Notre Dame Science

Summer Undergraduate Research Fellowships

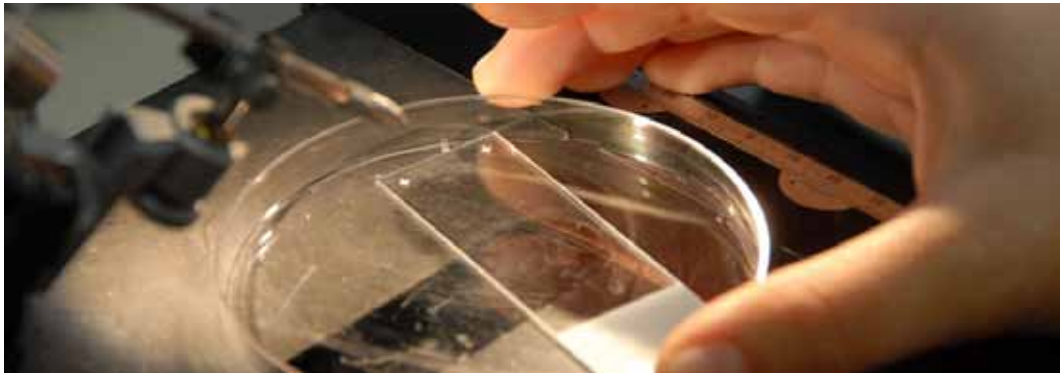
Notre Dame Science

Undergraduate Research

The possibilities for undergraduate research are almost endless, often limited only by the student's imagination.

Some students conduct original research on campus during the academic year while others conduct research through numerous other programs, both on campus and around the world. Forty-five College of Science students received support from University of Notre Dame endowments to conduct research during the summer of 2009, and many of those students are featured on the following pages. Under the direction of a research mentor, each student typically worked for 9-10 weeks on an original research project.

Beyond engaging in scientific research, the University of Notre Dame students communicated the results of their research through presentations and publications, and deepened their own experience, knowledge, and preparation for life after their undergraduate years.



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Working in collaboration with alumnus Thomas Kelley, biologist Michelle Whaley, graduate student Kara Huegel, and the Cell Biology Team was an incredible experience that allowed me to not only participate in a full time research project, but also helped me to discern whether or not I desire to pursue a career in research. Realizing that I thoroughly enjoy research, I learned new skills and developed proficiency in techniques that will become critical as I continue on my journey towards attaining a Ph.D in Biological Sciences. Due to the independence of this project, my experience helped me gain more confidence in the laboratory, which helped in greatly improving my scientific creativity and efficiency.

Some of my responsibilities this summer included participating in a weekly journal club, maintaining cells, and working on the western blotting. These tasks were particularly beneficial because they allowed me to work both with a group and independently in a laboratory. The aid from my peers was not only useful in the physical lab work, but also as we bounced ideas off each other while planning and troubleshooting experiments. We entertained each other during slow parts of the day, which helped to keep us motivated and alert. Overall, my summer research was a great experience that allowed me to thoroughly explore life in a laboratory.

Advisor: Michelle Whaley
Mentor: Thomas Kelley

Studying the effects of cholesterol-lowering drugs on cystic fibrosis cells

During my summer research experience, I had the opportunity to work on a cell biology research project with mentor Thomas Kelley, advisor Michelle Whaley, and a team comprised of three of my undergraduate colleagues. The atmosphere in the laboratory was a pleasant mix of hard work, critical thinking, and fun.

One of the valuable things I learned this summer in addition to new laboratory techniques was creating a protocol and making a budget. Each group member researched exactly which protocol would best fit each experiment and what supplies were needed. I greatly benefited from this high degree of independence because it allowed me to understand research from planning an experiment to analyzing the results.

Whenever a member of the research team was having trouble with a part of their procedure, we would jointly discuss the experiment and look closely at each step to solve the problem. We also collaborated with advisor and mentor through Skype and email. This work method allowed us to have a great deal of independence, but also made resources available to us if we had a hard problem to solve.

Overall, I had a great time and learned many new laboratory techniques this summer. The amount of trust that my advisor and mentor had in me gave me great confidence that I could successfully perform my experiment.

Advisor: Michelle Whaley
Mentor: Thomas Kelley


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jose alfredo blackey-ruiz

Studying the effects of cholesterol-lowering drugs on cystic fibrosis cells

My summer research experience was very productive. My research group did research on cystic fibrosis and was able to produce statistically relevant data that demonstrated that the drug miglustat reduced cholesterol accumulation in cystic fibrosis cells and reduced the levels of activated the protein complex NF-kB in the nucleus of cystic fibrosis cells. Since NF-kB increases transcription of many of the inflammatory proteins, this indicated a correlation in miglustat's affect on cholesterol accumulation and inflammation.

Overall, this experience was good because it gave us independence in our research while still giving us resources in case we ran into trouble, it gave us an opportunity to finish the work we had started during the semester, and it gave us a good look at the research process. This is a great opportunity for an undergraduate since many times undergraduate researchers are unable to play a very large role in deciding what questions are being asked and designing the experiments with which to answer them.

This experience showed me that I really do enjoy doing research and that I want to do it in the future. I hope that other groups will have the opportunity to do this next year.

Advisor: Michelle Whaley
Mentor: Thomas Kelley

Studying the effects of cholesterol-lowering drugs on cystic fibrosis cells

This summer, I participated in an independent undergraduate research project under the direction of a research mentor, Notre Dame Alumnus Thomas Kelley, and an on-campus advisor, Michelle Whaley. My experience was both intellectually challenging and personally rewarding.

I, along with three research colleagues I had worked with throughout the previous semester, worked in the Cell Biology labs in Jordan Hall of Science.

My colleagues and I decided at the beginning of the summer that we each wanted to work on our own independent research with the understanding that we would each be additional support to each other. This way, we each specialized and became proficient in a technique that we had become acquainted with throughout the semester. I was responsible for running a luciferase assay. This system worked incredibly well, since everyone was willing to help if a particular person was having a rough week.

