining a clear depiction of the metastatic niche can be instrumental in clarifying questions about cancer metastases and immune cell recruitment in the brain. Traditional imaging techniques capture a 2D image, revealing cell structure in one plane, however, imaging 3D brain sections provides the opportunity to obtain a more complex and comprehensive understanding of the spatial organization of brain metastases. The composition of cell membranes and structures creates a barrier to 3D imaging wherein the refractive index resulting from complex arrays of lipids and other structures hinders the acquisition of clear images in a 3D plane. Additionally, previously published tissue clearing protocols often tend to quench antigen molecules rendering immunocytochemistry as an insufficient tool to detect protein expression. Extending the antigen retrieval step using a sodium dodecyl sulfate (SDS) based solution in a temperature-controlled environment followed by a gradual clearing process in Benzyl Alcohol / Benzyl Benzoate (BABB) solution addresses both aforementioned limitations permitting a clearer image [Messal et al., 2021]. This project aims to adapt this revised tissue clearing protocol to study the spatial organization of the immune microenvironment of breast cancer brain metastasis. Using a syngeneic mouse model of breast cancer brain metastasis, this project has evaluated the success of the clearing method and antibody staining to elucidate immune cell localization within the brain metastatic niche. Improved understanding of the immune landscape of the brain metastatic niche will guide studies aiming to improve the efficacy of immunotherapy and brain metastasis prevention strategies.

Messal, H.A., Almagro, J., Zaw Thin, M., Tedeschi, A., Ciccarelli, A., Blackie, L., Anderson, K.I., Miguel Aliaga, I., van Rheenen, J., and Behrens, A. (2021). Antigen retrieval and clearing for whole-organ immunofluorescence by FLASH. Nat. Protoc. *16*, 239–262.

What inspired you to participate in undergraduate research?

I've always been interested in the small details of science- how the tiniest details can have a much larger impact. I also have always liked the idea of having to creatively analyze a problem, and problem solving involved in working on a project that doesn't have a simple answer already available. Research in a biology lab helps me combine these interests into projects that are both challenging, as well as informative.

How did you get your research position, and what preparation did you undertake for it? My freshman year, I went to a dinner hosted for students where we sat with professors and learned about their research. Following this, I reached out to Dr. Zhang. I shadowed in his lab during my freshman year, learning more about what current undergraduate students were doing, before starting in the lab sophomore year.

Where was your research experience located?

Harper Cancer Research Institute

What did you get out of your research experience?

Through my research experience, I learned about the steps involved in research, and the trial and error that accompanies any bench work. I learned a great deal about the exploration, creativity, and modifications that are needed to run an experiment. These skills and new ways of learning will shape my future as a scientist and student.

Logan A. Barrios
Undergraduate
University of Notre Dame, Notre Dame, IN

Rinku Majumder, PhD
Louisiana State University Health Sciences Center, Department of Biochemistry

"A Novel Role of the Anticoagulant Protein S in Preventing Thrombosis"

Blood coagulation is an intricate process that occurs by the actions of numerous procoagulants and anticoagulants. Protein S (PS) is a vitamin K-dependent anticoagulant whose physiological importance is underscored by several hematological disorders in PS-deficient individuals. Genetic deficiency of PS is associated with increased risk of venous thrombosis and recurrent thrombosis, e.g., familial venous thrombosis. Acquired PS deficiency predisposes to (recurrent) venous thromboembolism and loss of fetus. PS knockout mice are embryonic lethal. Currently, three disparate functions of PS are known: 1) PS is a cofactor for activated protein C, 2) PS is a cofactor of tissue factor pathway inhibitor, and 3) PS is a direct inhibitor of coagulation Factor IXa.

Deep vein thrombosis, cardiovascular diseases, and stroke are common among obese individuals, as well as among individuals who have high body mass index. Obesity is a major health threat to the global population. According to 2014 statistics, 13% of the world's population is obese, and more than 42% of the USA population is obese. The liver is a major organ that is negatively affected by obesity. For instance, obesity causes diseases like nonalcoholic fatty liver disease. In obesity-induced diseases, the liver develops hypoxia. Hypoxia stabilizes transcription factors such as Hypoxia Inducible Factor-1α (HIF-1α) by preventing Von Hippel-Lindau-mediated hydroxylation of HIF-1α and its degradation. Recently, work from Dr. Majumder's laboratory showed that an increase in HIF-1α expression downregulates Protein S expression in HEP-G2 cells. **The goal of this project was to determine whether hypoxia associated with obesity results in a prothrombotic state because of downregulation of PS.**

We measured thrombin generation (a prothrombotic state indicator) with a thrombin generation assay, and free PS concentration was measured by ELISA assays. We used plasma from HIF1α knockout mice and the HIF1α P564A mutant (HIF1α dPA) mice which are resistant to degradation, resulting in sustained, elevated HIF1 protein abundance, even under normal O2 concentrations. We observed a higher amount of thrombin in obese and HIF1α dPA mice compared with the control mice. However, HIF1α knockout mice generated less thrombin, like the control mice. Additionally, we observed that the clotting times of HIF1α dPA mice was significantly higher than in HIF1α KO mice. This result showed the effect of HIF1α on PS expression and thrombin generation. Because the mice were exposed to more hypoxic conditions, they were more likely to have a decreased PS level.

Completion of these studies will provide understanding of the regulation of PS expression. This project will be instrumental in investigating new antithrombotic strategies for chronic complications that have high thrombotic risk, such as obesity.

Radiolysis of Lunar Regolith and Surrogates

Annika Barron
Major: Neuroscience and Behavior, Global Affairs
Advisor: Jay LaVerne, Dept. of Physics, University of Notre Dame
Coauthors: none

Our research seeks to understand the effects of ionizing radiation on lunar regolith, the fine powder on the surface of the moon, and the possibility of water formation on regolith under ionizing radiation. First, certain components of lunar regolith were examined to understand the changes in their chemistry due to radiation and develop effective protocols before examining real lunar soil. The primary focus thus far has been on silicon oxide (SiO_2) and calcium oxide (CaO), both of which are found in abundance in lunar regolith. Individual materials were exposed to 100 MGy of proton and helium irradiation using the 9S accelerator in the Nuclear Science Laboratory, and 1-3 MGy of gamma irradiation using a self-contained ^{60}Co source at the Notre Dame Radiation Laboratory. Proton radiation in particular mimics the conditions in space which might lead to water formation due to the reaction of protons with oxygen on the material surface. Possible changes in the materials brought by irradiation were explored with various techniques. In particular, Raman spectroscopy and Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) showed no significant differences in spectra of SiO_2 and CaO before and after irradiation, suggesting high stability of these materials under chosen irradiation conditions. Current analysis of Raman and infrared spectroscopy data suggests that both materials are relatively stable throughout the radiation process. As the project continues, more unstable materials found in lunar regolith, including some minerals, and lunar regolith itself will be studied to further understand radiation effects and what implications they may have for the future of space travel, energy, and human life.

What inspired you to participate in undergraduate research?
It is one thing to learn about science in the classroom, but I wanted to see how science takes shape in the real world. I have always been curious about space, and the project that I got involved in allowed me to explore my interests while also learning how to implement what I learn in the classroom in a very tangible way.

How did you get your research position, and what preparation did you undertake for it?
To get this position, I simply reached out to faculty in the physics department who were working on projects that I was interested in. This project interested me because radiation chemistry was an area that I did not know much about, but I wanted to learn more about how this influences the world, and universe around us. To prepare for this position, I spent time over winter break engaging with previous literature on the subject, and then came back to campus early in January to receive training on much of the equipment I would be using.

Where was your research experience located?
University of Notre Dame
What did you get out of your research experience?
I got an enriching summer engaging in full time research, where I learned a lot about the scientific process including how to conduct experiments, interpret results, and write about them! I also have learned a lot from the people who I have worked with in the lab, both the advisor and other students, and made some great friends along the way.

AAV9 Gene Therapy as a Potential Molecular Treatment for Nonketotic Hyperglycinemia

Caroline Bickerton
Major: Neuroscience and Behavior
Advisor: Kasturi Haldar, Dept. of Biological Sciences, University of Notre Dame
Coauthors: none

Nonketotic hyperglycinemia (NKH) is a rare neurometabolic disease characterized by a defect in glycine cleavage which results in the elevated levels of glycine, the simplest of amino acids, in the blood plasma and tissues, including the brain. Eighty percent of NKH cases result from an autosomal recessive mutation in *GLDC*, a central protein of the mitochondrial glycine cleavage system. This mutation prevents GLDC protein from cleaving glycine in the body, resulting in an accumulation of glycine that is thought to lead to detrimental symptoms such as epileptic seizures, hypotonia, and severe developmental delays. Current treatments for NKH strive to reduce glycine, but they do not substantially relieve symptoms or prevent progression of the disease. The rapidly expanding field of gene therapy offers a potential method for corrective treatment. To this end, a novel AAV9 viral vector containing a functional wildtype copy of *GLDC* was designed and injected into mice genetically engineered with a disease-causing *GLDC* mutation. Mouse plasma was then collected monthly for evaluation of glycine levels, to determine whether the gene therapy reduced the elevated glycine levels in the homozygous mutant mice. Preliminary data indicate that over half of the homozygous mutant mice treated with the AAV9 vector showed a reduction in plasma glycine, whereas control mice with the *GLDC* mutation continued to exhibit elevated glycine levels. AAV9 gene therapy therefore shows promise as a therapeutic option to correct the genetic defect causing NKH.

What inspired you to participate in undergraduate research?
"I have a deep love of learning and am particularly intrigued by the biological mechanisms underlying diseases. My current project allows me to explore novel treatment options for rare diseases, which makes my lab research a rewarding learning experience."

How did you get your research position, and what preparation did you undertake for it?
"The lab skills I had gained in my previous summer internship in breast cancer research helped me jump into the rare disease work in Dr. Haldar's lab during my sophomore year. Notre Dame's COS-SURF program generously provided funding for me to continue my research this past summer as I started my senior thesis."

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

What did you get out of your research experience?
"I not only learned how to conduct biochemical assays for genotyping and glycine levels, but I also learned how to handle mice and perform behavioral tests in the context of rare genetic disorders. My research in the Haldar Lab has helped me prepare for graduate school by building strong scientific and laboratory skillsets spanning from molecular/genetic to behavioral analysis."

Reduction of Data of Binary Stars to Determine Age and Other Characteristic Qualities

Josiah Castillo
Major: Physics
Advisor: Jeffrey Chilcote, Dept. of Physics, University of Notre Dame

Monitoring binary stars in moving groups can provide a critical measurement of the age of star systems. OMG (Orbits of Moving Groups) Binaries searches for and measures binary star systems. More data and more stars are constantly being observed and analyzed. Using data taken by the CHARA array, that data was reduced using a method of MCMC (Markov Chain Monte Carlo) to determine the separation, position angle, and the flux of the companion star of the binary star system with respect to the primary star. With this information, we are able to compare these data points to existing data and track with extremely high precision the members of each binary star systems. I have determined systems like HD 35850 and HIP 51317 are most likely not binary star systems, while systems such as HD 62883 and HD 113449 have enough data to try and fit their orbits. Using a program called orbitize, which once again utilized MCMC, the orbits of those systems were predicted and fitted. Next steps of this project would include obtaining more data of both these systems and new ones to reduce, and using that data to fit better and better orbits.

