

EXCELLENCE

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Excellence is achieved through hard work and determination. Through persistence. And through planning and collaboration. At Notre Dame, faculty and students combine these traits with strong mentorship and principles guided by the ethics and values present since the University was founded in 1842.

In this issue of Notre Dame Science, we share a digest of news and stories from the past year—stories about how striving for excellence has led to many scientific breakthroughs. Our cover story highlights the success of John Grieco '90, formerly mentored at Notre Dame by George B. Craig, Jr., one of the world's foremost experts on malaria. Grieco, now a research associate professor, is following in Craig's footsteps and, along with



research professor Nicole Achee, is developing a novel repellent to curtail the spread of vector borne diseases caused by mosquitoes.

Excellence is demonstrated throughout the College of Science through other projects and research as well. These include the search for therapies that may help heal diabetic foot ulcers, and discussions about how mathematical algorithms may, in fact, be biased. Excellence happens when we share our work with the world, as Notre Dame particle physicists and their collaborators did with the introduction of the QuarkNet program two decades ago.

I am honored to share the many ways that we are touched by excellence through the work of our faculty and students in all of their scientific endeavors.

Sincerely,

MARY E. GALVIN, Sc.D.
William K. Warren Foundation Dean of the
College of Science
Professor of Chemistry

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Front cover photo:
Anopheles mosquitoes feed in the lab of
John Grieco and Nicole Achee, which
is kept at 80 degrees F and 80 percent
humidity to mimic the tropical climate
the mosquitoes prefer.



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ALSO FIND US ON



Partnership solidified with Chilean university

Universities can work independently to advance new discoveries through scientific research. Collaborating with other institutions, however, sparks greater advancements and innovations by tapping into the unique opportunities each academy holds.

The College of Science at the University of Notre Dame has cemented a partnership with the five schools of science within the Pontificia Universidad Católica de Chile, as part of the Chilean government's new initiative, "Science and Innovation for 2030."

"We are pleased to have forged this partnership between the two universities," said Mary Galvin, William K. Warren Family Foundation Dean of the College of Science. "Not only does this collaboration solidify a relationship that began with the exchange of professors, students, and

ideas, but it will also advance science by harnessing each institution's strengths."

Notre Dame and Católica hold a similar worldview despite being in different hemispheres, and can offer varied research opportunities, according to Michael Hildreth, associate dean of research and graduate studies for the College of Science. For instance, Notre Dame students and faculty will have access to Católica's world-class telescopes and astrophysics opportunities.

Notre Dame researchers will be able to assist Católica with their work in computational astrophysics. And Notre Dame's history of working closely with industry, based on research findings, will be a boon for scientists at Católica as Chile has only recently recognized scientific research as a way to lead an economy through commercialization.

Notre Dame already sends students and professors to Chile for research. However, this formal partnership may also lead to an expansion of study abroad opportunities for Notre Dame students. "The official partnership will fund their ability to send people up here, and the ability to host our people when we send them to Chile," Hildreth said.

Hildreth described the partnership as a win-win for both institutions, fitting into the Catholic mission of both and fostering a spirit of diversity and discovery from which all levels of researchers can learn and grow.

"Scientific discovery doesn't happen through the work of just one institution," Galvin noted. "Science is a global endeavor." ■

Summer undergraduate research meaningful

Several undergraduate students from the College of Science spent their summers on campus conducting research. Their enthusiasm and dedication toward their projects embodied the spirit of using scholarship and creative endeavor to advance scientific understanding of the world.

Senior honors mathematics major Nicholas Rohr appreciated being able to focus on a single task. "Instead of being pulled in four different directions from classes, I could instead focus on just one thing," Rohr said. His project aimed to understand the Riemann mapping theory using circle packings, which meant he had to learn a new type of geometry that was challenging but also rewarding.

Emma Sheedy, a junior majoring in mathematics and preprofessional

studies, enjoyed engaging in work she could not do in the school year. "When I did research in the school year... I was rarely given the responsibility to help plan experiments.

Working full-time this summer, I was able to help design experiments, and I learned about the trial-and-error aspect of true scientific discovery."

Other students enjoyed spending time with their research teams, which provided a friendly and supportive learning environment for research to take place.

Senior neuroscience and behavior



student Jocelyn Gaona said, "I really enjoyed the lab environment because it fostered my learning and gave me the opportunity to expand my knowledge on a daily basis." She credits two graduate students in her lab, Alyssa Lesko and Casey Stefanski, with showing her that research is an opportunity to gain knowledge while also making a difference. ■

12th annual COS-JAM highlights undergraduate research

From poster sessions to presentations, the College of Science Joint Annual Meeting (COS-JAM) on May 4, 2018, showcased the depth of undergraduate research completed by students within the fields of science and engineering.

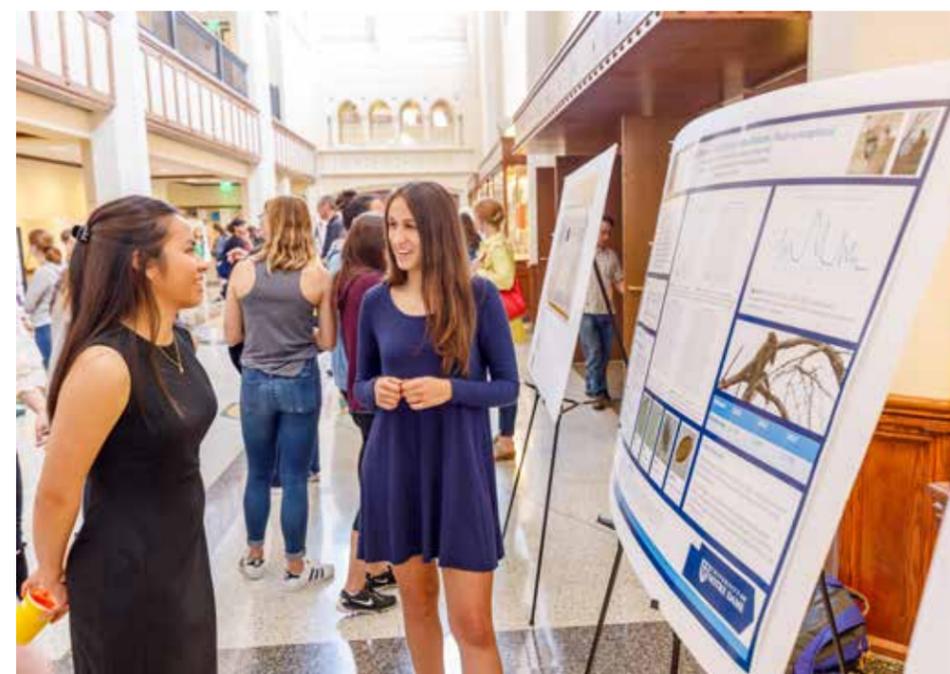
Eighty-nine students presented posters and 23 gave oral presentations during sessions held in the Jordan Hall of Science. Hundreds of students, professors, and others met with the presenters to learn more about their work.