Thomas Kelley held weekly videoconferences using Skype, and we would send emails to him as needed to ask more technical questions that would arise. I am incredibly grateful to have been given the opportunity to research this summer. The program was the perfect balance between necessary support and intellectual independence so that I feel as though I truly grew as a researcher.

Advisor: Michelle Whaley
Mentor: Thomas Kelley

cecilia scrafford

katie washington

Determining genes required for epidermal grow factor receptor dependence in lung cancer tumors

Recently, Raffaella Sordella, of the Cold Spring Harbor Laboratory, and other scientists demonstrated that some lung tumors were dependent on epidermal growth factor receptor (EGFR) and its downstream signaling cascades. By treating patients with a drug called gefitinib, the scientists inhibited EGFR, and substantially reduced the tumors. This summer, as a participant in the Cold Spring Harbor Laboratory Undergraduate Research Program (CSHL-URP), I used a new technique to determine which genes are required for EGFR dependence in lung cancer tumors. Additionally, I hope to determine which genes contribute to the tumors' eventual ability to overcome treatment with gefitinib.

My project in has been a remarkable opportunity to apply knowledge acquired from my coursework to an exciting problem with substantive consequences. While I employ my newly acquired technical skills to perform daily experiments, appropriate interpretation of my results has required me to synthesize different parts of my scientific background into relevant, sound conclusions.

My experience at CSHL this summer has helped me to solidify my plans to incorporate both clinical medicine and medical research into my life's work. In the fall of 2010, I hope to matriculate into a combined MD/PhD program in search of unconventional solutions to challenging and exciting problems in modern medicine.

Advisor: Raffaella Sordella

Characterizing unknown genes and regulatory networks that are important for normal cardiac development and function

My summer research project focused on developmental genetics and heart formation. My goal was to characterize unknown genes and regulatory networks that are important for normal cardiac development and function. I screened the drosophila genome for genes that interact with the transcription factor Doc A to regulate dorsal vessel (heart) development. Proper heart formation is critically dependent upon intercellular signaling and regulated gene expression using transcriptional effectors and signal transduction pathways. I identified many important chromosomal regions by narrowing down the deficient regions and identifying promising genes.

I plan to continue screening throughout the school year and move closer towards my goal of locating a significant interaction between heart development and a specific gene mutation. The identification of genes required for heart formation is relevant to the study of congenital heart disease, one of the most common birth defects.

After a summer of research, I have learned that the road to discovery is often long and meticulous. Nevertheless, discovery through research is a powerful tool in answering the greater questions of our world. Working in a genetics lab has allowed me to gain both the tools and knowledge to become a better researcher and scientist, and I hope to continue broadening my horizons through laboratory investigation during my college career.

Advisor: Robert Shulz

katherine dorociak

jason miller

The promise of an omega-3 fatty acid supplement ingested prior to the Whipple procedure

This past summer I participated in the Indiana Clinical and Translational Sciences Research Summer Program hosted by the Indiana University-Purdue University at Indianapolis. As a part of this program, I was paired with a research team consisting of Dr. Thomas Howard, an internal surgeon and associate professor at the Indiana University School of Medicine, and Chad Short, a fourth year medical student.

As a member of this research team, I aided in the development of a grant proposal documenting the promise of an omega-3 fatty acid supplement ingested prior to the Whipple procedure, currently the only surgical option in cases of cancer in the head of the pancreas. My research required extensive investigation of current medical literature and also provided the opportunity to observe Dr. Howard in the operating room on a number of occasions. As a result of my summer with the Indiana CTSI program, I gained an understanding for the regimentation of grant proposals, an appreciation for the wealth of information available to members of the medical field, and insight into the basics of clinical research.

I am currently in the medical school application process and cannot iterate the importance of this experience for my future career in the medical field enough. The opportunity to work alongside an accomplished surgeon in addition to a fourth year medical student allowed for insight that provided both perspective and motivation for the next portion of my life following graduation.

Advisor: Thomas Howard

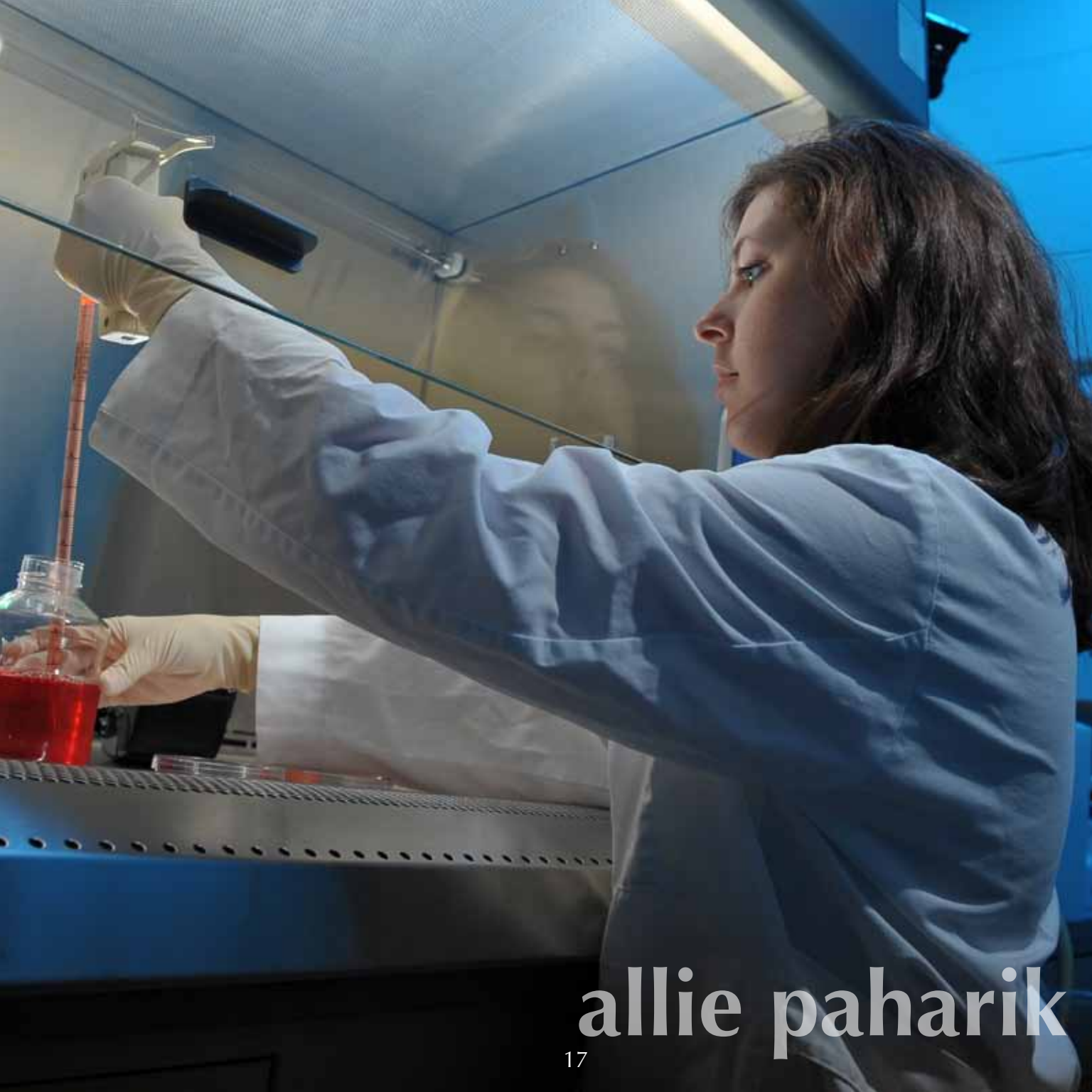
The pathogenicity of the Mycobacterium avium complex (MAC), which consists of M. avium and M. intracellulare