What inspired you to participate in undergraduate research?
I am extremely interested in learning more about what lies in our universe and discovering the many different phenomena that exist outside of our planet. When I learned Professor Chilcote worked on directly imaging binary star systems and searched for exoplanets, I had to take that opportunity.

How did you get your research position, and what preparation did you undertake for it?
I started doing preliminary work with Professor Chilcote in the spring of 2021. After submitting a research proposal based on an extension of my academic-year research, the Notre Dame College of Science Summer Undergraduate Research Fellowship provided funding for my research.

Where was your research experience located?
The Department of Physics at the University of Notre Dame

What did you get out of your research experience?
I got a clear view of what life after my time here at Notre Dame will be like. As someone who is interested in attending graduate school, this research experience gave me a first-hand look at what I can expect to do and work once I start my graduate research and studies.

Implementation of the Tri-Sol System

Sydney Coil
Major: Physics
Advisor: Dan Bardayan, Dept. of Physics, University of Notre Dame
Coauthors: none

The twin solenoid system, also known as Twin-Sol, has been essential in the past for producing unstable beams and subsequently refocusing these beams for analysis. To improve on the system, an addition of a third solenoid has been commissioned, therefore turning Twin-Sol into Tri-Sol. This upgrade to the system was completed and tuned for four discrete energies using an alpha source. Furthermore, the upgraded Tri-Sol system has been used to study the decay of an unstable beam. By upgrading to Tri-Sol, the capabilities of analyzing an unstable beam is greatly improved.

Molly DeLuca
Physics

Fission product yields (FPY) refer to the quantity of a particular fission product produced per fission. As a quantifiable feature of the fission process, FPY both provide insight into the mechanics underlying fission and hold significant implications for the fields of nuclear forensics, stockpile maintenance, and nuclear energy. While it is known that FPY vary with excitation energy, there is a lack of accurate data on the energy dependence of FPY, particularly in the low-energy regime. This study continues a collaboration between the Triangle Universities Nuclear Laboratory (TUNL), Los Alamos National Laboratory (LANL), and Lawrence Livermore National Laboratory (LLNL), formed in order to collect accurate, consistent data on the energy dependence of neutron-induced FPY at energies below 14 MeV. In this investigation, Uranium targets were activated with a mono-energetic neutron beam. Following irradiation, the activated targets were γ ray counted with HPGe detectors for 5 days. The resulting spectra were used to identify fission products by their characteristic γ rays and decay curves; FPY were quantified by comparing γ ray counts in the detector to total fission counts in the DFC. Cumulative FPY for 238U were measured at 2.0, 2.4, and 3.6 MeV.

Decoding Microorganism Communication for Antibitoic Drug Discovery and Development

Jeannette Dimpel
Major: Science-Business
Advisor: Jaclyn M. Winter, Dept. of Medicinal Chemistry,
College of Pharmacy, University of Utah

With resistance mechanisms spreading rapidly among disease-causing bacteria, our ability to treat common infections is becoming more difficult. Unfortunately, while antibiotic-resistance is on the rise, antibiotic discovery is on the decline. Natural products, also called secondary metabolites, are small molecules produced in nature. Unlike primary metabolites, which are required for growth and survival of all living cells, secondary metabolites are synthesized upon environmental challenges and their production varies across organisms. In their host organisms, natural products are synthesized by a dedicated suite of genes. Because microorganisms exist in complex communities in their natural environment, specific intra- and interspecies communication can trigger the activation of silent biosynthetic gene clusters leading to the production of specialized metabolites. Pestalone (**1**) is a fungal natural product that is only observed in co-culture and possesses potent antimicrobial activity against methicillin-resistant *Staphylococcus aureus* (MIC = 8.4 nM) and vancomycin- resistant *Enterococcus faecium* (MIC = 17 nM). This interspecies system therefore serves as an ideal resource to interrogate not only the biosynthesis of this antibiotic agent, but the context-dependent expression of its biosynthetic cluster. The genome of *Pestalotia sp.* CNL-365 was sequenced at the University of Utah Huntsman Cancer Institute and genome mining led to the identification of a biosynthetic cluster harboring one polyketide synthase gene, a FADH2-dependent halogenase, a prenyltransferse and a homoserine lactonase. A combination of bioinformatics, transcriptomics and chemical analyses were used to interrogate the pestalone biosynthetic cluster and its regulation. Further genome mining revealed a wealth of biosynthetic clusters in *P.* sp. CNL-365 that have little similarity to other biosynthetic clusters in public databases. These biosynthetic clusters have the potential to produce novel secondary metabolites and should be further investigated to understand how they are regulated and transcribed.

What inspired you to participate in undergraduate research?

I am passionate about discovering new ways to target modern health problems. I love hands-on learning and being in the lab has developed my knowledge and interest in science.

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

My high school had a summer research program that paired students with PI's which allowed me to get integral research experience early on.

Where was your research experience located?

The University of Utah in Salt Lake City, UT

What did you get out of your research experience?

I learned many common techniques performed in lab, and while I was diving into the field of natural products I strengthened my ability to learn about and understand complex topics in a short amount of time. I also received great advice and mentorship from Dr. Winter and the grad students I worked with.

Enzyme Kinetics of Glucose Oxidase Using Paper Analytical Device for Field Friendly or at Home Use

Samantha Eyolfson
Major: Chemical Engineering
Advisor: Marya Lieberman, Dept of Chemistry, University of Notre Dame

Enzyme kinetics is crucial to the interpretation and improvement of many biological and chemical processes, but it is difficult to visually study and lacks hands-on experiments that could aid in the understanding. This project aims at providing a hands-on, engaging microfluidics-based laboratory experiment using an enzyme-based paper device called a SugarPAD to study the kinetics of glucose oxidase. The sugarPAD uses glucose oxidase, horseradish peroxide, and o-dianisidine to give a blue color response when glucose is added, permitting the students to track the color change over time using image analysis. This data allows for a Lineweaver Burk plot to be created with varying concentrations of glucose, allowing for the determination of Vm and Kmax to be compared to real values. One application of enzyme kinetics is how glucose is inhibited when insulin is not properly produced or utilized in the body in patients with diabetes. Not only is diabetes one of the leading causes of death in the United States, there is a huge racial disparity when it comes to the death rate. Understanding how kinetics can work, even in a small scale experiment, and linking that experiment to a real world issue engages young students and informs them of how their work can be impactful.

What inspired you to participate in undergraduate research?
I love to learn, and research provides me with the greatest possible situation to learn and be challenged. I also love how my lab has many applications of helping in the real world, that is very important to me and I appreciate seing an impact on people with what I am working on.

How did you get your research position, and what preparation did you undertake for it?
I was in the STEM mentorship last fall, and I told my mentor, Natalie Warlen, how interested in research I was, and how it was a profession I thought I might want to puruse but had never tried it so wanted to see. She set me up with one of the graduate students, Jessica Zinna, in the Lieberman group.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
So much learning! Through developing my own experimental plans to understanding why things worked/didn't work, I am challenged every day in lab. I have loved working with the group and am currently applying to graduate programs to continue working in similar settings post-college.

Peroxisome Proliferator-Activated Receptor–γ Coactivator 1-α (PGC1-α) is Downregulated During Bacterial-induced Experimental Colitis

David Fletcher
Major: Biochemistry
Advisor: Kevin Mollen, Division of Pediatric Surgery, Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA
Coauthors: Elizabeth Novak, Department of Surgery, University of Pittsburgh School of Medicine, Pittsburgh, PA; Meredith Flanagan, Department of Surgery, University of Pittsburgh School of Medicine, Pittsburgh, PA

Peroxisome Proliferator-Activated Receptor–γ Coactivator 1-α (PGC1-α) is a primary regulator of mitochondrial biogenesis, and under conditions of cellular stress, it is a potent stimulator of antioxidant activity and mitochondrial turnover. While our lab has shown that PGC1-α transcript and protein are downregulated within the intestinal epithelium of patients with IBD and in mice undergoing to T cell-induced colitis and dextran sodium sulfate-induced colitis, its role within the intestinal epithelium of mice subjected to infectious colitis is not known. Here, we investigated the role of PGC1-α in the intestinal epithelium during infectious murine colitis via subjecting mice (n=8) to *Citrobacter rodentium*-induced colitis ($1x10^9$ CFU/mL, oral gavage) for 8 days. Mice infected with *C. rodentium* showed shorter colon lengths and increased colonic mRNA levels of proinflammatory cytokines, including *Tnfα*, *inos*, and *Il-1***β**, as compared to sham-infected controls. Furthermore, we found that the transcript and protein levels of PGC1-α were also decreased in mice with infectious colitis. PGC1α is activated when it is deacetylated by Sirtuin 1 (SIRT1)—a protein dependent upon the cofactor NAD+ for its deacetylase activity. Interestingly, although we found no significant change in the mRNA levels of Sirt1 in mice infected with *C. rodentium*, we did find decreased levels of NAD+ within the intestinal epithelium of mice subjected to *C. rodentium*-induced colitis as compared to sham-infected controls. Thus, we hypothesized that NAD+ depletion during intestinal inflammation may render SIRT1 inactive, which results in a decrease in deacetylated PGC1α. Ongoing studies into the upstream pathways involved in PGC1-α activation (i.e., SIRT1) may help to elucidate the decrease in PGC1α levels during infectious colitis. Approaches targeted at enhancing the activity of PGC1-α, and in turn mitochondrial health, through NAD+ regeneration may complement the treatment for (IBD).

What inspired you to participate in undergraduate research?
Working in a lab has always captivated my mind. In my future career plans, I want to get a MD-PhD, so I will be, hopefully, continuing to work in a lab.

How did you get your research position, and what preparation did you undertake for it?
I applied to University of Pittsburgh's Summer Undergraduate Research Program, and I was accepted. I showed up every day willing to learn, and I learned from trial and error; no special preparation was necessary for the work.

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

What did you get out of your research experience?
I learned how to think critically as a scientist. I also learned small rodent handling skills, advanced molecular biology techniques, and histological techniques. Furthermore, I practiced my craft of writing and presenting scientific knowledge.

Impact of Targeted Mutations on Aquaporin-7 Structure and Breast Cancer Progression

Daniel E. Fulkerson
Major: Biochemistry
Advisor: Laurie E. Littlepage, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: William Castillo (Graduate Student) and Verodia Charlestin (Graduate Student)

Breast cancer is the most common cancer among American women and is projected to cause 43,600 deaths in 2021. Relative five-year survival rates associated with localized primary tumors are high (99%) but drastically decrease for individuals with metastatic disease. The development of metastatic potential remains poorly understood. Our lab has previously identified the water and glycerol channel Aquaporin-7 (AQP7) as a predictor of overall survival in breast cancer patients and a key metabolic regulator of breast cancer metastasis. However, the structure-function relationships that facilitate AQP7's pro-cancer phenotype are unknown. To further characterize these interactions, our lab is utilizing site-directed mutagenesis to create point mutations in the mouse homolog of Aquaprorin-7, specifically targeting residues known to be involved in protein regulation, pore selectivity, and post-translational modification. Mutant AQP7 variants are validated through restriction enzyme digestion and Sanger sequencing. Once mutant AQP7 variants have been validated, they will be introduced and expressed in stably infected 4T1 (triple negative mouse breast cancer) cells by lentiviral infection. The functional impact of AQP7 mutations will examined by evaluating glycerol transport potential, metabolic influence, and pro-metastatic cellular characteristics, including proliferation, invasion, and migration.

What inspired you to participate in undergraduate research?
I pursue undergraduate research because I wanted to apply my scientific education to further the scientific understanding of human disease progression and treatment.