Presenting to peers at COS-JAM is a low-stakes way for students to develop experience sharing their research. It is a skill they will use as they advance to graduate school and the workplace. "Scientific communication, like presentations at COS-JAM, is an integral part of research," said Xuemin Lu, undergraduate research director for the College of Science and assistant teaching professor in the Department of Biological Sciences. "The quality of the research and the professionalism of the students was amazing."

Research topics ranged from the study of the tiniest building blocks of life to the expanses of the universe, and a variety of topics in between.

Biological sciences junior Elise Paietta researched the effect of parasite burdens on the survival of yellow baboons. Her work was guided by Elizabeth Archie, associate professor in the Department of Biological Sciences, as well as laboratory manager David Jensen.

"I really enjoy working with all the data and learning about the baboons, and this project



helped me solidify what I really want to do," she said.

Senior Eric Lee, who is majoring in Applied Computational Mathematics and Statistics (ACMS), used mathematical formulas to attempt to predict dust storms in Saudi Arabia. The research will help pinpoint the best locations to build wind farms. He worked with assistant professor Stefano Castruccio.

"Oh man, this is everything," Lee said, his voice building with enthusiasm after being asked about the benefit of completing undergraduate research. "I've always been interested in sustainability, in energy services, and this has led me to take a couple of classes next year in sustainability. There is a lot you can do with just numbers." ■

ELISE PAIETTA DESCRIBES HER WORK REGARDING THE EFFECT OF PARASITE BURDENS ON THE SURVIVAL OF YELLOW BABOONS, RESEARCH SHE COMPLETED UNDER THE GUIDANCE OF ELIZABETH ARCHIE, ASSOCIATE PROFESSOR IN THE DEPARTMENT OF BIOLOGICAL SCIENCES.



TB survives by using host system against itself

In a new study published in the *Journal of Experimental Medicine*, scientists at the University of Notre Dame have discovered that the pathogen *Mycobacterium tuberculosis* (MTB) releases RNA into infected cells. This RNA stimulates the production of a compound known as interferon beta that appears to support the growth of the pathogen.

As part of the study the researchers found that mice lacking a key protein required for responding to foreign RNA and therefore required for interferon beta production were better able to control the MTB infection. The discovery was a surprise to the researchers, as interferon beta is essential to controlling several viral infections.

“The results suggest that our immune response to mycobacterial RNA is beneficial for the pathogen and bad

for the host. It’s the total opposite of viral infections,” said Jeff Schorey, George B. Craig Jr. Professor in the Department of Biological Sciences at Notre Dame and co-author of the study. “This study gives us a better understanding of how the mycobacteria causes disease and what makes it the most successful pathogen in human history.”

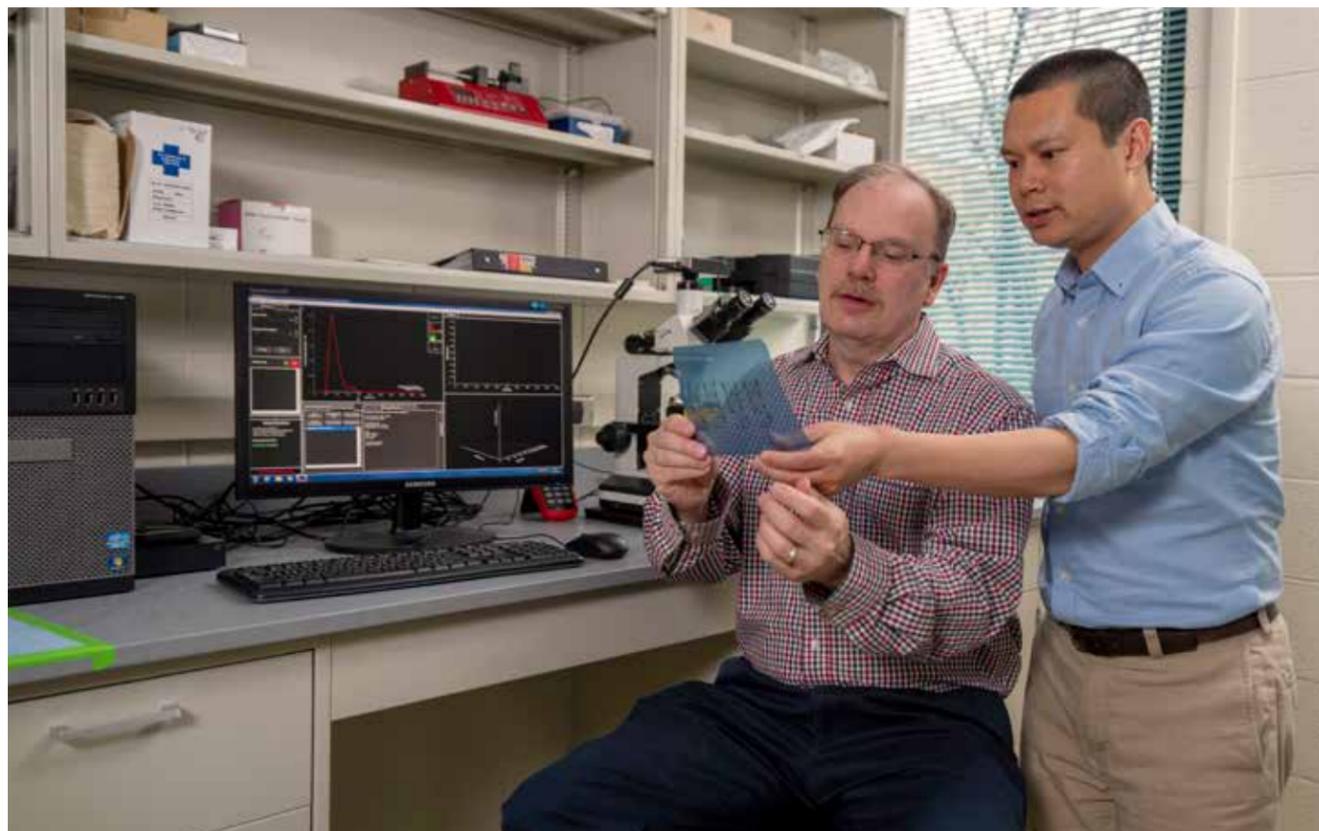
MTB infections cause a battle between the immune response and the ability of the bacteria to circumvent that response. Schorey and Yong Cheng, a research assistant professor at Notre Dame, set out to determine how mycobacteria RNA could be affecting the host response. They found that by releasing RNA, the bacteria set off a chain reaction inside the macrophage, a cell type of the immune system — resulting in a mechanism that benefits the survival of MTB through the

production of interferon beta.