I performed two projects this summer in Jeffrey Schorey's laboratory. The first was an investigation of the effect of cellular secretory vesicles called exosomes on the ability of macrophages to overcome an infection with Mycobacterium bovis. The second project was an experiment on the role of the interaction between a mycobacterium cell surface component (GPL) and a macrophage cell surface receptor (mannose receptor) during infection. It is hoped that this work will be useful in creating a more effective vaccine for Mycobacterium tuberculosis, which is similar to the bacteria I worked with and is the cause of tuberculosis.

My work this summer has given me invaluable insight into the world of academic research. I have seen how my project complements the work of other lab members and fits into the larger goals of the lab. Performing my projects independently has also taught me how to organize and plan my work as well as make adjustments and troubleshoot as the process progresses. I have also become much more confident in my laboratory technique and have learned about new topics in biology.

This experience will help me to achieve my goal to pursue a Ph.D. in biological sciences. What I have learned by performing laboratory research this summer has reinforced my ambition to receive my Ph.D and continue to be involved in biological research as a university professor.

Advisor: Jeffrey Schorey



allie paharik

kristopher kast

Determining the expression patterns of putative axon guidance genes invector mosquitoes

This summer I studied the developmental roles of axon guidance molecules in mosquito species known to carry human disease. To analyze the expression of putative axon guidance genes in the developing mosquito embryo, we modified techniques for localizing gene expression in fruit fly embryos, and analyzed the expression of these genes in developmental stages that correspond to the central nervous system genesis of fruit flies. By enhancing our understanding of the roles of specific proteins in mosquito development, future translational studies may design compounds to target these polypeptides or their corresponding genes in an effort to control the populations of these vectors of human disease.

My research experience has allowed me to dive into the scientific community as a contributing member, and I have gained valuable insight into the most basic details of conducting laboratory research. In our field of basic research, much of what we are doing has never been done before. We are forced to formulate procedures or modify existing ones to meet our needs. We approach problems with an optimistic understanding that the truth is within our grasp if only we can figure out how to seize it. By expanding my knowledge of the numerous approaches to scientific problems, this summer has better prepared me for a career in biological research.

Advisor: Molly Duman-Scheel

Identification of Cytochrome P450(s) Responsible for Metabolism of Gelatinase Inhibitors

My research this summer involved working with a series of gelatinase inhibitors discovered by the Mobashery lab. These compounds have shown great promise in animal models of cancer metastasis and stroke, so it is important to determine which enzymes are responsible for their metabolism in the body. In this study, two of these gelatinase inhibitors were separately incubated with individual purified CYP enzymes to qualitatively determine which enzyme(s) produce the metabolites. This data will provide a basis for further study of how these compounds react in the body, and hopefully bring these drugs one step closer to human clinical trials.

Going into this experience, I never thought that lab work I can do as an undergraduate could help advance a potentially clinically beneficial drug, but this project taught me that I do have the capability to produce important results. This experience far exceeded my expectations in terms of the significance of the work I performed and the responsibility that comes along with it.

I plan on pursuing a career in medicine, but this research exposure has also encouraged me to continue to do research throughout my time in medical school.

Advisor: Shahriar Mobashery

rachel staran

sara fossum

The role of endocytosis of apoptotic photreceptor cells in signalling Müller glia proliferation

This summer I investigated the regeneration of the retina in zebrafish following damage to the retina. I studied the Müller Glial cells, which are located in the retina and divide following retinal damage to replace dead cells. The results from this research will contribute to two publications. In addition, it takes the lab one step closer to understanding the complexities of the zebrafish retina. Understanding the zebrafish retina has eventual medical applications for humans; it can be used to develop treatments for human retinal disorders.

This experience exceeded my expectations of what research involved. Through my lab courses, I had merely been exposed to basic skills. During my time in the lab this summer, I learned that research is much more than running western blots and mixing chemicals. There is a lot of intellectual investment and creativity involved with designing experiments and interpreting results.

My time in the laboratory has helped me develop skills that will help me in graduate school and my career, like reading and understanding scientific literature, designing experiments to answer a scientific question, and presenting research. This experience has also allowed me a glimpse of what a future in research will be like.

Advisor: David Hyde

Assessing the stability of MHC-peptidomimetic complexes through temperature-graded circular dichroism

A prospective target for vaccine development utilizes the body's adaptive immune response by inducing the stimulation of T-cells, which detect and destroy cells infected with disease. In order to stimulate an adaptive immune response, a protein complex on the surface of the cell displays an antigen to the T-cells. One antigen in particular, Melan-A/MART-1, is known to be displayed on the surface of most melanoma tumor cells. A series of analogues have been synthesized to mimic the MART-1 antigen with the expectation that the analogues will overcome barriers of natural antigens. My project is to determine the stability of this set of analogues with the display molecule.