How did you get your research position, and what preparation did you undertake for it?
I joined the Littlepage Lab in January 2020, drawing on my biochemistry coursework and the guidance of graduate students to learn research techniques. I began working on my current project in Fall 2020. I continued this research over the summer of 2021 using a Summer Undergraduate Research Fellowship through the College of Science and the Glynn Family Honors Program.

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

What did you get out of your research experience?
During my time in the Littlepage Lab, I have formed strong relationships with scientists from diverse personal and academic backgrounds. I have also gained experience in a professional scientific setting, helping to prepare me for future research projects as a medical student.

Estrogen Signaling Identified as a Novel Regulator of Nephrogenesis

Allison Gatz
Major: Biological Sciences
Advisor: Rebecca A. Wingert, Dept. of Biology, University of Notre Dame
Coauthors: Hannah Wesselman, PhD Candidate

Kidney development requires correct formation of nephrons, which are functional units comprised of discrete proximal and distal segments with unique roles in solute secretion and reabsorption. The zebrafish is an exemplary model organism to study renal cell development, as transparent embryos allow for high throughput visualization of nephrogenesis through whole mount in situ hybridization (WISH). Further, segmentation of the zebrafish nephron and overall genetic composition is highly conserved with humans. Through a chemical screen to identify the molecular signals governing nephrogenesis, we identified candidate 17ß-Estradiol (E2), which was particularly interesting because the effect of estrogenic compounds on kidney development remains poorly understood. Here, we investigated the effects of E2 on nephron cell fate. At 24 hours post fertilization (hpf), WISH analysis of exogenous E2 treatment revealed an expansion of the distal early (DE) segment and truncation of the distal late (DL) segment. A follow-up targeted chemical screen suggested that *estrogen receptor 2 (esr2)* is likely a key player in nephrogenesis, as antagonist PHTPP resulted in opposite phenotypes. Additionally, E2 treatment resulted in expansion of *irx3b* and *irx1a* transcription factor domains, suggesting that E2 may be acting upstream of these critical factors to promote DE fate. Due to the environmental relevance of xenoestrogens (XEs), we examined the effect of three common XEs: Bisphenol A (BPA), ethinylestradiol (EE), and genistein (GEN), present in plastics, birth control, and soy products, respectively. Similar to E2, exogenous EE and GEN led to an expanded DE, reduced the DL, and did not affect other nephron segments. Taken together, these data suggest that estrogenic compounds are essential for distal segment fate during nephrogenesis and suggest the importance of further research on estrogen signaling on aberrant kidney function. Future directions include morpholino knockdown and CRISPR analysis to discern the interaction between *esr2* analog *esr2b* and E2.

What inspired you to participate in undergraduate research?
"The kidney and its intricacies have always fascinated me. Dr. Wingert's lab has provided me with outstanding mentorship throughout my years, allowing me to develop many skills."

How did you get your research position, and what preparation did you undertake for it?
"I have been a member of Dr. Wingert's lab since the fall of 2019. This past summer, my research was funded by the Notre Dame College of Science Summer Undergraduate Research Fellowship."

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

What did you get out of your research experience?
"I plan on continuing research with the Wingert lab for the rest of my undergraduate career. This is integral to my future career aspirations of pursuing a M.D. degree. Not only does research provide me an opportunity to think critically, it allows me to develop my research skills. I have also developed skills in scientific communication and time management."

Body Postures and Orientation of Visuospatial Attention in Multi-Person Social Contexts

Helen Gu
Major: Neuroscience and Behavior
Advisor: Dr. James Brockmole, Department of Psychology, University of Notre Dame
Coauthors: None

Social cues from the body provide crucial information about an individual's internal state, as well as the environment around them. It is well-established that some social cues, such as eye-gaze and head direction, can reflexively orient visuospatial attention. Research examining the allocation of visuospatial attention in response to body postures or in multi-person social contexts, however, remains limited. Here, we examined attentional biases in response to body posture cues in social scenarios. Participants completed a dot probe task in which they were tasked with identifying the location of a target (a black dot) with a key press. A cue stimulus, depicting either one or three people, was presented prior to the appearance of the target. Participants were found to be significantly faster at locating targets when the depicted body posture stimulus was oriented toward them. Though participants were faster on average to respond to the three-person cue, the size of the attentional cueing effect was the same for the single and group stimuli. Hence, observers are biased to attend to the area of space in front of other people, indicating that body posture is used as an attentional cue to prioritize certain areas of space for processing, but this bias effect does not differ for individuals and groups.

What inspired you to participate in undergraduate research?

I am someone who learns best by "doing". The research process not only allows me to apply concepts I learn in class in a practical setting, but also gives me opportunities to answer questions that haven't yet been answered, which is super exciting!

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

I have been a research assistant in the Visual Cognition Lab since August of 2019. Since then, I have worked on a total of 5 different eye-tracking and cognitive projects in the lab, which have equipped me with the knowledge and technical skills I needed for this project. I spoke to Dr. Brockmole about undertaking a senior thesis project in the spring of my junior year. With his guidance, I was able to design a project that combined the skills I learned with my interests in body language and visual attention.

Where was your research experience located?

Visual Cognition Laboratory at the University of Notre Dame

What did you get out of your research experience?

Through my summer participating in the COS-SURF program, I was able to make significant progress on my senior thesis project, allowing me to pursue additional follow-up experiments during the school year. I was also able to dive deep into the research process and learned so much about experimental design, problem solving, and data analysis that will come in handy in my future career.

Have a grasshopper problem? We "mite" have a solution for you.

Emma Heston
Major: Environmental Science
Advisor: Dr. Chelse Prather, College of Arts and Sciences, University of Dayton
Coauthors: None

Grasshoppers can be serious economic pests, causing millions of dollars in damage a year through their predation of cereal crops and the food competition with grazers in rangelands. The chemical pesticides that are typically used to manage these pests come along with many negative side effects for public health and ecosystem function. Integrated Pest Management is a great alternative to using chemical pesticides exclusively. It incorporates biological control agents into pest management. Grasshopper mites are natural parasites of grasshoppers and can reduce fertility and influence a younger death age in grasshoppers, making them good options as biological control agents. In this experiment I aim to better understand host preference in grasshopper mites to gauge efficacy as a biological control agent. Grasshopper were collected at different locations at UNDERC and the species, instar stage, and sex of 5th and 6th instar stages was identified. The number of mites and location on the grasshopper was visually estimated. The soil moisture percentage was calculated for each site. The hind wing surface area to body mass ratio for 2 species was measured. While there are many factors that influence the host selection for mites, my results indicate that mites prefer grasshoppers with a high hind wing surface area to body mass ratio.

What inspired you to participate in undergraduate research?
"I was drawn to the process of research and of science. I loved the opportunity to find answers that did not already exist in the literature. It seemed like it would be very empowering."

How did you get your research position, and what preparation did you undertake for it?
"I applied for the UNDERC West summer program after multiple professors suggested it was something I look into. To prepare I took a course in the spring that prepared me for what I could expect to encounter during the summer. I also read a lot of literature of what was already known about grasshopper and mite interactions."

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

What did you get out of your research experience?
"I discovered what type of research that I am passionate, and I also was introduced to an incredible mentor who has helped me further my academic growth. I also left this experience with many more questions and research ideas/"

Investigating Cellular Senescence as a Novel Treatment for Glioblastoma

Regan Hines
Major: Neuroscience and Behavior
Advisor: Kevin T. Vaughan, PhD, Dept. of Biological Sciences, University of Notre Dame
Coauthors: none

The reformation of the nuclear envelope at the end of mitosis is a highly-regulated process. We identified a novel pathway involved in nuclear envelope reformation that, when disrupted, induces defects in nuclear lamina assembly. These defects mimic Hutchinson Gilford Progeria Syndrome (HGPS) with blebbed nuclei and uneven accumulation of Lamin A around the nuclear perimeter. As seen in HGPS, nuclear blebbing can lead to cellular senescence through the cGAS-cGAMP-STING pathway. In order to form an intact nucleus, phosphorylation of both Lamin A and Barrier – to – Autointegration (BAF) are required for their interaction at the nuclear envelope. The protein vaccinia-related kinase 1 (VRK1) has previously been shown to phosphorylate BAF. Inhibition of VRK1 through either genetic approaches or drugs in a glioblastoma (GBM) cell line resulted in blebbed and highly micronucleated nuclei. Our results indicate that targeting the reformation of the nuclear envelope could be used as a novel treatment pathway for GBM by avoiding targeting the cell cycle. Induce nuclear blebbing and, therefore, cellular senescence would help circumvent the problems GBM treatments typically have in highly mutated GBM tumors.

What inspired you to participate in undergraduate research?

"I love taking concepts I learn in my classes and applying them to solve the problems in the real world. The ability to work on well-funded research project under experienced members of a lab seemed like such a great opportunity that I had to take advantage of!"

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

"I have been a member of the Vaughan lab since August of 2019, and I immediately began learning about the projects in lab, as well as learning preliminary techniques for the research I would do. After submitting a research proposal based on an extension of my academic-year research, the Notre Dame College of Science Summer Undergraduate Research Fellowship provided funding for my research."

Where was your research experience located?

"University of Notre Dame"

What did you get out of your research experience?

"I was able to learn what being a scientist truly entails, that being collaborating with others, constantly doing further research, and lots and lots of troubleshooting! I built up my problem-solving skills, along with how to present results, write grant proposals, and do all the work it takes to have a "completed" project. My research experience in the Vaughan lab provided me the confirmation I needed that a future in research was exactly what I wanted."

Improving Solar Cells with Two-Dimensional Lead-Halide Perovskites

Nathaniel Hiott
Major: Physics
Advisor: Dr. Prashant Kamat, Dept. of Chemistry and Biochemistry, University of Notre Dame

Lead-halide perovskites have recently emerged as a frontrunner for semiconductor research and applications. Two-dimensional perovskites have shown promise in being more environmentally stable than their three-dimensional counterparts, and they have tunable bandgaps based on their layer thickness. The superior photophysical properties of 2D perovskites make them suitable candidates for photocatalysis applications in light-emitting diodes (LEDs) and solar cells. This research focuses on the interactions between colloidal two-dimensional perovskites and the electron acceptor fullerene. By observing the absorbance and photoluminescence of the single, double, and triple thickness perovskites as the electron acceptor is added, the recombination pathway of the excited electrons can be determined. The addition of fullerene decreases the photoluminescence of the samples without significantly degrading the 2D perovskite, suggesting that the excited electrons are transferred to the fullerene. Our next steps will focus on repeating these experiments with other lead-halide perovskites to determine if they share similar properties. Investigating this further will open new opportunities in exploring 2D perovskites in photocatalytic applications which have not yet been explored by the scientific community.

What inspired you to participate in undergraduate research?
My career goal is to address climate change by helping transition our energy systems toward renewable energy solutions. When I found Dr. Kamat's research into next-generation solar cells, I knew that this was a way I can combine my love of research with my passion for sustainability.

How did you get your research position, and what preparation did you undertake for it?
As I was searching for professors that did the renewable energy research I am interested in, I had a conversation with Anne Pillai at ND Energy about research groups that would match my interests. I joined the Kamat lab in the Spring of 2021 and was able to apply for a College of Science Summer Undergraduate Research Fellowship to fund the continuation of my project into the summer.

Where was your research experience located?
The Notre Dame Radiation Laboratory

What did you get out of your research experience?
My summer experience introduced me to the reality of what full-time academic research will look like. I found that I enjoy the challenge and freedom of working on an independent research project, and I learned a lot about perovskites, which are an emerging and exciting topic in the energy field.