Without an effective vaccine, MTB is the leading cause of death by an infectious organism and kills up to 1.8 million people each year. The disease is prevalent in parts of the world where health care systems lack infrastructure and funding.

Despite those challenges, Schorey said the study’s results show potential for the development of immunotherapies to selectively stimulate protective immune responses as a treatment option for MTB and other bacterial infectious diseases. ■

JEFF SCHOREY, GEORGE B. CRAIG JR.
PROFESSOR IN THE DEPARTMENT
OF BIOLOGICAL SCIENCES, AND
YONG CHENG, RESEARCH ASSISTANT
PROFESSOR, IN SCHOREY’S LAB.



Session held to accelerate research for rare disease cures

Medicine and patient care for those who have rare diseases is undergoing a revolution, according to John Crowley, chairman and chief executive officer of Amicus Therapeutics and founding board member of Global Genes.

And the first question he posed to researchers, drug companies, and patient advocate groups who gathered in a working session at the University of Notre Dame in October was simple: “What role can Notre Dame and universities play in this revolution?”

The collaborative session was sponsored by Amicus Therapeutics and drew stakeholders from across the country who discussed strategies for advancing research, bringing new drugs to market, advocating for patients, and disseminating information about rare diseases, among other topics.

Overall, the working session highlighted the need for more collaboration in order to find cures for rare diseases. Partnerships among all stakeholders—foundations, academic researchers, industry, and government—are critical to bringing ideas to the forefront.

“It’s hard to be collaborative,” said panelist Jennifer Bernstein, executive vice president of Horizon Government Affairs. “Yet, that’s where the magic happens.” ■

Scientists discover potential method to boost cancer immunotherapy

Immunotherapy — harnessing T-cells to attack cancer cells in the body — has given hope to patients who endure round after round of treatment. For all of its promise, however, immunotherapy still benefits only a minority of patients.

One method for improving efficacy is the development of bio- and activity-based markers to better predict which patients will respond to immunotherapy and identify why some don’t. In a new study, researchers at the University of Notre Dame studying tumors in prostate cancer models found that nitration of an amino acid can inhibit T-cell activation, thwarting the T-cell’s ability to kill cancer cells.

“People put a lot of hope on immunotherapy, and it has worked well for some patients, but overall the number is still low,” said Xin Lu, John M. and Mary Jo Boler Assistant Professor of Biological Sciences at Notre Dame. “The question is how we reach more people. The goal is to identify biomarkers and therapeutic targets that enhance current immunotherapies to unleash more power from these therapies. By doing this, we may benefit many more patients.” ■



GEORGE TIMMINS '19,
EMILY EAGLE '21, FRANCES
FITZGERALD '18, AND
MEGAN CROWLEY '19
PARTICIPATED IN A PANEL
PRESENTATION: NEXT
GENERATION OF PATIENT
ADVOCATES:
NOTRE DAME STUDENTS
LIVING WITH RARE
DISEASES MAKING A
DIFFERENCE.

New hope for the treatment of diabetic foot ulcers

In America, more than a million people suffer from diabetic foot ulcers.

In Latin, SalvePeds means “saving feet.”

SalvePeds, an IDEA Center startup, was developed by Notre Dame researchers Mayland Chang, professor of chemistry and biochemistry, and Shahriar Mobashery, professor of life sciences. The development means patients may soon have a more effective option to treat diabetic foot ulcers and prevent some of the 100,000 amputations the condition necessitates every year.

An estimated one in four diabetes patients will develop foot ulcers during their lifetimes. Diabetic foot ulcers are notoriously difficult to heal, often resulting in lower-limb amputations. The wounds do not heal properly because of a protein that results in prolonged inflammation, and current treatments do not address this root problem.

The topical gel, ND-336, addresses the underlying condition by counteracting that protein, thus inhibiting the breakdown of tissue so the wound can heal. The compound was developed in the labs at Notre Dame, and is currently being tested in preclinical animal trials.

“Cognizant of the unmet clinical need surrounding the effective treatment of diabetic wounds, we directly addressed the issue of why

diabetic wounds are difficult to heal through pharmacological intervention,” Shahriar explained.

The only currently approved drug, Regranex, has modest efficacy and comes with an increased risk of cancer and mortality — on top of the already high one-year-mortality rate of diabetic amputees, sitting currently around 50percent.

SalvePeds presents a new solution to this problem. Early pre-clinical results show the topical gel to be 150percent more effective than Regranex, and 200percent faster than a placebo.

“I am interested in studying diabetic foot ulcers for personal reasons,” Chang said. “My mother and aunt who took care of me as a child so that my mother could help my father in the family business both had diabetes and died prematurely. My sister has diabetes and I am prediabetic. I hope that our compound can make a difference in the lives of patients with diabetic foot ulcers.”

The head of SalvePeds is Notre Dame graduate student Trung Nguyen, a Ph.D. candidate in biochemistry who has been working with Drs. Chang and Mobashery for five years to develop the drug. ■

PROFESSORS MAYLAND CHANG AND SHAHRIAR MOBASHERY COLLABORATE IN THE FIGHT TO DEVELOP EFFECTIVE TREATMENT FOR DIABETIC FOOT ULCERS.

“I HOPE THAT OUR COMPOUND CAN MAKE A DIFFERENCE IN THE LIVES OF PATIENTS WITH DIABETIC FOOT ULCERS.”
— MAYLAND CHANG



Collaboration creates better way to treat trauma patients

In 2007, Dr. Scott Thomas and Dr. Mark Walsh of Memorial Hospital in South Bend were looking for a better way to treat trauma patients, many of whom would arrive at an emergency room with excessive bleeding, or coagulopathy, without clotting. Their search eventually led to a collaboration with the W. M. Keck Center for Transgene Research at the University of Notre Dame and the development of a new method for treating trauma patients.