As the project progressed, I was faced with many hurdles. Procedures that should have worked, did not always work. It took strategizing on my own and in collaboration with my colleagues to find new ways to continue the experiment.

Overall, my research experience has helped me grow and prepared me for the future. I plan on becoming a physician scientist, and the medically relevant content of my research as well as the skills that I have gained will be useful to me when performing my own medically influenced research and when interacting with peers and patients.

Advisor: Brian Baker

priscilla do

maureen early

Effects of an Orexin antagonist on Inverse Benzodiazepine Agonist-induced Anxiogenic Behavior

During my summer research experience, I participated in psychiatric research for about two months through the Institute of Psychiatric Research, part of the Indiana University School of Medicine. The research projects that I worked on in the laboratory of Anantha Shekhar consisted mostly of animal behavior testing, specifically testing anxiety behaviors in lab rats. Due to our involvement in the experiments and the paper-writing process in the lab, undergraduate Scott Barton and I each may be co-authored on up to two scholarly articles submitted for publication by the Indiana University Institute for Psychiatric Research.

With a very limited knowledge and preliminary idea of what research would be like before this summer, my understanding of the job of a research scientist really formed due to this experience. I found myself capable of understanding the material to a degree that was very satisfying for me as an undergraduate student and found myself capable of conducting it, writing about it, and presenting it to other research scientists as well. This program helped build my confidence as a scientist and has made me aware that doing research as a professional scientist is a very realistic possibility for my future.

Overall, this research experience has helped me grow as a scientist and as a person trying to discern what I should do with my talents.

Advisor: Philip Johnson

The Role of the Lrp5 Pathway in the Regulation of Bone Growth

Over summer, I conducted research at the Indiana University School of Medicine in Indianapolis through the Indiana Clinical and Translational Sciences Institute. My advisor, Alexander Robling, who studies the mechanisms of bone growth, helped me learn many different skills, including how to conduct RNA analysis, microCT scanning of bones, and fluorescent microscope imaging. I worked on many different projects, all of which were designed to understand how the body regulates bone growth through the Lrp pathway. Mutations to the gene encoding for the Lrp5 protein can cause an individual to develop very dense bones, and understanding how these mutations function may lead to the discovery of new treatments for osteoporosis.

I conducted research with an ecology lab here at Notre Dame throughout my sophomore year, so I came having previous research experience. However, I still benefited greatly from being able to compare the two labs. Both experiences have taught me that research requires critical thinking, patience, perseverance, and teamwork.

My future plans are to go to graduate school for a master's in education and teach at a middle school or high school. Alternatively, I would also consider a research-based occupation that involves working in a lab.

Advisor: Alexander Robling

marita neidecker

james masters

Titanium-Catalyzed Ring-Closing Reactions

During this past summer, I performed research in synthetic organic chemistry, in the laboratories of Dr. Brandon Ashfeld. My research focused on the development of a titanium metal-catalyzed reaction which provides cyclic (closed-ring) molecules from acyclic starting materials. The use of only catalytic amounts of the titanium complex—and the high yields associated with the reaction—make this reaction an extremely economical means of producing these structurally-complex products.

In performing this research, I have developed invaluable research skills that will serve me throughout my scientific career. Nearly every day, I learned a new technique or faced an unexpected research problem that I needed to resolve in order to proceed with my project. As a result, I have developed into a more capable, independent researcher. Thanks to my summer research experience, I will begin my graduate career with a firm background in the basics of synthetic organic chemistry and academic research, and I will be better prepared to begin the independent research projects I will be required to complete.

Advisor: Brandon Ashfeld

Microbial Denitrification in an Agricultural Two-Stage Ditch

During my research experience, I have investigated nutrient pollution in agricultural streams. Excessive nitrogen runoff remains one of the most serious environmental problems linked to current agricultural practices. One recently developed nitrogen removal method is the two-stage ditch, which, unlike traditional ditches, has floodplains (benches), which are inundated during high flows. This design may increase denitrification, which is performed by soil and sediment microbes when carbon and nitrate are present and oxygen is not. This summer I investigated how bench denitrification rates change over the course of flood events and if additions of nitrogen and carbon can increase denitrification rates.

Participation in scientific investigation has taught me much about both the process of scientific inquiry and myself as a scientist. By posing questions, developing methods, and collecting data, I have seen a project through from conception to completion. I learned how to answer big questions with smaller experiments and make the results meaningful in the collective body of scientific research.

The research I have participated in has helped me decide that the next step in my career path will be graduate school, not medical school. My research in the College of Science has prepared me for the future of research and enabled me to make lasting connections with colleagues and mentors.

Advisor: Jennifer Tank

maureen williams

andrew medvecz

Synthesis and Reactivity of Organometallic Complexes with Fuel Cell Applications

One of the challenges in the current energy crisis is the inefficiency with which chemical fuels are converted into useful energy. My research project during the summer and school year examined organometallic complexes with potential applications in increasing the efficiency of a fuel cell. The results of my studies will be influential for the overall application the increasing the efficiency of the fuel cell cycle and energy research as a whole.

Research has provided me with the opportunity to grow as a scientist. One of the fundamental challenges of research is confronting new problems that have not been experienced by others. Many of the compounds I synthesized have never been made before. While this is a remarkable thought, it presents a difficulty when experiencing problems synthesizing or working with the compounds. When introduced to one of these problems, I must find a solution using available resources. As I confront these problems, I discover the importance of my research for my overall intellect.

Following my graduation from Notre Dame, I intend to enter medical school. Many of the skills I have learned during the course of my research can be transferred to the practice of medicine. I hope to take the experience in scientific investigation that I have gained through research at Notre Dame and use it to provide care for patients in my practice of medicine.