Colorimetric Drug Detection of Pharmaceuticals on a Paper Analytical Device

Sarah Honegger
Major: Biology
Advisor: Marya Lieberman, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coadvisor: Kathleen Hayes, Graduate Student

According to the World Health Organization, at least one out of every ten medical products in sub-Saharan Africa is substandard or falsified (SF), but this number has been estimated to be as high as 70% in the worst cases.[1] Whether the SF pharmaceuticals contain an excess of the active ingredient, a deficit of active ingredient, or no active ingredient at all, they pose an extreme threat to human health. One reason for the prevalence of SF drugs is a lack of widespread quality control testing, as many SSA countries don't have access to the necessary instrumentation for analysis. My work in combating this issue has been centered around developing various colorimetric drug detection reactions, which contribute to the overall Paper Analytical Device, or PAD. This small, easy-to-use device employs a variety of chemical reactions that produce color changes in the presence of functional groups unique to the drugs we test for. In addition to this, we test and process drug samples from African countries using High-Performance Liquid Chromatography. By doing this, we can validate the purity of specific samples and corroborate the results with the results of PAD analysis.

One of these projects involved a method for peptide quantification by using a bicinchoninic acid assay to detect concentrations of various proteins. The bicinchoninic acid assay I developed was successfully applied to detect both the chemotherapy drug bleomycin and the uterotonic drug oxytocin for further work on lane testing with both of these drugs.

In addition to detecting typical pharmaceutical drugs, we also have an interest in detecting illicit drugs for the purpose of harm reduction using the illicit drug PAD, or idPAD. I am currently adapting the Simon/Rimini test as a colorimetric reaction for the detection of secondary amines, which should be able to distinguish methamphetamine from other illicit drugs like cocaine and heroin, which have tertiary amines. In the future, I will attempt to put this reaction on the paper analytical device by combining the reagents as spots on the paper.

What inspired you to participate in undergraduate research?

I am truly inspired by the work that the Lieberman lab does that has real-world implications that I get to see day-to-day. These devices are making a difference around the world.

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

I joined a STEM mentorship program that matched me with a graduate student in the Lieberman lab, and I was immediately interested in the lab as soon as she explained it to me. I learned a lot of lab techniques and lab notebook taking as soon as I started working in the lab. Part of the process of working with color change tests involved searching and reading peer-reviewed scientific literature.

What did you get out of your research experience?

I have learned to ask critical questions and troubleshoot issues that come up in the course of experimenting. I have also learned how to design and document experiments.

[1] Peter Mwai, "Fake Drugs: How Bad Is Africa's Counterfeit Medicine Problem?," BBC News (BBC, January 17, 2020)

The Effects of Children with Intimate Partner Violence Exposed Mothers on the Amount of Prosocial Talk

Kailyn Janiga
Major: Neuroscience and Behavior
Advisor: Laura Miller-Graff, Department of Psychology, University of Notre Dame
Coauthors: none

Intimate partner violence (IPV) is described by the Centers for Disease Control and Prevention (CDC) as sexual violence, stalking, physical violence, and/or psychological aggression committed by a romantic or sexual partner. This global issue can have life-long adverse outcomes including an increased risk of psychological, social, emotional, and behavioral problems including mood and anxiety disorders, posttraumatic stress disorder (PTSD), and substance abuse. Similar to the direct victims of IPV, children exposed to IPV are at an increased risk for developing PTSD and are at an additional risk of exposure to additional traumatic events, heightening the risk of psychological effects. In order to investigate the further effects of IPV exposure in children, this study aimed to determine if there is a difference in the amount of prosocial talk be children whose mothers have been exposed to IPV versus children whose mother have not been exposed. Participants were comprised of 70 mothers and 116 children in the St. Joseph area. After assessment by the Revised Conflict Tactics Scale to determine IPV exposure, each mother was asked to engage in a 15-minute dyadic play session with their child using a standardized set of age-appropriate toys. Audio and visual data was transcribed and coded using the Manual for Dyadic Parent-Child Interaction Coding System (DPICS), Third Edition. The amount of prosocial talk by the child and praise by the mother were tracked during coding. Following this, data will be analyzed using a multiple linear regression model with potential confounding variables (i.e., child, sex, and family income) included as covariates.

What inspired you to participate in undergraduate research?

I knew I wanted to take what I was learning in class and be able to utilize that knowledge to impact people. After taking my first psychology course at Notre Dame, I knew I wanted to pursue a psychology lab, especially one that emphasized helping those with trauma.

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

In freshman year, I asked to be able to volunteer in the lab to get a better sense of research and the type of work the BRAVE lab was doing. After a semester, I knew I found my passion for applying psychological principles to helping women and children exposed to trauma. It took me several semesters and many psychology courses to be able to help conduct this research.

Where was your research experience located?

University of Notre Dame, BRAVE lab

What did you get out of your research experience?

I know have a deep admiration for the people exposed to trauma. This research and the BRAVE has allowed me to witness the amazing resilience these people possess in the face of trauma and IPV.

Psychological Effects of Societal Pressures on Women

Shannon Kasun
Major: Neuroscience and Behavior
Advisor: Dr. Mark E. Cummings, Department of Psychology

The present study investigated the relationship between societal pressures, specifically those pertaining to marriage and motherhood, and women's mental health using data collected by Dr. Cumming's Northern Ireland (NI) project, a 6-wave longitudinal study funded by the National Institute of Mental Health. The NI project studied women of various marital statuses and utilized the General Health Questionnaire-12 (GHQ-12), a measure of psychological well-being, specifically anxiety and depression, loss of confidence, and social dysfunction, and Security in the Marital System Subscale (SIMS-PR), an assessment of emotional security within a marriage, both of which were applied and analyzed in the present study. A hierarchical regression in R was utilized to analyze the data and compare models. There was no statistical significance ($p = 0.0569$) between models when examining GHQ-12 among women of different marital statuses, suggesting spousal standing did not influence mental health. However, GHQ-12 and SIMS-PR shared a positively correlated relationship, as suggested by the overwhelming number of positive standardized coefficients, proposing that insecure marriages and imperfect child behavior negatively impact women's psychological wellbeing.

What inspired you to participate in undergraduate research?
"I have personally endured a long battle with anxiety, depression, and self-esteem, all of which was partly due to my failure in being society's idea of a "perfect" woman, heavily influencing my interest in this field of study. Through my research, I aspire to bring attention to this prominent issue to alleviate societal pressures, as well as disassemble the ridge definition of "perfection" to teach girls and women to appreciate and love themselves."

How did you get your research position, and what preparation did you undertake for it?
"I applied for and was awarded the University of Notre Dame College of Science Summer Undergraduate Research Fellowship (SURF), which funded my research. I applied my experiences as a student in Dr. Cummings' Family Studies Laboratory to assist me in my research."

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

What did you get out of your research experience?
"I learned a lot about the research process, including developing a study question, analyzing data, coding, and scientific writing. I loved everything about it and cannot wait to apply what I learned this summer to my future studies."

Macrophage MicroRNAs as Therapeutic Targets for Aplastic Anemia Treatment

Emily Kozlowski
Major: Biological Sciences
Advisor: Richard Dahl, Dept. of Biology, University of Notre Dame
Coauthors: Andrew Appert

Aplastic anemia is a rare autoimmune disease characterized by a loss of hematopoietic stem cells (HSCs) in the bone marrow, which corresponds to threateningly low numbers of red blood cells, white blood cells, and platelets which can cause symptoms such as anemia, thrombocytopenia, neutropenia, and bone marrow failure (BMF). Recently bone marrow inflammatory macrophages have been implicated in driving BMF in aplastic anemia. Our laboratory has observed that microRNA cluster 11 (*Mirc11*), encoding miR-23a, miR-24-2, and miR-27a, promotes macrophage polarization towards a proinflammatory (M1) phenotype by inhibiting expression of anti-inflammatory (M2) associated genes. We hypothesize that antagonization of the responsible M1-promoting microRNA would favor M2 polarization and "protect" against HSC loss. To test this, we generated mouse models of aplastic anemia in wildtype and *Mirc11*$^{-/-}$ mice in which we expect to observe improvement of bone marrow hematopoiesis in the *Mirc11* deficient mice compared to wildtype, tested through analysis of total bone marrow cell counts and flow cytometry following disease maturation. In addition, we have shown that *Mirc11* expression in human macrophages inhibits M2 polarization similar to what was observed in mouse macrophages through a gene expression analysis of macrophages differentiated from human monocytic cell line Thp1 overexpressing *Mirc11.* Lastly, we wanted to determine if any single microRNA in the *Mirc11* cluster mediated the regulation of inflammatory responses in macrophages. Individual *Mirc11* microRNAs were antagonized or overexpressed in Thp1 monocytes or RAW264.7 murine macrophages. Cells were polarized to M1 or M2 and polarization was evaluated by flow cytometry and gene expression. The results demonstrated that no one microRNA mediated all the effects of *Mirc11* on macrophage polarization, however each microRNA had some effect on inhibiting M2 polarization and enhancing M1 macrophage polarization. Future experiments will address whether antagonizing one *Mirc11* microRNA *in vivo* will be sufficient to ameliorate disease progression in aplastic anemia models or whether all three microRNAs will need to be simultaneously targeted.

What inspired you to participate in undergraduate research?
"I wanted to experience the process of taking a question, thinking about it, and designing a plan that would generate an answer (or at least a progression towards answer)."

How did you get your research position, and what preparation did you undertake for it?
"I have been a member of the Dahl lab since February 2021 and was excited for the opportunity to stay in the lab and work on my own project over the summer. After submitting a research proposal designed according to the lab's current resources and expertise, the Notre Dame Center for Rare and Neglected Diseases 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?
"I learned how to adapt a given protocol to the circumstances of an experiment, which I had previously struggled with until this summer. This came from a deeper understanding of what each experiment encompasses and what my desired goal was. I also learned how to analyze results and use our current progress to plan out our next experiments. My summer research definitely taught me a lot about the research process in general, specifically how to stay on track and progress from point A to point B, even with the inevitable hiccups in your plan.

Common Pathomechanisms of PKD1 and PKD2 Missense Variants in Autosomal Dominant Polycystic Kidney Disease (ADPKD)

Jessamine Kuehn
Major: Biochemistry
Advisor: Peter C. Harris, Department of Nephrology and Hypertension, Mayo Clinic College of Medicine and Science, Rochester, MN
Coauthors: Cynthia J. Sieben, Ph.D. and Peter C. Harris, Ph.D.