Without a standard method to determine the individual blood replacement needs of trauma patients, Thomas and Walsh learned about a machine called the thromboelastogram, or TEG, that could be used in the emergency room to look at coagulation profiles.

Walsh and Thomas reached out to Francis J. Castellino, Kleiderer/Pezold Professor of Biochemistry and director of the Keck Center, who worked to develop a model for Thomas and Walsh that helped determine which replacement blood product was needed for treating a trauma patient who wasn't clotting properly.

“When our initial studies were being published in 2011, most trauma centers had not yet adopted the use of TEG machine analysis,” said Thomas. “However, because of this collaboration ... we were better prepared here in South Bend than many other trauma centers in the country with this technique.” ■

American Chemical Society conference draws teachers from across nation

In July 2018, 1,700 college, high school, and middle school chemistry educators from across the country attended the American Chemical Society's 25th Biennial Conference on Chemical Education (BCCE) hosted for the first time at Notre Dame.

The five-day conference provided teachers the opportunities to network, share and gather new ideas, and learn about what their colleagues are doing in the classroom. Topics centered around chemical education research, including information on how students learn and how to apply that to teaching.

“This conference represented 50 years of chemical education,” said Steven Wietstock, the conference program chair and associate teaching professor in the Department of Chemistry and Biochemistry at Notre Dame.

Over the years, non-tenure track teaching faculty have become more mainstream in top-flight institutions like Notre Dame, Wietstock explained. “We are all chemical educators who work in the classroom, and we are not doing research,” he said. “This conference is a great opportunity to get to know others doing the same thing and showcase our innovative teaching methods and learn from our colleagues at other institutions.” ■



SCAN CODE
TO READ MORE

Data scientist warns about algorithmic bias

BEST-SELLING AUTHOR CATHY O'NEIL SHARES SKEPTICISM ABOUT HOW MATHEMATICAL MODELS ARE USED



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Organizations are increasingly counting on mathematical models to make hiring, admissions, lending, and other decisions. But according to mathematician Cathy O'Neil, over-reliance on big data and algorithms has become a destructive force in society, further causing divisions between the "haves" and the "have-nots."

Moral and ethical decisions are embedded into algorithms that benefit organizations and often not the people they are claiming to assist, described O'Neil, *The New York Times* best-selling author of *"Weapons of Math Destruction: How big data increases inequality and threatens democracy,"* as she spoke to an audience at the University of Notre Dame in September.

"If you think about a life, starting with going to high school or college, or getting a job, or a mortgage, or insurance...during every moment you are funneled by algorithms as a winner or loser," she said. "It's not just destructive for the individual, but it's also destructive for society."

Although a data scientist herself, O'Neil's skepticism about how mathematical models are used is outlined in her book. Tracing subjects' lives and describing how algorithms affected them, she melds social justice issues with what many think are the black-and-white answers of mathematical algorithms.

"The algorithms destroy exactly what they were trying to improve," O'Neil told the audience. "They undermine science in a very important way—and this is a claim I'm making that you can challenge me on—but my problem is it's called 'data science,' but there's very little science. Data scientists are asking us just to trust them, but science is based on the idea of testing, or evidence. And algorithms, because of their secrecy, are by definition not tested."

Sponsored by the Master of Science in Data Science program and Mendoza College of Business, O'Neil's talk about ethics and data science fit perfectly with the data science program's goals of training technically proficient and ethically focused graduates, according to Roger Woodard, director of the data science program.

"Examples of Weapons of Math Destruction are everywhere," O'Neil warned the audience. "Who gets into high school, who gets into college, who gets this job, who keeps this job. If you think about a bureaucracy and a difficult decision for a bureaucracy to make, it's probably being replaced by an algorithm right now." ■

Program centers on geometric representation theory

Professors, graduate students, and undergraduates shared their knowledge about geometric representation theory for three weeks in June during the eighth consecutive Center for Mathematics Thematic Program.

The yearly event showcases the different areas of mathematics research at Notre Dame and gives mathematicians at all stages of study the chance to collaborate and learn new ideas. Most papers are now written in collaboration, and the thematic programs prepare students for that process by including time for students to work together on problems, said Samuel Evens, professor in

the Department of Mathematics and one of the program's organizers...

"The pure math community is very small; in the U.S. it's probably counted in thousands rather than tens of thousands," said Evens. "This conference is a good way to find out what others are researching, and is a great opportunity to meet young people and share with them what the more senior people are doing."

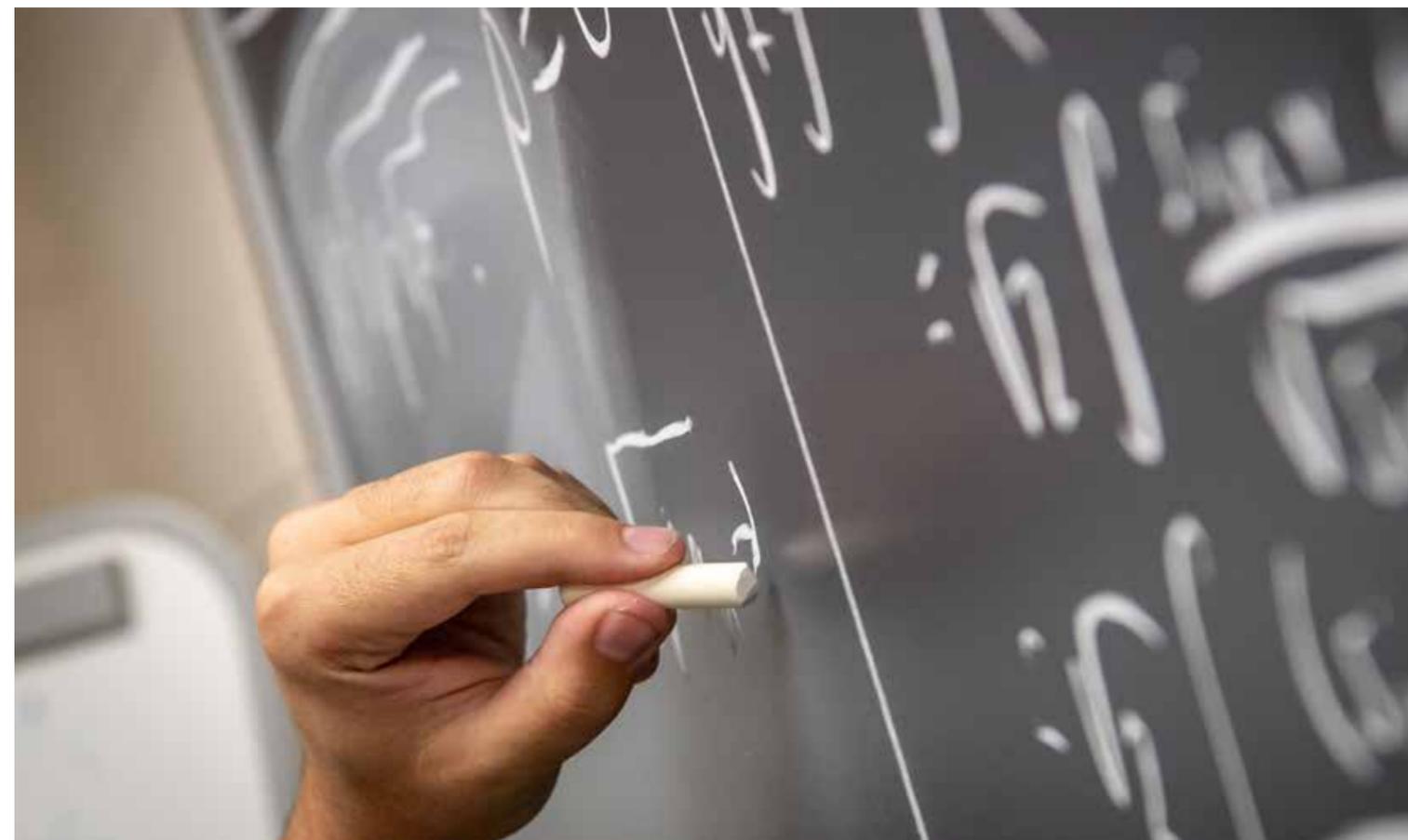
Geometric representation theory is one of the major tools for understanding the role of symmetry in mathematics, physics, and nature. The thematic event covered all topics and current research.