Advisor: Seth Brown

An Amazing Intellectual Experience

I worked with Dean Crawford as a Science Business intern, and assisted in writing 50 project proposals for the ESTEEM program. For every proposal, the interns met with each professor to discuss his or her research. During the discussions, we were introduced to new areas of cutting-edge science and brainstormed possible commercial applications for the research. We then chose several proposals and developed full-scale business plans consisting of market analysis, financial projections, cost analysis, competition searching, and Intellectual Property studies.

Before this internship, I had no idea of all of the amazing research that was being conducted at Notre Dame and its commercial potentials. Now that I have seen the many applications of the science I have been studying, I can think outside of the box to find novel solutions to a problem.

My internship was an amazing intellectual experience and has been rewarding on a number of levels. The one-on-one interaction with professors and entrepreneurs has taught me many lessons that could not have been achieved in a classroom setting. This research experience has also shown me the many possibilities of a career in science entrepreneurship. I could see myself starting a science-based company in the future and feel that it is possible as a result of what I have learned in this internship.

Advisor: Gregory Crawford

michael dean

kathleen schenkel

Applying Basic Scientific Findings

As a science-business intern, I had the opportunity to learn about the basic scientific research at Notre Dame and its potential applications in diverse markets. Working with other interns, I built in-depth business plans for more developed research projects. I was able to listen and learn from the experience of successful leaders in high-end technology industries. I learned the importance of being able to apply basic scientific findings to solving problems faced in today's society. There is an amazing amount of raw scientific knowledge that can be effectively utilized in business. People need to take ideas from labs into the marketplace. I found that it is possible to integrate my formal business and science education in this process.

As I am contemplating a career in the legal profession, this research experience has taught me about the importance of intellectual property laws and has motivated me to investigate careers that could utilize my science background. My experience also has made me interested in eventually working for a science-based company.

Advisor: Gregory Crawford

Valuable Business Skills

My summer research project involved reviewing patents that Notre Dame currently holds and evaluating the feasibility of moving the technology to the market. This required our group to develop business plans to help create future funding for Innovation Park, the ESTEEM Program, and future research in this field. Through this research, I was exposed to vast amounts of information on the specific technology and markets they would serve, allowing me to examine the inherent connection between science and business.

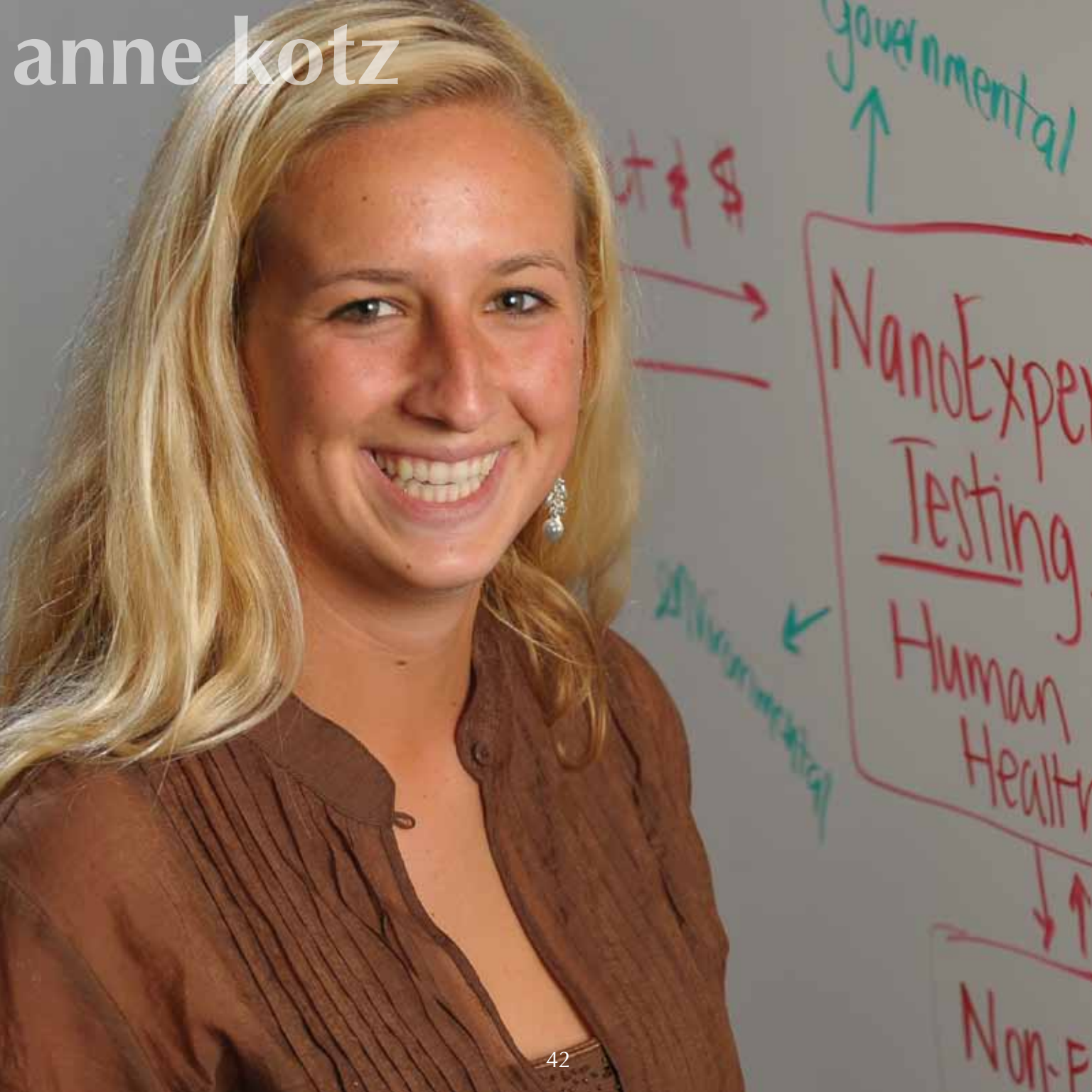
Conducting research is far different from taking separate courses in entrepreneurship or chemistry. This project provided me the opportunity to use my science knowledge and innovation while developing valuable business skills necessary in the real world. Rather then just admiring the current technology in market, I was able to get an in depth look at technological improvements that are on the horizon.