Autosomal dominant polycystic kidney disease (ADPKD), characterized by the formation and expansion of fluid-filled renal cysts, is the most common genetic kidney disorder, affecting approximately 1:1000 individuals. *PKD1* and *PKD2* pathogenic variants are responsible for ~79% and ~15% of ADPKD cases, respectively, with >3000 known. *PKD1* and *PKD2* encode polycystin 1 (PC1) and polycystin 2 (PC2), which form a functional complex. Determining variant pathogenicity has become increasingly important with the advent of genome-wide variant screening approaches. Perturbation of PC1 maturation/trafficking is one common pathomechanism among *PKD1* and *PKD2* missense variants. Here, we employed exogenous expression systems to assess PC1 cleavage at the GPS/GAIN domain by western blotting, and localization of PC1 and PC2 to primary cilia by immunofluorescence imaging. Analysis of *PKD1* variants showed that 9/11 or 3/10 variants with mild or severe defects in PC1 surface localization have cleavage patterns similar to wildtype, or dramatic defects, respectively. Overall, 12/21 *PKD1* variants had consistent correlations between PC1 surface localization, predicted pathogenicity from clinical information, and PC1 cleavage patterns. However, some likely inactivating variants did not impact cleavage, while a few blocked cleavage more than expected; these require further study. For the ciliary localization analyses, several different conditions, including timing of exogenous expression, PC1/PC2 detection methods, and fixation were tested. Although PC1/PC2 coexpressing cells were identified, expression levels and ciliation conditions require further optimization. Together, these data indicate that using a single method to assess variant pathogenicity is not ideal, and future studies to determine the most effective model are needed.
Funding: R25-DK101405; R01-DK058816

What inspired you to participate in undergraduate research?
I plan on going into pharmacology research, and wanted to broaden my research experiences to get an idea of what research looks like across different labs. I also wanted to learn about the differences between basic research at a university and translational research at a clinic. It is inspiring to know that my work in this nephrology lab could have an impact on the development of diagnostics for polycystic kidney disease.

How did you get your research position, and what preparation did you undertake for it?
I applied to the Mayo Clinic Summer Undergraduate Research Fellowship (SURF) program. Prior to this research experience, I began doing basic cancer research in the White lab in the Harper Cancer Research Institute at the University of Notre Dame, and this research experience prepared me for a more intensive full time summer research experience.

Where was your research experience located?
Mayo Clinic, Rochester, MN

What did you get out of your research experience?
Doing research at Mayo Clinic over the summer was a wonderful opportunity to experience day-to-day research in a lab at a clinic. I was able to meet several experienced researchers and explore career opportunities in research. I gained experience applying biochemical techniques I had learned while doing cancer research at Notre Dame to a different disease area. The skills and connections I made will provide a foundation for my research career after graduating from Notre Dame.

Analyzing the Neural Landscape and Quantification of Nerve Phenotypes in Oropharyngeal Cancer

Margaret Kurop

Mentors: Moran Amit, Dept. of Head and Neck Surgery and Jared Burks, Dept. of Leukemia, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

Coauthors: Tongxin Xie and Jennifer Covello

Oropharyngeal cancer is a type of head and neck cancer in which cancer cells are found within a specific area of the throat known as the oropharynx. Over 90% of oropharyngeal cancers are squamous cell carcinomas (SCC), with the cancer arising from the flat surface cells that line the mouth and throat. Treatments such as radiation therapy can produce adverse effects causing oropharyngeal cancer patients to often have trouble with speech or swallowing. Studies have examined the effects of oropharyngeal cancer and radiation therapy on the muscular systems in the oropharynx, however, there is little known about the implications of this form of cancer and radiation on nerves. Understanding the neural environment is imperative to alleviating symptoms of oropharyngeal cancer as nerves often have nociceptive receptors and pain is the most common presenting symptom in oral SCC. Epithelium samples affected by oral SCC of oropharyngeal cancer patients treated at MD Anderson Cancer Center were stained for tumor and neural markers via immunofluorescence and analyzed for nerve quantification and phenotypes using AI-driven digital histopathology. Results indicated significance in the quantity of autonomic and myelinated nerves in OPC patients. Future studies within this project will aim to correlate significant nerve phenotypes with patient clinical data on pain levels and swallowing abilities in OPC patients in order to improve functional outcomes.

What inspired you to participate in undergraduate research?
I have always loved complex problem-solving that requires me to think critically, especially when the problems relate to the health of global populations and the answers I seek could potentially provide insight and understanding into how to provide relief to those that are suffering.

How did you get your research position, and what preparation did you undertake for it?
I had been working in Dr. Brian Blagg's lab at the University of Notre Dame and really enjoyed my research, but was also interested in working on more clinical or translational research in order to expand my skills and participate in novel research. When I learned of the MD Anderson University Outreach Program, I submitted an application to be reviewed by Notre Dame and eventually MD Anderson. Upon being accepted into the program, the University of Notre Dame College of Science provided a stipend for my research and housing in Houston, Texas.

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

What did you get out of your research experience?
This full-time position taught me how to incorporate AI-driven pathology in analyzing neural landscapes in patient tissue samples. It has also allowed me to experience both bench and analytical research through using cutting edge technology and novel techniques. The implications of this project will create solutions to the difficulties in swallowing and speech that greatly impact the quality of life of oropharyngeal cancer patients even after they enter remission, which allowed me to begin to understand how to integrate analytical and clinical data. I also learned important skills in communicating my research through presenting my findings to renowned physicians at the conclusion of the summer and I formed close relationships with my mentors, which I will be continuing to collaborate with throughout the year as we work to publish results.

Investigating Mate Choice Strategy Ratios of Female Gray Treefrogs using Agent-Based Modeling

Yu Min Lee
Major: Neuroscience and Behavior
Advisor: Sunny K. Boyd, Dept. of Neuroscience and Behavior, University of Notre Dame
Coauthors: none

The evolution of mate choice behavior used by animals that gather in groups, or leks, during the mating season is fundamental for looking at the significant consequences of individual fitness and evolutionary mechanisms. Anuran amphibian species like *Hyla versicolor,* or the common North American gray treefrog, are especially optimal for studying the evolutionary changes in mate choice behavior. Computational agent-based modeling was used to investigate different *Hyla versicolor* female mate sampling behaviors and the consequences on reproductive success measured within both the individual agents and the overall female mating population, such that testing different ratios of strategies may provide insight on how a combination of strategies might be more or less beneficial than all females using the same one. Simulations of a mixed model using two main female mating strategies, *best-of-n* (fixed search rule) and *minimum-threshold* (sequential search rule), were run using NetLogo, a programming language developed for agent-base modeling. Average pulse number of successful mates, the average time it takes for female frogs to find a mate, and the average distance traversed by female frogs to approach an intended male mate were recorded for analysis. Results demonstrated that average mate quality based on pulse number and time spent in search of a mate were highest and travel costs of distance were minimized when at least fifty percent of females used the *minimum-threshold* rule for mate choice. Pulse number of mated males increased and distance traveled by females decreases when the parameter for *minimum-threshold* was above average pulse number of all male frogs. Although this model does not explicitly include search costs related to biological constraints or environmental factors, an alternative approach may consider implementing changes within the female frog biological system and its effects on mate decision.

What inspired you to participate in undergraduate research?
"Being able to act upon my unlimited curiosity is one of the best things about being part of a research lab. I also was intrigued by the idea of playing around with computational model in a biological setting."

How did you get your research position, and what preparation did you undertake for it?
"After doing research at the Harper Cancer Research Institute, I wanted to focus on a different type of research like computational modeling."

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

What did you get out of your research experience?
"I not only was able to explore programming languages and look at a different perspective of neuroscience research, but I have also been able to improve my writing and presentation skills as well."

Notch1a and the downstream *her* target genes in the regenerating zebrafish retina

Jaclyn Levendusky
Major: Biological Sciences
Advisor: Dr. David R. Hyde, Dept. of Biological Sciences, University of Notre Dame
Co-advisor: Dr. Leah J. Campbell, Senior Research Scientist

Blindness impacts a substantial part of the population, yet there is no cure for any blinding retinal disease. The zebrafish (*Danio rerio*) retina shares the same vertebrate retinal structure as in humans, yet the adult zebrafish retina can regenerate any cell type lost to damage. Following damage, the Müller glia in the retina undergo reprogramming and cell cycle reentry to produce neuronal progenitor cells that replace the lost cell types. Notch1a is a pro-proliferative signaling protein and transcription factor necessary for a complete retinal regeneration response. However, the specific role that Notch1a plays in this response and the identity of the target genes of Notch1a are not sufficiently understood. During the regeneration response, *notch1a* gene expression increases at early time points, suggesting that Notch1a plays a role in the reprogramming and cell cycle reentry of Müller glia cells. However, in the absence of damage, overexpression of Notch1a is not sufficient to induce proliferation. Known targets of Notch signaling are the *her* genes. Some of these genes, namely *her4*, *her9*, and *her12*, increase in expression during retinal regeneration and substantially increase in expression in transgenic fish that overexpress Notch1a in the absence of damage, indicating that these genes may be direct targets of Notch1a. Other *her* genes, namely *her2*, *her13*, and *her15*, also increase in expression during regeneration, but do not increase in expression when Notch1a is overexpressed in the absence of damage, indicating that these genes may be important for regeneration but are not direct targets of Notch1a. Gaining a deeper understanding of the retinal regeneration response in zebrafish will illuminate why humans lack the same capacity for self-repair and may identify certain genes, like the *her* genes, as potential targets for future therapies for blinding retinal diseases.

What inspired you to participate in undergraduate research?
I enjoyed doing bench work and thinking through problems in classroom laboratory courses, but I was not as interested in doing experiments the professors already knew the outcome of. I love doing research because I get to answer novel questions and struggle through new results that nobody has seen before.

How did you get your research position, and what preparation did you undertake for it?
I reached out to the professor of my Genetics course and joined his lab by the next semester. The Genetics course and guidance from one of the post-docs in the lab prepared me to take on my own project and gain independence.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
My critical thinking, data interpretation, and problem-solving skills have significantly improved since doing research. I feel like I do meaningful and interesting work every time I go into lab and have learned so much about what it means to do good science. I also spent last summer doing research and was able to share my results and receive feedback from all members of the lab, which helped me gain confidence and build relationships with my labmates.

Understanding the Opportunity for Telehealth in Mental Health Provision

Fiona McAlearney
Major: Neuroscience and Behavior and Economics
Advisor: Dr. Cindy S. Bergeman, Dept. of Psychology, University of Notre Dame
Coauthors: none quite yet

Telehealth refers to virtual healthcare that is delivered over a distance. It encompasses various modes of communication between patients and providers, including video conferencing, telephone communication, patient portal messaging, or emailing. Prior to the emergence of coronavirus disease 2019 (COVID-19), very few providers had experience utilizing telehealth to provide mental health care. However, the onset of COVID-19 quickly forced providers to consider new methods of providing care in their collective efforts to reduce transmission of the highly contagious COVID-19. In addition, with the emergence of the pandemic, federal regulations around reimbursement and licensure for remote care were relaxed, enabling providers to conduct and be reimbursed for telehealth appointments. The objective of this study is to comprehensively examine the use of telehealth in treating and diagnosing mental health conditions by interviewing psychiatrists, clinical psychologists, and mental health providers and learning how they perceive COVID-19 has impacted the mental health landscape. Telehealth has also been noted as a potentially effective solution for the treatment of anxiety, depression, and chronic conditions that require long term follow up care. Initial interviews of providers have suggested that providers feel less comfortable conducting new patient visits or provide care to patients with more severe cases of psychosis and suicidality over telehealth. However, providers believe that adequate reimbursement and the elimination of state licensure restrictions will be necessary to promote continued and extended use of telehealth as a form of mental health care delivery. It is hoped that this research will lead to a better understanding of the effectiveness, benefits, deficits, and future implications of using telehealth in the context of mental health care provision.

What inspired you to participate in undergraduate research?
As a neuroscience major, I love asking questions and learning about various mental health conditions as well as their forms of treatment. Further, I really enjoy connecting with and hearing about the experiences of professionals within the mental health care industry. Currently, this area is especially interesting given all of the changes we have seen in mental health and mental health care since COVID-19. I was very excited to have the opportunity to explore all of these interests through my current research project.