The conference was an ideal way for undergraduates and graduate students to learn a broad overview of the topic, said Martha Precup, who earned her doctorate in mathematics at Notre Dame, and joined the mathematics faculty at Washington University in St. Louis in August 2018.

The summer thematic programs are funded in part by the National Science Foundation, and last year the program met a milestone with its 1,000th participant. In 2019, the graduate segment of the program will be extended to two weeks in order to further foster discussion, group work, and presentations among young mathematicians. ■



SCAN CODE TO READ MORE



Firefighter clothing tested for fluorinated chemicals

STUDY TO MEASURE GEAR'S FLUORINE CONTENT OVER TIME

HALEY BORSODI, ACCELERATOR TECHNICIAN IN THE NUCLEAR SCIENCE LABORATORY, PREPARES THE NEWEST PARTICLE ACCELERATOR FOR A DATA COLLECTION RUN. SAMPLES ARE PLACED ON A TARGET WHEEL WHERE THEY WILL BE HIT WITH A PARTICLE BEAM AND DETECTORS WILL MEASURE THE SUBSEQUENT INTERACTIONS. GRAHAM PEASLEE (INSET) USES THE ACCELERATOR TO IDENTIFY CHEMICALS IN COMMON PRODUCTS LIKE COSMETICS, FAST FOOD WRAPPERS, AND FIREFIGHTING EQUIPMENT, AMONG OTHERS.



Scientists at the University of Notre Dame will begin an independent study of turnout gear worn by firefighters to test for the presence of perfluorinated alkyl substances (PFASs).

Graham Peaslee, a professor of experimental nuclear physics at the University of Notre Dame, and his lab tested fabric swatches taken from unused personal protective gear for the presence of perfluorinated alkyl substances (PFASs).

"We're going to measure each piece of gear and look at the difference in fluorine content over time and extensive use, including after the fabric has been washed, and look at how much of the chemical can transfer off the fabric," he said.

To test for PFASs, Peaslee's lab uses particle-induced gamma-ray emission spectroscopy, a novel and specialized method he developed as an efficient and cost-effective way to analyze for total fluorine content. For this study, Peaslee said he and his students plan to test for content and how much—if any—is coming off the fabric with time and use.

He decided to embark upon the study after initial samples

tested positive for fluorine.

Following the initial tests, Peaslee is leading the study of new and used turnout and personal protective gear issued throughout the 2000s, including jackets, pants and undershirts—all of which are either new or have been in service for more than a decade. The continued research should help determine the impact, if any, the use of this substance has on firefighters' health.

Various forms of PFASs have been linked to prostate, kidney, and testicular cancers, as well as thyroid disease and low birth weight. The chemicals are commonly associated with stain-resistant products and

the manufacture of nonstick cookware. In 2017, Peaslee was one of several researchers who uncovered the presence of PFASs in fast-food wrappers.

The chemicals are also a component of aqueous film-forming foams. These foam fire suppressants have been linked to incidents of contaminated drinking water. The United States Air Force began phasing out PFAS-based foam for an environmentally safer alternative in 2016, and finished replacing its stock in 2017. ■

PEASLEE'S LAB USES PARTICLE-INDUCED GAMMA-RAY EMISSION SPECTROSCOPY, A NOVEL AND SPECIALIZED METHOD HE DEVELOPED AS AN EFFICIENT AND COST-EFFECTIVE WAY TO ANALYZE FOR TOTAL FLUORINE CONTENT.



SCAN CODE
TO READ MORE

NSF funds QuarkNet program through 2023

QuarkNet, a program founded at Notre Dame that brings university-level physics research opportunities to high school teachers and students across the country, has been granted funding through 2023 by the National Science Foundation (NSF). The NSF has funded the program since its inception in 1998.

"QuarkNet is a wonderful program, and is very well known in the particle physics community," said Mitchell Wayne, a physics professor who has been the lead principal investigator for the QuarkNet program since 2004. "It's done great things for teachers and students over the past two decades, and I believe that QuarkNet has played an important role in U.S. particle physics during that time."

Nationally, more than 400 teachers each year gain scientific experience by working with university professors and laboratory scientists, according to Wayne. The teachers and their students have created components that have been installed in the detectors at the LHC, which in 2012 discovered the Higgs boson, a particle that bridged the gap in the understanding of the Standard Model of Physics.

With support from Notre Dame International, QuarkNet has had engagements in Santiago, Chile, and Mexico City, and they are exploring other international opportunities. ■

The search for heavy metals

Astrophysicist Timothy Beers needs only one hundred of the Milky Way Galaxy's 100 billion stars to understand the rapid-neutron capture process (r-process), which is thought to be responsible for the presence of heavy metals on earth, including gold, platinum, and uranium.