In the future, I hope to attend medical school or be part of the ESTEEM program. Either path I decide to take, I will be able to apply the skills I learned this summer. Having the ability to spot marketable technology and develop a business plan for it and understanding the business of working in the medical field are invaluable skills that I have had the privilege of acquiring and practicing this summer.

Advisor: Gregory Crawford

patrick o'brien

anne kotz



Synthesizing Knowledge

As a science, business, and entrepreneurship intern, I explored a rapidly growing area of science, where science and business interface. My intern team met with professors in the College of Science to discuss the types of research being done in their labs and possible commercial applications for this research. After creating project proposals from these discussions, the team developed commercialization plans that will be taken to Innovation Park, where investors can look at these ideas in an open, collaborative environment.

After that summer, I can now use the analytical skills that I have developed as a College of Science student and take scientific research concepts and transform those ideas into a commercialization plan that could be used as the foundation for a new company. The future of our world will face many obstacles, and our generation must find the solution to all these hurdles. Scientific professionals must be a catalyst for change by brainstorming ideas, guiding investments in research, and focusing scientific decisions on a more global scale in order to give science an upper hand in making a difference in the world.

This experience has enabled me to explore the possibilities that I have as a graduate of the College of Science. I look forward to applying my scientific knowledge in a business setting to help solve the problems that the world will face in the future.

Advisor: Gregory Crawford

A Unique and Rewarding Opportunity

I was afforded the unique and rewarding opportunity of being a Science-Business intern. The five week experience I had over summer furthered my knowledge of the relationship of these two fields, and provided me with extremely valuable skills and information that can help me no matter what career path I decide to follow in the future.

The most remarkable aspect of my internship experience this summer was learning about research conducted here at Notre Dame. The research of both students and professors at Notre Dame is fascinating, and it has the ability to make a significant impact on the future of our world.

Notre Dame research is important for the future as it has the ability to provide many benefits to society as a whole and the health of individuals. A notable amount of the technology that results from Notre Dame research focuses on being more energy-efficient by making better use of natural resources through science innovation. The health of many individuals could also be improved as a result of these research efforts. Notre Dame is committed to finding cures to rare diseases that often do not receive adequate research attention. Aside from the benefits this research provides, it also coincides with the Catholic mission of the University as the fruits of this research will uplift the dignity of the human person and increase the common good of society.

Advisor: Gregory Crawford

lauren fowlkes

rachel vandergenugten

Promoting Innovative Ideas

During my summer experience, I had the pleasure of working with some of the finest faculty at the University of Notre Dame. After three years of being a science student, I had no idea of the research my professors were doing behind the scenes. Meeting with faculty, learning about their ideas and sharing their passion for science and innovation was just a mere glimpse of the exciting work my fellow interns and I were able to do.

After writing over 50 proposals for the future ESTEEM students, we were able to immerse ourselves into a few projects that caught our attention. We took these projects, and alongside the professors, developed business plans to help promote the innovative ideas that Notre Dame faculty were creating. Writing these business plans allowed us to see not only the science side of an idea, but also the necessary marketing and financial planning that must be in place to have a successful product.

Throughout the internship, I was fortunate enough to come in contact with many passionate individuals. Meeting all these people helped open my eyes to all the career choices that are available for science-business majors. Simply being in the classroom does not offer the exposure to the growing career fields involving both science and business.

Advisor: Gregory Crawford

katherine manley

An Interdisciplinary Analysis of the Causes and Effects of the Current Economic Crisis

During my research experience, I created a precise explanation of the economic crisis that our country is currently attempting to rectify. By researching exploited financial instruments, I created an outline of the collapse of the mortgage market. Through further research, I found a correlation between the collapse of the mortgage market and the fall of other assets in different sectors. This research will lead to a systematic analysis of this crisis and a model of the fluctuations in the economy.

Through this research, I participated in a fusion of multiple research fields. As a mathematics and business administration major, it was beneficial to work with faculty from both the mathematics and finance departments. Merging these departments in my research allowed me to gain a more comprehensive knowledge of both fields. Notre Dame has offered me the unique opportunity of researching in a primitive area.

My research experience as an undergraduate has been tremendously rewarding and an invaluable asset to my education. As this is a current situation, I hope to continue following the repercussions of this economic crisis and formulate more accurate mathematical models to represent the economy. Not only have I expanded my learning, but also I have gained resources, confidence, and experiences that will contribute to success throughout my career.