How did you get your research position, and what preparation did you undertake for it?
I originally started my on-campus research as an assistant within Healthy Places ND before transitioning to Dr. Bergeman's Adult Development and Aging Lab this fall. During the summer of 2020, I worked as a research assistant in The Ohio State University's College of Medicine where I worked on a study that assessed the usability of telemedicine within the field of pediatric gastroenterology. Given that this profession relies on a physical assessment of the patients, I was curious to explore the use and effectiveness of telehealth in the field of mental healthcare in which physical examinations are not typically conducted as frequently. Ultimately, given this interest and my background in neuroscience, I decided to conduct my current research project. From my prior experiences, I had learned a variety of interviewing and survey-building techniques as well as how to qualitatively and quantitatively analyze data.

Where was your research experience located?
My research experience was located at the University of Notre Dame, but I also conducted interviews from Columbus, Ohio since the interviews took place over Zoom.

What did you get out of your research experience?
I had the opportunity to meet and learn about the experiences of many diverse mental healthcare providers and to gain a better understanding of the changes in mental health and the healthcare landscape since the onset of COVID-19.

Determining the relationship between organismal allometry and organ-level traits: an example from a temperate tree community

Anna McDonald Abstract

All living organisms follow certain rules or tradeoffs throughout their lives. A prominent example of these rules are growth and survival tradeoffs determining whether an organism lives acquisitively by growing quickly and dying young, or conservatively by growing slowly and dying old. This tradeoff can be connected to the ecological strategy of trees which coexist due to their differences in ecological strategies structuring the community ecology of a forest. The ecological strategy and tradeoffs of trees can be seen through both organismal allometry through crown morphology as well as through organ-level traits such as wood, leaves, and seeds. In this study, I look at whether organismal allometric scale strategies are predictive of organ-level traits, and vice versa. 170 individual trees among five different species (*Betula papyrifera* [Betulaceae]*, Acer saccharum* [Sapindaceae]*, Populus tremuloides* [Salicaceae]*, Tilia americana* [Malvaceae]*, Fraxinus nigra* [Oleaceae]) were used to measure diameter at breast height (DBH), two crown radii, crown top, and crown bottom - and a non-UNDERC dataset was used for the organ-level trait data. This data was then used to produce allometric regression models and correlations between the allometry and organ-level traits. While many of the correlation coefficients were high, very few of them were statistically significant. This could be due to a lack of data points in the correlations requiring an increase in the number of species, however, there was some support for this idea of predicting the organ-level traits through organismal allometry and vice versa.

Context Reinstatement Effects for Multiple Presentation Items in Varied and Repeated Contexts in a Delayed Recognition Memory Test

Meghan McReynolds
Major: Neuroscience & Behavior
Advisor: Dr. Joshua Koen, Dept. of Psychology, University of Notre Dame

Human memory is a complex process that informs how we interact with the world. Outside of a laboratory setting, which often only evaluates memory presented in one context, we often encounter both similar items in many similar environments and similar items in many different environments. It is not well understood how context reinstatement, which clearly benefits memory for items seen once in a single environment, impacts memory for objects seen multiple times in the same context or multiple times in different contexts. A within-subjects memory study was conducted in which participants incidentally studied objects in scenes once, multiple times with the same context, or multiple times with a different context each time. Participants completed an immediate recognition memory test for single presentation items and a delayed recognition memory test for single and multiple presentation items. The first hypothesized outcome was that context reinstatement effects will differ for multiple presentation items presented in varied contexts compared to multiple presentation items presented in the same context. The second hypothesis was that context reinstatement effects will differ for single presentation items over time.

What inspired you to participate in undergraduate research?
I was inspired to participate in research by hearing about the work that other students were able to do during their time in a research lab as an undergraduate student. I was amazed by the vast possibilities open to undergraduate students and I wanted to experience research for myself – I love answering questions in experiments rather than by through a textbook.

How did you get your research position, and what preparation did you undertake for it?
I have been an undergraduate research assistant in Dr. Koen's Memory, Aging, and Cognition Lab since the fall of 2019, during my sophomore year. At the end of my freshman year, I researched cognitive neuroscience labs on campus and reached out to Dr. Koen to learn more about the work his lab did. Since joining the lab, I took on a senior thesis project within the lab and participated in the Summer Undergraduate Research Fellowship here at Notre Dame.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I have learned so much about how research in cognitive neuroscience and other fields is conducted, and that I am more capable than I believe to contribute to science. Moreover, I learned that research is something I hope to continue to pursue after graduation.

Effects of Caffeine and Caffeine Withdrawal on Working Memory Capacity and Control

Isaiah Metcalf
Major: Neuroscience and Behavior
Advisor: Nathan S. Rose, Department of Psychology, University of Notre Dame

Caffeine has been shown to modulate and improve objective measures of working memory and consequently is the most consumed stimulant in the United States. This is significant because working memory, the ability to manipulate items held in the focus of attention, is an integral aspect of proper cognition providing a primary motivator for caffeine ingestion (Rose et. al., 2016). Important to this study are the expansion of working memory capacity and the filtering of irrelevant information, which can both be analyzed behaviorally by calculating the working memory capacity of a participant, represented by Cowan's k, with a change detection and filtering task respectively. There are two main hypotheses this project aimed to address. The first is whether the relationship between caffeine and working memory follows the Yerkes-Dodson law. If this is the case, then the caffeinated-control group will perform worse than the caffeinated-regular use group in the filtering task task due to over-arousal provided by non-tolerance of caffeine. The second hypothesis is that caffeine improves objective measures of working memory by expanding the focus of attention as measured with a change detection task. If this is the case, then the caffeinated group should be expected to perform better than both the control group and the withdrawal group in a simple change detection task.

What inspired you to participate in undergraduate research?
I wanted to learn how to ask scientific questions and formulate experiments to answer those questions. I knew that it would be an important part of my future career, so practice in my undergraduate was good preparation.

How did you get your research position, and what preparation did you undertake for it?
I got my research position after taking a class with Dr. Rose my spring semester of freshman year. I didn't do any preparation, but I was trained well by Dr. Rose and others in the lab by shadowing them in their projects.

Where was you research experience located?
University of Notre Dame

What did you get out of your research experience?
I learned about the process of grant writing and IRB approval, which are very large parts of any experiment getting off the ground.

Domain boundary dissolution of six and twelve-fold anisotropic vortex lattices

Daniel Minogue

Major: Physics

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

Cynthia Reichhardt, T Division, Los Alamos National Laboratory

Charles Reichhardt, T Division, Los Alamos National Laboratory

When superconductors are exposed to a magnetic field, it penetrates the material in the form of quantized vortices. These vortices are repulsive and, will organize themselves into an ordered lattice with a symmetry and orientation that depend on the form of their interaction potential. One such potential, manifested in the two-band superconductor MgB_2, is a combined 6 and 12 fold anisotropy which produces a triangular lattice with various orientations based on the ratio of the two anisotropic terms. Here, a large ratio resulting in two distinct domains of vortices and a low ratio forming a single domain. We have investigated the phase transition between the two domain ordering to the single domain using a molecular dynamics simulation. It was found that the system does not evolve completely by only changing the aforementioned ratio, but requires the application of additional perturbation through oscillating the effective density of the vortices which facilitates the phase transition and reduces the difference in the relative angle of the two domains logarithmically with respect to time. This is in agreement with small-angle neutron scattering studies carried out by our group [Louden *et al*., Phys. Rev. B **99**,144515 (2019)].

What inspired you to participate in undergraduate research?

I was most excited to pursue Physics at Notre Dame specifically for its broad availability to be involved in research early into the undergraduate career. Furthermore, I enjoy solving problems and figuring out solutions to setbacks so research was an interest from the start.

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

I came into Notre Dame eager to get involved in research, and following a talk by Professor Eskildsen about possible research opportunities involving my secondary passion, computer programming, I reached out and started on the project and have been working on it since my freshman year.

Where was your research experience located?

University of Notre Dame and briefly at Los Alamos National Laboratory

What did you get out of your research experience?

I have learned a great deal about the research process and how to manage and analyze large sets of data to find meaningful results, as well as working to update and implement new features into old code. Due to the COVID epidemic, I also learned how to work and collaborate remotely to make continual progress.

Evaluation of Acoustic Analysis to Detect Childhood Lead Exposure

Kyle Moon
Major: Neuroscience & Behavior

Advised by Dr. Marya Lieberman
Department of Chemistry and Biochemistry
University of Notre Dame
Co-authors: None

Roughly one in three children globally have elevated blood lead levels (BLLs ≥ 5 μg/dL), and while low- and middle-income countries bear a disproportionate lead burden, the challenge of childhood lead poisoning persists in the U.S. After the Flint Water Crisis, investigative journalists from Reuters identified South Bend, Indiana, as a "lead hotspot," with some of the highest rates of childhood lead poisoning in the U.S. Lead screening programs are known to reduce rates of childhood lead poisoning, but screening rates across St. Joseph County fall below 20%. Low screening rates across the country, especially throughout the course of the COVID-19 pandemic, are a result of barriers to healthcare. These barriers include those associated with existing tests that must be administered within the clinic. To work towards *prevention* of lead poisoning, there remains a critical need to develop new tests to detect childhood lead exposure that can overcome such barriers. A potential approach for childhood lead exposure screening involves the use of speech tests, which have shown great promise in detecting a number of neurological conditions. Existing applications of speech tests demonstrate they are minimally invasive, easy-to-use, low-cost, and readily deployed, all of which correspond to key features of screening tools in public health.

What inspired you to participate in undergraduate research?
I had the opportunity to engage in research before coming to Notre Dame, and I was really drawn to the iterative process: asking questions, seeking out answers, and using those findings to (a) develop interventions and (b) ask further questions that can better inform existing policies, practices, and/or interventions. Research is all about creating new knowledge and putting that knowledge to use in some capacity. Its ability to advance change is what really appealed to me.

How did you get your research position, and what preparation did you undertake for it?
I took a class with Dr. Lieberman in fall 2019 (CHEM 30331: Chemistry in Service of Community) that involved an independent research project, harnessing tools and techniques from analytical chemistry to respond to environmental lead hazards in the community. This work provided a natural stepping stone into further projects, taking what I learned from the first project to ask new questions and pursue further investigation in the Lieberman Lab.

Where was your research experience located?
My research experience has been based here at Notre Dame, with a significant amount of 'field work' in the community across St. Joseph County.

What did you get out of your research experience?
Undergraduate research has been the cornerstone of my time at Notre Dame and aids in my pursuit to live out the University's mission of putting "education in service to justice." Research has shaped my way of thinking, offered new opportunities for community engagement, and provided a way to connect what I learn in the classroom to real-world challenges.

A Dimensional Analysis of Exercise, Mood, Well-Being, and Personality Pathology

Kaley Murday
Major: Neuroscience
Advisor: Lee Anna Clark, Dept. of Psychology, University of Notre Dame
Coauthors: Lee Anna Clark, Ph.D., & Alejandro Corona-Espinosa

Personality disorder, defined as an enduring pattern of inner experience and behavior that is associated with distress or psychosocial impairment, affects nearly 15.5% of the population in the USA. There is a wealth of published research exploring interrelations among personality, mood, subjective well-being, and exercise, but there is a gap in the literature connecting personality pathology and exercise. The aim of this project is to determine whether the joint relations of physical activity, subjective well-being, and mood form underlying dimensions related to personality, and whether they are associated with the presence of personality disorders. In particular, the hypothesis of this project is that students who report both lower levels of physical activity and subjective well-being will report both higher levels of personality pathology and negative affect compared to students who report higher levels of physical activity and higher levels of subjective well-being. To test this hypothesis, we created a survey via Qualtrics that contains the Faceted Inventory of the Five-Factor Model (FI-FFM), the Personality Inventory for *DSM-5* Faceted Brief Form (PID-5-FBF), the Positive and Negative Affect Schedule (PANAS), the Satisfaction with Life Scale (SWLS), and the International Physical Activity Questionnaire (IPAQ). The subjects are currently being recruited via Prolific and undergraduates will be recruited via SONA later this semester, with a target total sample size of N=400. Correlational and factor analyses will be performed through SPSS.