To understand the nature of the nature of the r-process, astrophysicists including Beers, professor and Notre Dame Chair in astrophysics, need to compare the frequency of a sample of older r-process-enhanced stars with the predicted frequencies of newer stars arising from a collision.

Scientists now have the latter, thanks to the neutron star merger observed in August 2018, but now need the sample of the former—100 to be exact. And that's where Beers comes in. For every 100, only three might be r-process stars. To speed up the work, Beers and his team are working to identify the brightest low-metallicity stars in the Milky Way's halo, making use of modest, moderate-aperture-size telescopes. ■

Grant will fund research to study mosquito spatial repellent

The University of Notre Dame will lead a five-year program to determine the efficacy of a spatial repellent product in preventing mosquito-borne diseases such as malaria, dengue, and Chikungunya.

Unitaid will fund the \$33.7 million effort. It is the largest research grant awarded to a single proposal in Notre Dame's history. Unitaid is an international organization that invests in new ways to prevent, diagnose and treat HIV/AIDS, hepatitis C, tuberculosis and malaria more quickly, more affordably and more effectively. It accelerates access to innovation so that critical health products can reach the people who most need them.

"This grant will enable research with the potential to transform the lives of millions of people around the world who

suffer from mosquito-borne disease," said Robert J. Bernhard, Notre Dame's vice president of research. "We're grateful for the confidence Unitaid has shown in the University of Notre Dame to lead this program."

The program will include two clinical trials, one in Kenya and one in Sri Lanka, as well as studies among displaced populations in Mali and in refugee settings in Uganda.

"THIS GRANT WILL ENABLE RESEARCH WITH THE POTENTIAL TO TRANSFORM THE LIVES OF MILLIONS OF PEOPLE AROUND THE WORLD WHO SUFFER FROM MOSQUITO-BORNE DISEASE."

—ROBERT J. BERNHARD

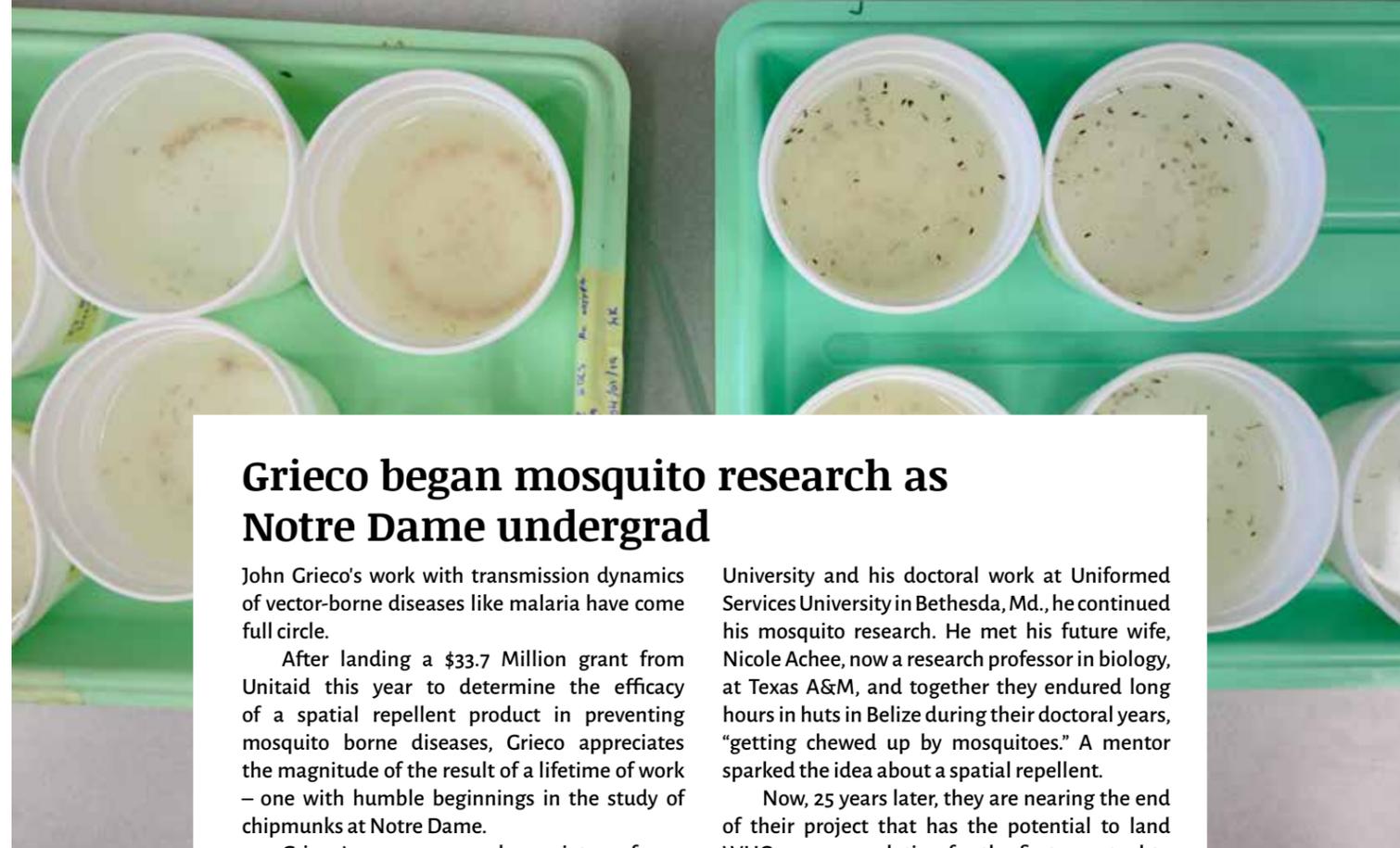
The goal of the program will be to further generate evidence to support a recommendation to the World Health Organization (WHO) of spatial repellent use for public health purposes and to inform the optimal delivery and implementation of use within humanitarian response situations.

"The global burden of vector-borne

diseases such as malaria and dengue can overwhelm health systems," said John Grieco, research associate professor in the Department of Biological Sciences and associate director of the Eck Institute for Global Health at the University of Notre Dame and principal investigator on the project. "We need new products to support ongoing mosquito control efforts with our ultimate goal being elimination of these diseases."

The World Malaria Report, an annual report published by WHO, estimated 219 million new cases of malaria and 435,000 deaths in 2017, and it estimates dengue to affect more than 3.97 billion people across 128 countries.