Advisor: Alex Himonas

Mathematical Methods in Financial Economics Workshop

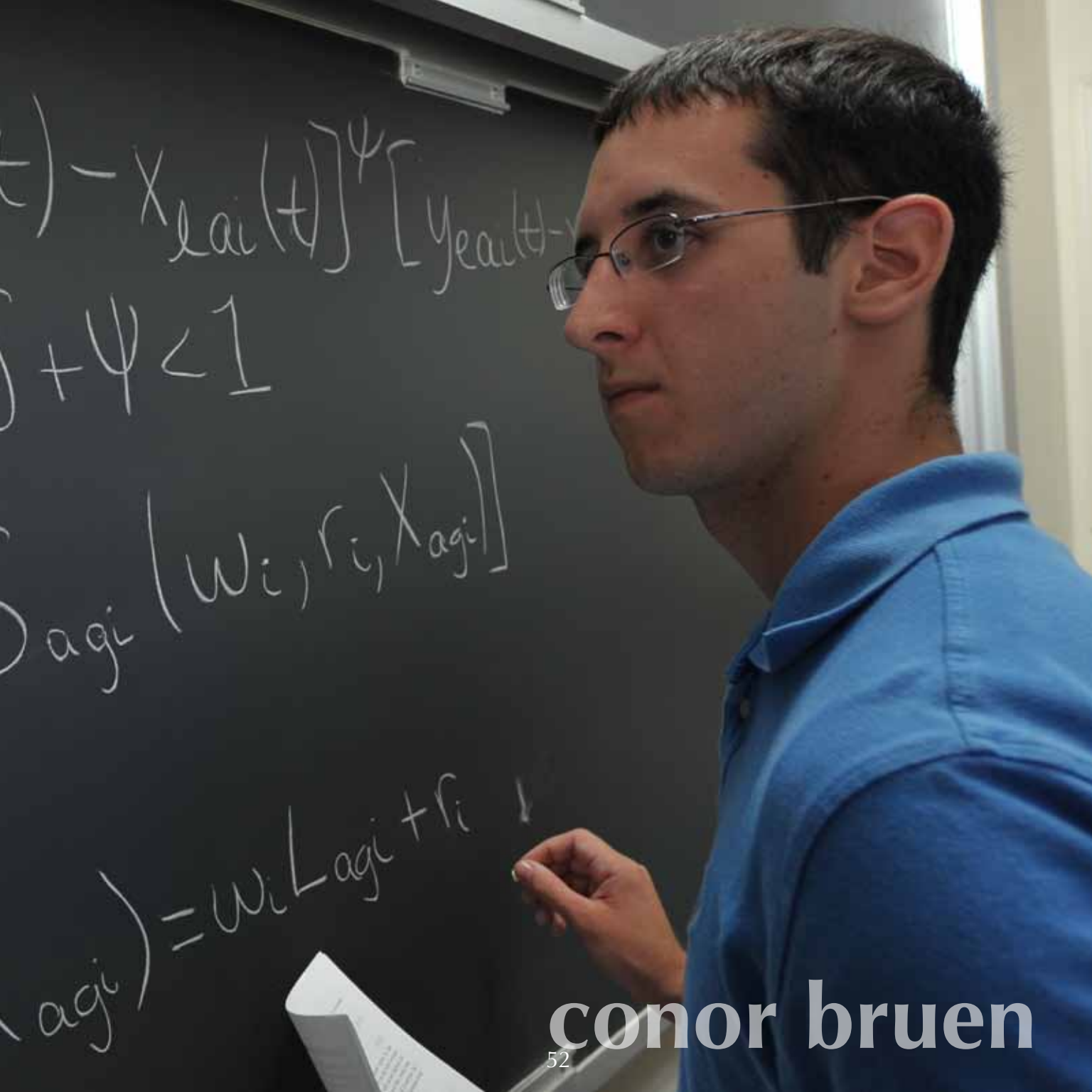
Over the summer, I did interdisciplinary work between the mathematics, finance, and economics departments. We examined many different economic and financial models, ranging from asset pricing to international trade to growth, taking a very rigorous mathematical approach to understanding, explaining, and understanding them.

The major problem I worked on dealt with the economic modeling of sustainable development. It truly is exciting—not to mention urgent—research. It is no secret that the depletion of our planet's resources and the negative effects on the environment wrought by global economic activity are an area of grave concern, and may be causing irreversible damage as we speak. Still, though, few economic models account for resource depletion and pollution. For example, the model which policy-makers in Washington use to account for the interplay between economics and environment is extremely weak. It does not account for uncertainty, the prices of distinct goods, or, most importantly, the production processes which occur in the different sectors of the economy. Thus, our current work focuses on producing a rigorous mathematical model, which accounts for the actual physical activity and environmental consequences of the global economy.

I am constantly amazed at how far I can push myself based solely on the knowledge that I am trying to solve a legitimate problem with real implications for the world and future generations.

Advisor: Alex Himonas

kyle dempsey



conor bruen

Financial Mathematics Applications in Sustainable Energy Development

The goal of my research was to take mathematical methods used in the subjects of Finance and Economics and apply them to the issues we are encountering in the energy sector. More specifically I am researching the situation created by the production of ethanol for fuel. Using data on the efficiency of ethanol production I tried to determine the most efficient allotment of resources relating to its production taking into account as many aspects of the economy as possible. If we can create evidence to support a potential solution to even some aspect of the problem, it can benefit people across the country and the world.

My experience researching this summer has been special because it has taught me about solving problems that are different than those posed in everyday classes. The problems that I am looking at don't have known solutions, and that makes the process of solving them much more daunting, but at the same time more rewarding. The lessons I have learned from this research presents great advantages for my career prospects. My research has provided me with a very rewarding experience that will hopefully continue to produce results over the next two years that I spend at Notre Dame and after that in whatever career path I choose.

Advisors: Alex Himonas and Tom Cosimano

Small part in the large quest to determine a nuclear 'equation of state'

I worked on a project that is a small part in the large quest to determine a nuclear "equation of state". Such an equation would relate important properties of different nuclei. I worked on a project that will eventually lead to the determination of nuclear incompressibility, which measures how much energy it takes to squeeze a nucleus. This research is exciting because a nuclear equation of state would have significance beyond the world of nuclear physics that reaches into astrophysics. For example, nuclear incompressibility determines whether a neutron star will explode into a supernova or collapse into a black hole.

A wonderful opportunity enriched my summer research. In May I traveled to the Research Center for Nuclear Physics at Osaka University, and while there I was able to collaborate on an experiment.