What inspired you to participate in undergraduate research?
The broad clinical significance of research has always attracted me—the ability to contribute to discoveries that help those in need. Researching at the Center for Advanced Measurement of Personality and Psychopathology (CAMPP Lab) has given me the opportunity to explore different diagnostic measures of personality disorders, and factors that contribute to the presence of personality pathology.

How did you get your research position, and what preparation did you undertake for it?
I applied to the CAMPP Lab because I am very interested in psychopathology. I want to contribute to research that helps patients with personality disorder receive proper diagnoses and treatment. I was accepted into the Lab, and then applied to the Neuroscience and Behavior (NSBH) Honors Program to delve deeper into the field of personality pathology.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
By completing a Neuroscience Honors Thesis, I am getting invaluable experience regarding research processes, from obtaining IRB approval to writing a manuscript. I have also learned so much about personality pathology, and the factors with which it is correlated.

Characterizing the Abraxas/BRCA1 Interaction in the Control of DNA Double Strand Breaks

Grace Murphy
Major: Science Pre-Professional Studies
Advisor: Bin Wang, Dept. of Genetics, MD Anderson Cancer Center
Coauthors: Xiao Wu, Dept. of Genetics, MD Anderson Cancer Center; Shengfeng Xu, Dept. of Genetics, MD Anderson Cancer Center

Genomic instability is a hallmark of cancer. Upon DNA damage, multiple repair mechanisms exist, one of which being the highly mutagenic break-induced replication (BIR). The BRCA1-A complex is a collection of proteins that repair dsDNA breaks. Two crucial proteins of this complex are BRCA1, a tumor suppressor, and Abraxas, a scaffold protein. When DNA is damaged, ATM signaling induces ubiquitination of lysines conjugated at the damage site. RAP80 binds to the polyubiquitin chain of lysine 63, recruiting BRCA1. Abraxas then dimerizes and stabilizes BRCA1 at the site. It has been shown that DNA end resection as a result of camptothecin (CPT), a topoisomerase inhibitor, is inhibited by Abraxas, limiting BIR. Abraxas and BRCA1 interact at two important points when they form the BRCA1-A complex: S406 and S404. S406 is phosphorylated in response to DNA damage. S404 is crucial for BRCA1 accumulation at damage sites. Its phosphorylation is required for dimerization of BRCA1-BRCT/Abraxas. My project aimed to test if Abraxas S404A S406A double mutant affects Abraxas's function in the inhibition of DNA end resection and BIR in response to CPT damage. Using the Single Molecule Analysis of Resection Tracks (SMART) assay, I tested the length of ssDNA in response to CPT treatment in complemented WT Abraxas and S404A S406A double mutant into Abraxas KO U2OS cells (ULF3). Three other cells lines were analyzed: untreated U2OS, treated U2OS, and treated ULF3. The cells were treated with 1μM CPT for 1 hour. The DNA was extracted and molecular combing stretched the DNA fibers onto coverslips. The fibers were stained with BrdU, causing them to fluoresce green when imaged using the 80i microscope. Based on the preliminary findings, the interaction of BRCA1 and Abraxas at these interaction points cannot be conclusively determined. The images produced did not show distinct ssDNA fibers, making quantification impossible. Further experimentation is needed to confirm the results.

What inspired you to participate in undergraduate research?
I have always had an interest in cancer treatment and research, and working at the top cancer research facility in the world was a learning opportunity that was a once-in-a-lifetime experience.

How did you get your research position, and what preparation did you undertake for it?
I applied and was accepted into the University Outreach program through the Notre Dame connection at MD Anderson. I prepared for the summer by reading the provided scientific papers on my topic and consulting with former participants in the program. Funding was provided through generous donations through Notre Dame.

Where was your research experience located?
MD Anderson Cancer Center

What did you get out of your research experience?
I gained a greater understanding of genetics and cancer research in general. I also had the opportunity to work closely with researchers at MD Anderson, and their mentorship shaped me into a better scientist.

Mini-CLIP, a Truncated CLIP-170 Construct, Forms Patches In Vivo

Nora T. Nelson
Major: Biochemistry
Advisor: Holly V. Goodson, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Yueh-Fu O. Wu

The +TIPs are conserved microtubule (MT) binding proteins that dynamically track the growing ends of the MT and regulate MT dynamics. +TIPs can associate through many weak, multivalent interactions to form the +TIP network. We recently proposed that the +TIP network forms a biomolecular condensate that acts as a scaffold around the MT tip to promote its polymerization. These biomolecular condensates form from proteins containing intrinsically disordered regions (IDRs) and multivalent binding sites, and their overall behavior in the +TIP network is not well understood. CLIP-170 is a +TIP that forms condensates which we hypothesize are important for CLIP-170's regulation of the MT. However, studying the properties of these condensates formed by CLIP-170 *in vitro* is challenging. We assessed the structural domains of CLIP-170 required for condensate formation and designed a truncated "Mini-CLIP" which we hypothesized will retain CLIP-170's behavior but be capable of *in vitro* analysis. Here, we show that Mini-CLIP forms patches comparable to CLIP-170's biomolecular condensates when overexpressed *in vivo*. Immunofluorescence results demonstrated that these patches colocalize with the master +TIP EB1, a behavior that is seen with full length CLIP-170 overexpression as well. These results suggest that Mini-CLIP's structure may be sufficient for CLIP-170 behavior *in vivo*, so it may then be more successful in *in vitro* studies as well. This research is significant since it will promote better understanding of CLIP-170's role in MT regulation and why MT dysregulation can factor into neurodegenerative diseases.

What inspired you to participate in undergraduate research?
I got involved in undergraduate research because I wanted to utilize the material I learned in the classroom for real scientific application and inquiry. It is exciting to explore questions and topics I am curious about, but it is even more enriching to investigate those answers myself.

How did you get your research position, and what preparation did you undertake for it?
I joined the Goodson Lab in fall of 2019. Since then, I have primarily been working on this project involving CLIP-170. Prior to this past summer, former lab member and now graduate Dr. Yueh-Fu Wu and I designed the Mini-CLIP construct based on structural analysis of full-length CLIP-170. Over this summer, COS-SURF allowed me to begin experimentation with the physical Mini-CLIP construct.

Where was your research experience located?
University of Notre Dame Goodson Lab

What did you get out of your research experience?
I gained many useful laboratory and critical analysis skills that will be useful in my future pursuit of research in graduate school. I think one of the most useful experiences was learning how to troubleshoot after unusual results and work towards resolving the issue.

Optimization of pyKLIP Parameters for CHARIS

Jonathan Pal
Major: Physics & Honors Mathematics
Advisor: Jeffrey Chilcote, Taylor Tobin; Dept. of Physics, University of Notre Dame
Coauthors: none

We present techniques and preliminary results for the optimization of parameters for the application of pyKLIP to reduced data cubes from the Coronagraphic High Angular Resolution Imaging Spectrograph (CHARIS), an Integral Field Spectrograph (IFS) located at the Subaru Telescope designed for imaging and spectroscopy of disks and sub-stellar companions. We analyzed parameter performance by injecting fake objects into datasets, running pyKLIP on the modified datasets, and analyzing the signal to noise ratio of the objects in the post-pyKLIP images. The optimized parameters will assist in an analysis of CHARIS performance and will assist in the implementation of ADEPTS, a fully automated backend system for CHARIS.

What inspired you to participate in undergraduate research?
"I find that physics and astronomy are much more interesting in practice than in the classroom. Working in Professor Chilcote's group gave me the opportunity to apply my knowledge in practice and see how real research is conducted."

How did you get your research position, and what preparation did you undertake for it?
"I contacted Professor Chilcote last fall to see if he would be interested in bringing me in to his group and I began working for one of his postdoctoral researchers last spring. I prepared for the summer (where the bulk of my work was conducted) by familiarizing myself with the FITS file system, the pyKLIP algorithm, and the CHARIS instrument."

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

What did you get out of your research experience?
"I gained insight and experience into the process of research: in particular, I learned that it is very non-linear and often a "two steps forward, one step back" experience. I also gained technical skills with Python programming and cloud computing. I also had a lot of fun and really enjoyed spending the entire summer focused on one project."

Quantifying importance of Chimney Swift (*Chaetura pelagica*) roost site at Columba Hall

Charlotte Probst
Majors: Biological Sciences and Philosophy
Advisor: Dr. Joel Ralston, Department of Biology, Saint Mary's College
Coauthors: None

The Chimney Swift (*Chaetura pelagica*) is an aerial insectivore distributed throughout the eastern United States and southeastern Canada. Although these birds are relatively common, their small size, highly aerial lifestyle, and inaccessible nesting sites have made them difficult to study. On the other hand, their roost sites tend to be easier to monitor, as they often roost in industrial chimneys in urban environments. I observed the Chimney Swift roost at Columba Hall on the Notre Dame campus during spring and fall 2021 and collected data on nightly swift occupancy. I then used citizen science data (eBird and chimneyswifts.org) to locate roost sites across the United States and compared these roost counts with the counts from Columba Hall. Preliminary analyses indicate that the Columba Hall roost is in the 96th percentile of largest roosts in the United States. I also plan to complete analysis of entry rate patterns in the spring versus the fall, with the hypothesis that entry patterns will differ with swifts exhibiting less flocking behavior during the spring. These results provide impetus for conservation of the Columba Hall roost site and demonstrate that the campus roost provides an easily accessible opportunity for ornithological research.

What inspired you to participate in undergrad research?
I find the natural world fascinating and a source of endless questions. In particular, my independent work on this project was inspired by my love for swifts and my desire to share that with others! I hope that, through this project, more members of the ND community will be aware of this really amazing spectacle and research resource on our campus.

How did you get your research position, and what preparation did you undertake for it?
I have researched for the past three years with Dr. Joel Ralston at Saint Mary's College, primarily on a separate project (involving the relationship between avian bill morphology and climate). I knew I wanted to study birds, but no one on Notre Dame's campus works with them. My freshman year, I attended FURF(!) and talked to Dr. Cramer, who connected me with Dr. Ralston at SMC. I emailed Dr. Ralston, met with him the following week, and have been working with him ever since.

Where was your research position located?
Primarily at SMC, but my research on the swifts has been largely self-directed. The roost site is located on ND's campus.

What did you get out of your research experience?
Dr. Ralston has been an amazing mentor over the past three years. Through my work with him, I've been able to develop and complete a research project (the bill morphology project), culminating in my first authorship of our paper which was recently accepted at the Journal of Avian Biology. He has also encouraged me to explore my own interests and questions, which resulted in the swifts project, and has been an invaluable source of support and guidance in the process of applying for grants and graduate school.