Spatial repellents release volatile chemicals into the air to inhibit certain insect behaviors such as feeding and encourage movement away from a treated space. ■



Grieco began mosquito research as Notre Dame undergrad

John Grieco's work with transmission dynamics of vector-borne diseases like malaria have come full circle.

After landing a \$33.7 Million grant from Unitaid this year to determine the efficacy of a spatial repellent product in preventing mosquito borne diseases, Grieco appreciates the magnitude of the result of a lifetime of work – one with humble beginnings in the study of chipmunks at Notre Dame.

Grieco '90, now a research associate professor in the Department of Biological Sciences, completed his undergraduate research under the guidance of Notre Dame's George B. Craig Jr., a professor known worldwide for his research in vector biology. They studied how chipmunks reacted to being bitten by mosquitoes.

"One time we actually filmed one eating a mosquito, and that became a new potential route for the transmission of virus," Grieco said.

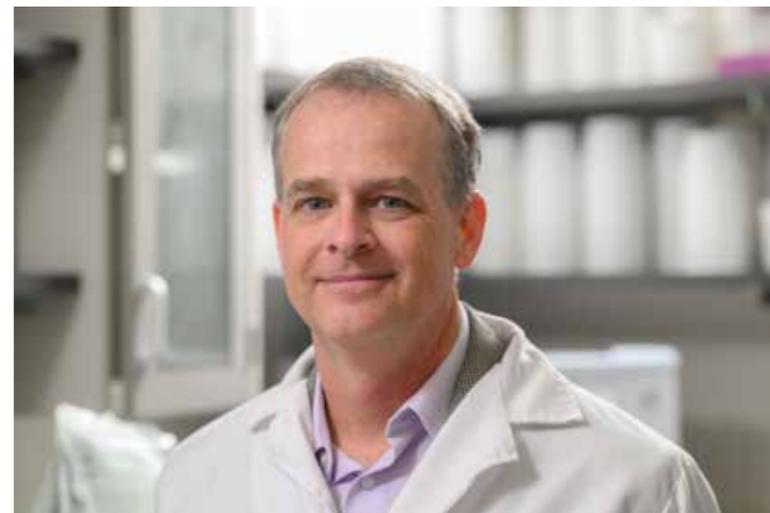
During his graduate work at Texas A&M

University and his doctoral work at Uniformed Services University in Bethesda, Md., he continued his mosquito research. He met his future wife, Nicole Achee, now a research professor in biology, at Texas A&M, and together they endured long hours in huts in Belize during their doctoral years, "getting chewed up by mosquitoes." A mentor sparked the idea about a spatial repellent.

Now, 25 years later, they are nearing the end of their project that has the potential to land WHO recommendation for the first new tool to combat mosquitoes since the approval of bed nets. "To see something you had worked on your entire life come to fruition is really amazing...it's the culmination of everything," he said.

Grieco, who never thought he'd return to Notre Dame after he finished his undergraduate degree, said that the University prepared him well for the rigors of an academic career.

He's in the midst of finalizing plans toward completing work for approval of the spatial repellent. "One of the things Nicole and I like to do is to make sure we give the opportunities we didn't have as undergraduates to do international work, to get into the field and work in these communities that need to fight against vector-borne diseases." ■



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Alumni spotlight

Dr. Brian Gray '02

Gray is an assistant professor of surgery and a pediatric surgeon at the Riley Hospital for Children at Indiana University Health and IU School of Medicine.

How did you develop an interest in the field of medicine?

I've always imagined myself becoming a doctor, and I think that was born out of a desire to do good for people. I was always on a fairly straight line for medical school, which I realize is not the same for every person. Once I got to medical school, I felt that I might go into primary care - out of a sense of service. However, in medical school, I realized there was this entire world of general surgery where you can act as a general practitioner of surgical care and have the ability to affect change with your hands.

What drew you to become a pediatric surgeon?

I like that a patient can come to you with a problem and you can take him or her to the operating room - to offer immediate help. Pediatric surgery involves caring for the most vulnerable members of society, when they are at their most vulnerable states. I get the opportunity to help my patients by doing small routine operations and very large life-changing operations that can give a newborn or young child an extra 90 years of life.

How has your Notre Dame education formed you into the person you are today?

I think the most important part of my Notre Dame education was the humanistic tilt to scientific education. The science pre-professional major allowed me to take basic science and medical prerequisite courses to prepare me for medical school. Meanwhile, the spiritual education I received helped me to see the person and not just the disease when interacting with patients, as we are all one in the end. ■



Photo courtesy of Riley Children's Health

Dr. Gina Camarata '10

The value of hard work, combined with the emphasis on forming the "whole person" at Notre Dame, has been a guiding force in Tierney's life since graduating and becoming a veterinarian.

After earning her degree in biology, Tierney graduated from the Cummings School of Veterinary Medicine at Tufts University and now works as a veterinarian at West Loop Veterinary Care in Chicago. The Overland Park, Kans., native said, "Notre Dame definitely instilled the value of working hard, and trying to learn as much as possible to be better able to achieve the tasks that you need, which in my case, is helping animals and also their people."

She appreciated the bevy of different events for learning at Notre Dame, from seminars to other activities, and attending all that she could. Because Notre Dame emphasizes the formation of the whole person—spiritually, academically, and emotionally—she felt she was able to look at different issues and weigh the

effects they have on not only individuals, but also the world.

That approach was continued at Tufts, she said, where they called it the One Health approach. The idea is that scientists and health care professionals are interconnected with the globe. The concept has shaped her practice.

"It's larger than just one patient or just one job or career path, or just you work from 9 to 5 and then go home. It's more than that," Tierney said. "And I feel I would not have been so open to that idea if I hadn't had that foundation at Notre Dame."

She suggests that students who want to become veterinarians study hard, because that will be necessary in veterinary school. "Also, really look into the career as you're deciding on it, and look at different options of what you can do as a veterinarian—make sure you are really committed to that, because it's not easy to get there, and it's not easy to continue." ■

"I THINK THE MOST IMPORTANT PART OF MY NOTRE DAME EDUCATION WAS THE HUMANISTIC TILT TO SCIENTIFIC EDUCATION."
— DR. BRIAN GRAY



Photo courtesy of West Loop Veterinary Care

New minor developed in compassionate care

A new minor focusing on training in the science of compassion in medicine for future health care professionals will be offered starting during the Fall 2019 semester, about a year after the position of director of the Hillebrand Center for Compassionate Care in Medicine was endowed.