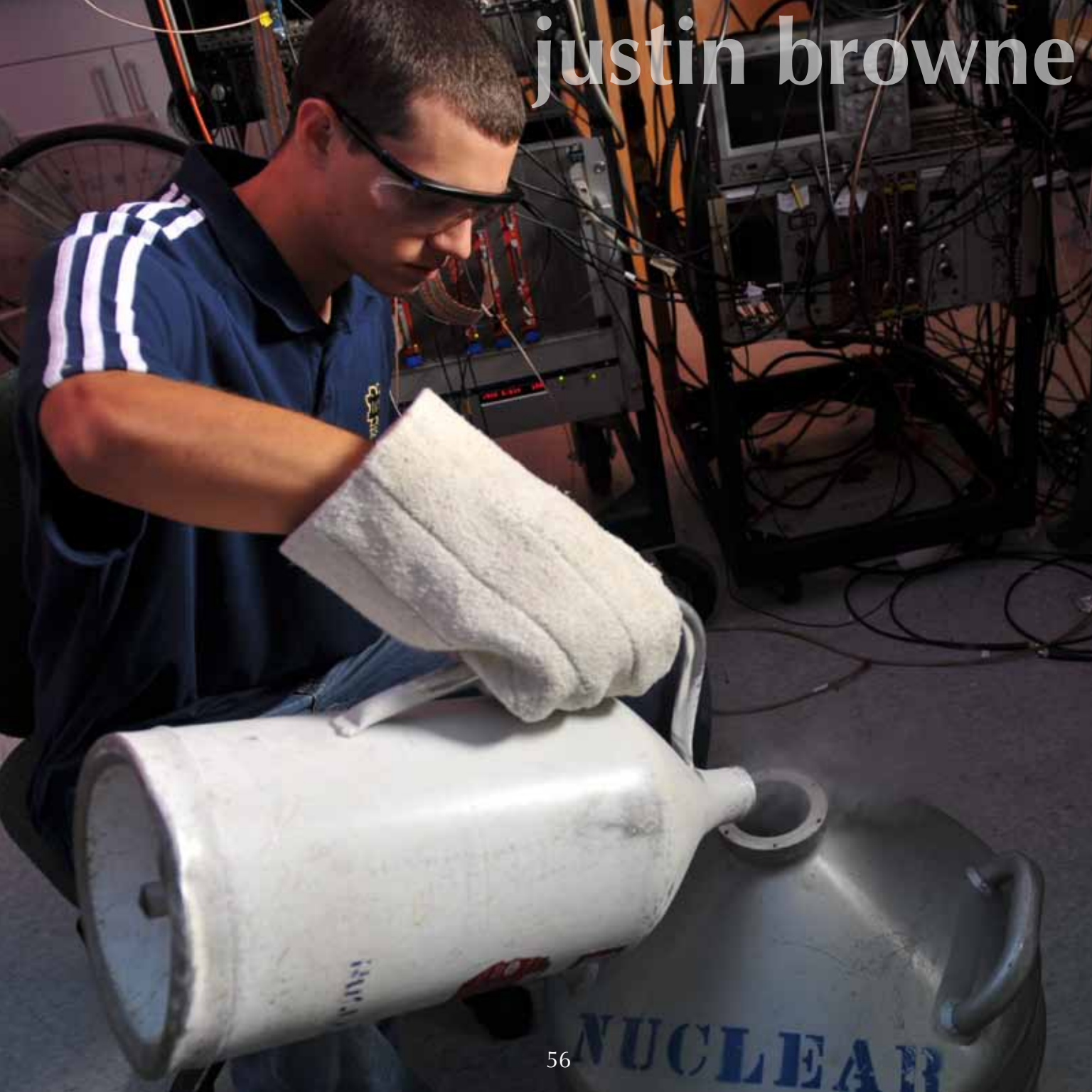
From this experience, I learned that sometimes research has setbacks that must be overcome in order to succeed. Also, I saw the importance of teamwork in research.

I am currently applying to medical school. I hope to continue researching throughout my career; however, I intend to switch from nuclear physics to a more medically related field.

Advisor: Umesh Garg

molly white

justin browne



Determination of neutron branching in the 12C+12C reaction

Almost all the elements heavier than Fe are formed through the s- and r-processes, which require an abundance of neutrons. One way that neutrons are produced is through the 12C (12C,n)23Mg reaction happening inside of stars. The neutron production yield is determined by detecting the b+-decay of 23Mg, which will help us understand the rate at which this reaction occurs in stars.

Over summer I developed and tested a compact plastic scintillator array for efficiently detecting □-particles, and gathered information about 23Mg decay to determine the amount of 23Mg that was produced in each experiment. With more experiments like this, we can eventually find out how fast this occurs in stars and compare it the model we use to understand how stars evolve.

This was a great learning experience for me because I went through the complete development cycle for the detector . Throughout this process, I learned how to use all the machines in the machine shop to make parts, electronic devices to process data, and ROOT to analyze the data.

Even though I worked with the same advisor and group that I've been working with for the last two years, I've learned a lot of things, mostly because my entire day is dedicated to research, instead of having hours of classes and schoolwork as my first priority. I think I've gotten a glimpse of what doing research in graduate school might be like, and I am pretty sure I want to go to graduate school now.

Advisor: Xiao-Dong Tang

Magnetic Vortex Properties of the MgB2 Superconductor

During my summer research experience, I worked with Professor Eskildsen to study the behavior of magnetic vortices in the Magnesium Diboride (MgB2) superconductor. Our goal was to verify the vortex flux quantization, construct a detailed vortex lattice (VL) phase diagram, and explore the existence of metastable vortex lattice states.

I accompanied Professor Eskildsen to the Institut Laue Langevin (ILL) in Grenoble, France, to perform a Small Angle Neutron Scattering (SANS) experiment. The ILL is the world's most powerful research reactor and the premier facility to conduct VL measurements. The experiment consisted of a neutron beam diffracted by the magnetic vortices as it passed through the sample. This beam then stroked a position-sensitive detector that tracked the number of times that each location was struck. Using the data from this experiment, we confirmed flux quantization, constructed a large portion of the phase diagram we set out to determine, and discovered the existence of metastable VL states.

I learned an incredible amount about experimental physics this summer. I have always planned on going to graduate school in physics, and my research experience will undoubtedly help make me an attractive candidate. Through this experience, I expanded my intellectual capabilities and broadened my experience base, both of which will eventually define me as a scientist.

Advisor: Morten Eskildsen

thomas o'brien

robert schafer

Nanoparticle studies using Laser Transmission Spectroscopy

Over the course of my research experience, I worked with a biophysics group to test the limits of a laser system that measures viruses and bacteria. Using milk as my main substance, I saw how diluted I could get a sample without it disappearing, or what the smallest particle that the system could detect was. I also worked with aluminum oxide particles in conjunction with a geosciences group studying iron oxide nanoparticles in order to analyze their properties under different circumstances.

In the future, my research could be miniaturized to provide a portable microorganism and nanoparticle analyzer with very diverse and far-reaching uses, such as on a battlefield to determine if something is safe to drink, or in a hospital to check for viruses and bacteria in the blood.

As a result of my research project, I have become much more involved in discussions as I learned more and more about this field of physics. My summer experience has given me a clear view of what an academic science career consists of. I now know that while research can be tedious, it can also be exciting. I entered this project with very little knowledge of advanced physics, and now I have a better understanding about optics, especially at the nano level, and the mathematical theory behind my research.

Advisor: Steven Ruggiero

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