Dynamics of Magnetic Vortices with a Twofold Anisotropic Vortex-Vortex Interaction Potential

Edward J. Roe
Majors: Physics and Honors Mathematics
Advisors: Morten R. Eskildsen, Dept. of Physics, University of Notre Dame; Cynthia J. O. Reichhardt, T-4 Division, Los Alamos National Laboratory; Charles Reichhardt, T-4 Division, Los Alamos National Laboratory
Coauthors: None

The dynamics of vortices in type-II superconductors has been studied extensively in systems with an isotropic vortex-vortex interaction potential; however, much less is known about systems in which the potential is anisotropic. We use molecular dynamics simulations to study the dynamics of vortices with twofold anisotropic interactions, for driving forces applied along the two principal symmetry directions of the interaction potential. The simulations are performed with varying numbers of randomly placed pinning sites to represent the defects which are always present in real materials. We find that as the anisotropy of the potential is increased, the vortex lattice defect density becomes less sensitive to the magnitude of the applied drive. Furthermore, the system exhibits a hysteresis effect in which, for a decreasing drive, an ordered state persists down to currents below the threshold current at which the ordered state first forms for an increasing drive. We discuss these results and their possible underlying mechanisms.

What inspired you to participate in undergraduate research?
"My primary goal in life is to contribute as much as possible to human knowledge. Research is the way to do that. I also wanted to start exploring specific fields to help me decide what I want to study in graduate school."

How did you get your research position, and what preparation did you undertake for it?
"My summer research was a continuation of my academic year research, but with a new collaboration with Cynthia Reichhardt and Charles Reichhardt of Los Alamos National Laboratory. My experience from doing research at Notre Dame gave me the skills I needed for my summer research. My position was funded by Professor Eskildsen and by Los Alamos National Laboratory."

What did you get out of your research experience?
"I gained a lot of programming experience and learned more about how professional researchers organize multiple projects and decide what to focus on. I was also able to visit Los Alamos for a week. While in Los Alamos I was able to meet some brilliant scientists and explore the mountains of New Mexico."

Structure and Dynamics of Water around Small Molecule Cryoprotectants

Jasmine Sindelar
Major: Science-Business, Minor: Compassionate Care in Medicine
Advisor: Dr. J. Daniel Gezelter, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Benjamin M. Harless

Cryoprotectants are substances that prevent ice formation and are used to protect cells or tissues from damage due to freezing. These molecules disrupt the local structure and dynamics of the surrounding water. The two local properties we are focusing on are the tetrahedral organization of water and the hydrogen bond jump times. The molecules examined (methanol, methane diol, formate, formic acid, and DMSO) are either known cryoprotectants or have similar functional groups to certain amino acids found in the protein DAFP-1, an antifreeze protein found in the beetle, *Dendroides canadensis*. The water disruption due to small molecule cryoprotectants examined will be compared with the amino acid functional groups found in DAFP-1. Through examination of the underlying structural effects of cryoprotectants, we hope to better understand and characterize the effect of cryoprotectants on its surroundings in a way that helps to further understand how these molecules are able to disrupt the local water structure and prevent ice formation.

What inspired you to participate in undergraduate research?
I did research as a senior in high school and have enjoyed it ever since. I like asking questions and having the opportunity to figure out the answer for myself.

How did you get your research position, and what preparation did you undertake for it?
I have been a member of the Gezelter Lab since fall 2019. I submitted a research proposal based on a project I started during the academic year, and the Notre Dame College of Science Summer Undergraduate Research Fellowship provided funding for my research.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
An in-person lab experience on campus where I was able to get to know the graduate students in my lab a lot better. I also learned more about the field of computational chemistry and how applicable the field is to conducting medical research which I hope to do after I've earned an MD.

Investigation of Medicinal Plant Use by Long-tailed Macaques in Response to Parasite Infections

Carson Smith
Major: Biological Sciences
Advisor: Hope Hollocher, Dept. of Biological Sciences, University of Notre Dame
Coauthors: none

Studies have shown that nonhuman primates may be deliberately eating medicinal plants to treat symptoms associated with parasite infections. However, these studies tend to focus primarily on helminth infections, leading to a significant gap in the literature on whether similar behaviors are associated with the treatment of protozoal infections, such as those caused by *Plasmodium* species. This study used barcoding data of the *18S rRNA* gene amplified from fecal samples of long-tailed macaques (*Macaca fascicularis*) in Bali and Singapore to analyze the plants in their diets and detectable protozoan and helminth infections. Information about the medicinal qualities of plants identified in the macaque diet was gained through a search of the scientific literature on antiparasitic activity and general human medicinal use of plants. Each plant item detected in the macaque diet was labeled as antiprotozoal, anthelmintic, antibacterial, antifungal, and/or human medicinal depending on its documented medicinal properties. Partial Mantel tests were used to determine correlations between medicinal plant categories and detected parasites. The Mantel tests showed only very weak interactions between plant categories and helminth infections; the strongest positive correlation was between plants with broad spectrum medicinal activity (anti-all plants) and detected *Plasmodium* infections for samples from Bali ($r=0.2583$, $p=0.001$), Singapore ($r=0.2429$, $p=0.001$), and both islands combined ($r=0.3007$, $p=0.001$).

What inspired you to participate in undergraduate research?
I really enjoyed my lab courses for different classes, but we never really were able to do in-depth research projects. I thought it would be fun to join a lab and really dive into a problem in order to gain more information on why something was happening.

How did you get your research position, and what preparation did you undertake for it?
At the beginning of my sophomore year of college, I researched the various labs on campus to see what kinds of research projects professors on campus were conducting. I found Dr. Hollocher's page on the Department of Biological Sciences' website, thought her research was really interesting, and reached out to her through email. Before joining the lab as an undergraduate researcher, I did a semester of directed readings with Dr. Hollocher.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I have learned how to narrow down a potential research question into a manageable project. My research experience has also taught me how to better interpret results from statistical tests and communicate those results in the appropriate manner.

Plasma Irradiation of Amino Acids and its Extension to Nucleobases for Medical Applications

Diana Spulber
Department of Physics
Ptasinska Lab, Department of Physics, Radiation Research Building

Plasma medicine is an innovative and promising field combining plasma physics and clinical research. Plasma has been widely studied, but an obstacle in the translation of experimental results to clinical applications comes from the fact that much is still unknown about the mechanisms involved in the interaction between plasma and biomolecules. One such biomolecule, the amino acid cysteine, was investigated using a gel medium under an atmospheric-pressure plasma jet. Analysis with Fourier-Transform Infrared Spectroscopy (FTIR) revealed significant damage in the structure of cysteine due to reactive oxygen and nitrogen species formed in the medium by plasma. This successful method was then applied to the nucleobase thymine. However, modifications need to be made to the method as the differing properties of amino acids and nucleobases prevent an exact translation. Studies are ongoing of the extension to nucleobases to further the implementation of plasma in medical applications.

What inspired you to participate in undergraduate research?

I knew I wanted to conduct research because I am very interested in creating something new using the information I learn about in class. I like the idea of working on a project long-term and learning about a particular topic in-depth.

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

I started working in the Ptasinska Lab in fall of 2020 by reaching out to Dr. Ptasinska as her work sounded extremely interesting to me. I conducted an extensive literature review and gained familiarity with Python before I began full-time research this past summer. The College of Science was generous to provide me with funding for this summer's research through COS-SURF.

Where was your research experience located?

The Radiation Research Building at the University of Notre Dame

What did you get out of your research experience?

I learned that research is not as easy as it looks! There is a lot of failure involved with experiments, but an open mind and persistence are the keys to success. I also greatly enjoyed the collaboration on projects with graduate students and my research advisor.

Investigating the Relationship between Intracellular pH and Cell Polarization using Archaerhodopsin as an Optogenetic Tool

Christina Troll
Major: Biochemistry
Advisor: Katharine White, Department of Chemistry and Biochemistry, University of Notre Dame
Coauthors: none

Intracellular pH (pHi) dynamics have been linked to the regulation of normal cell behaviors such as cell polarization, cytoskeleton remodeling, and migration. However, studies linking increased pHi to these cell behaviors have been performed using non-specific pHi manipulation tools and analyzed at the population level. Previous work done in the lab characterizes Archaerhodopsin (ArchT) as a light-activatable tool to increase pHi in single cells. In that work, they showed that pHi could be increased by 0.1-0.35 pH units over the minutes to hour timescale. The same previous work also showed that increased pHi is sufficient to drive membrane ruffling in single cells. In this work, we will be expanding upon previous work and will apply ArchT to investigate whether increased pHi can drive polarization changes in single cells. Our hypothesis is that stimulation of ArchT will increase pHi and drive single cells to both polarize and migrate when these behaviors would otherwise be inhibited. Using a wound healing assay, the role of pHi in driving single-cell migration and polarization can be tracked. By lowering the pHi, which has been shown to inhibit these behaviors by previous work, ArchT could be activated. This should raise the pHi locally, allowing the cells to adopt the ability to polarize and migrate once again. These results would allow us to conclusively elucidate for the first time if increased pHi can drive single-cell polarization and migration. This work has implications in understanding cancer metastasis, as metastasis is inherently a single-cell process. Understanding the role of pHi in driving this behavior would allow us to better target metastasizing cells for treatment.

What inspired you to participate in undergraduate research?
I love getting hands on experience in scientific research. Actually being able to participate in experiments outside of the classroom setting has been extremely rewarding.

How did you get your research position, and what preparation did you undertake for it?
I was able to get my research position by contacting the P.I. of my lab Katharine White. Upon interviewing with her, I was granted acceptance into the lab. In order to prepare for this, I read Dr. White's previous published works and completed some of the additional training.

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

What did you get out of your research experience?
I was able to learn some of the scientific thought process behind designing and altering experiments, as well as entering a community of likeminded individuals who all seek to create advances in the scientific community for the benefit of others.

Thermostability and Activity Study of Epistatic Relation in Clinical Mutants of OXA-24/40

Haizhen Zhang (Vita)
Advisor: Jeffrey W. Peng
Coauthor: None

Carbapenems are a class of highly effective antibiotic agents commonly used as a treatment of severe or high-risk bacterial infections. This class of antibiotics is usually reserved for known or suspected multidrug-resistant (MDR) bacterial infections. Carbapenem-hydrolyzing Class D *β-lactamases* (CHDLs) is known to hydrolytically inactivate β-lactams ring in carbapenem antibiotics, causing antibiotic resistance. Thermodynamic stability assay which demonstrates flexibility and substrate activity assays of the three known clinical single mutants N87I, G224D, as well as double mutant N87I/G224D indicates epistatic coupling relationship of N87I and G224D. Profiles of backbone dynamics were done using 2R2-R1 TROSY methods and complementary assays of carbapenem binding were done using Differential Scanning Fluorimetry. The dynamics profiles of stability and activity for the three constructs were compared to the wild type and to each other.

What inspired you to participate in undergraduate research?

I am fascinated by the wealth of information NMR protein study can offer about protein dynamics in solution, instead of in solid-state, as most crystallography structure studies of protein. I am also interested in studying the physical basis of protein that can potentially help to build a model to predict how protein mutation can affect drug resistance.

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

I was introduced to multidimensional NMR spectroscopy used to study protein dynamics in Dr. Peng's Physical Biochemistry course. I reached out to Dr. Peng and submitted a research proposal to the Notre Dame College of Science Summer Undergraduate Research Fellowship, which provided funding for my research over the summer.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

In my senior year, I will continue to work in the Peng Lab and finish my senior honors thesis. I have learned not only techniques and instrumental methods, but also independent problem-solving skills during summer research. It also solidified my decision to apply to a biochemistry graduate program doing research similar to the Peng lab.