The minor is rooted in the new science of compassion in which the biology, neuroscience, and psychology of compassion is providing new insights into how clinicians can achieve and sustain their compassionate care while also remaining balanced in providing excellent patient care. Compassionate care not only improves patient outcomes but also reduces burnout, and sustains the well-being of the health care clinician. Through the courses, students learn how to train their minds for the emotional challenges of working in health care, and also gain practical instruction in how to communicate well with patients.

More than half of physicians experience some type of burnout, said Dominic Vachon, the John G. Sheedy, M.D., Director of the Ruth M. Hillebrand Center for Compassionate Care in Medicine.

The program's 15-credit-hour requirements include a gateway course, electives, an experiential/skills-based course, and a three-credit-hour capstone project.

In addition to the minor, the position of director of the Ruth M. Hillebrand Center for Compassionate Care, held by Vachon, was recently endowed by Bill and Patti Sheedy. The endowment honors Bill's late father, Dr. John G. Sheedy '54.

"This endowment from the Sheedy Family will be vitally important as the Hillebrand Center moves toward becoming a national center for the improvement of patient care and clinician well-being," said Mary E. Galvin, the William K. Warren Foundation Dean of the College of Science.

The mission of the Hillebrand Center at Notre Dame is to restore the spirit of compassion in healthcare by advancing the application of the science of compassion at every level of medical education and practice, which will transform clinician well-being and patient care. ■



DOMINIC VACHON, PH.D., INSTRUCTS STUDENTS IN THE SCIENCE OF COMPASSION.

New Faculty

We are pleased to announce that the following accomplished faculty have joined the College of Science in FY 2018-2019.



Maria Alexandrova
Assistant Professional Specialist, Biological Sciences
Research: Prevention of maternal and infant mortality and Human Papilloma Virus-associated cancers

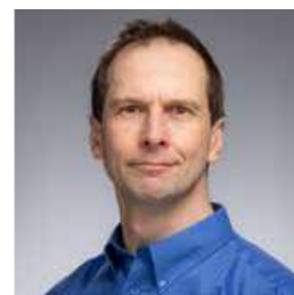


Badih Assaf
Assistant Professor, Physics
Research: Angle resolved photoelectron spectroscopy



Jeffrey Chilcote
Assistant Professor, Physics
Research: Construction of infrared astronomical instruments and direct imaging of extra solar planets

Evgenii Kovriguine
Research Associate Professor, Chemistry and Biochemistry
Research: Nuclear magnetic resonance spectroscopy instrumentation and analysis



Christian Melander
George and Winifred Clark Professor, Chemistry and Biochemistry
Research: Developing novel, organic chemistry-based methods to address emerging problems associated with antibiotic resistance



Roberta Melander
Research Assistant Professor Chemistry and Biochemistry
Research: Medicinal and bioorganic chemistry and the development of new antibiotics



Patrick O'Malley
Research Assistant Professor, Physics
Research: Stellar fusion, novae, supernovae, and developing radioactive beam techniques for the next accelerator project



Eric Riedl
Assistant Professor, Mathematics
Research: Arithmetic geometry, combinatorics, and computational projects



Jason Rohr
Ludmilla F., Stephen J., and Robert T. Galla College Professor, Biological Sciences
Research: Ecology and environmental biology, population biology, and infections and vector-borne diseases



Ana Flores-Mireles
Janet C. and Jeffrey A. Hawk Assistant Professor, Biological Sciences
Research: Bacterial pathogenicity in catheter-associated infections



David Hansen
Assistant Professor, Mathematics
Research: Number theory, algebraic geometry, p-adic methods, and the theory of diamonds



Tyvette Hilliard
Research Assistant Professor, Chemistry and Biochemistry
Research: Link between obesity and ovarian cancer metastasis



Choon Kim
Research Assistant Professor, Chemistry and Biochemistry
Research: Investigating the human pathogen methicillin-resistant Staphylococcus aureus (MRSA)



Felipe Santiago-Tirado
Assistant Professor, Biological Sciences
Research: C. neoformans' survival mechanisms within a host phagocyte



Hyungsuk Tak
Assistant Professor, ACMS
Research: Astro-statistics, time series and image data analysis in astronomy



Thomas Totten
Visiting Assistant Professional Specialist, ACMS
Research: Actuarial science and consulting



Victoria Weber
Assistant Professional Specialist, ACMS
Research: Statistics education and the use of technology in education

Cristian Koepfli
Assistant Professor, Biological Sciences
Research: Development of genetic markers for malaria disease surveillance



John Koren
Research Assistant Professor, Chemistry and Biochemistry
Research: Role of chaperones in neurodegeneration and the development and screening of new therapeutics for neurological diseases

Rebecca Whelan
Associate Professor, Chemistry and Biochemistry
Research: Early detection and treatment of ovarian cancer using analytical biochemistry methods



Katharine White
Clare Boothe Luce Assistant Professor, Chemistry and Biochemistry
Research: Investigating the role of pH sensitivity in cancer development and progression

Faculty Accolades

Nancy Michael, director of undergraduate studies for Neuroscience and Behavior, and **Jenifer Proserpi**, an assistant professor of chemistry and molecular biology, were inducted into the 2018 Michiana Forty under 40 class in recognition for being talented young leaders who have demonstrated career success and community engagement. Additionally, **Michael** earned the 2018 Frank O'Malley Undergraduate Teaching Award, an annual prize that honors any faculty member who displays "outstanding service to the students of the Notre Dame community."

College of Science faculty **Patricia Clark**, **Paul Huber**, **Mark Olsen**, and **Kevin Vaughan** were awarded the Rev. Edmund P. Joyce, C.S.C. Award for Excellence in Undergraduate Teaching.

Physics professor **Umesh Garg** received the Notre Dame Faculty Award in 2018 for his outstanding service to the University of Notre Dame through leadership, mentoring, and dedication to students. Garg has also given numerous talks on his research across Europe, South Africa, and Japan. He was also reappointed as an honorary guest professor in the physics department at Peking University in Beijing, China.

Jeff Peng, associate professor of chemistry and biochemistry, was elected to the Executive Committee for the annual Experimental NMR Conference, where students and experts in NMR spectroscopy gather to discuss the latest developments in the field.

Mathematics professor **Juan Migliore** was the recipient of the 2018 Father James L. Shilts, C.S.C./Doris and Gene Leonard Teaching Award in the College of Science.

Prashant V. Kamat, the Rev. John A. Zahm, C.S.C., Professor in the Department of Chemistry and Biochemistry, was named to the Clarivate Analytics' 2018 Highly Cited Researchers, an honor given to those who have produced multiple highly cited papers that rank in the top one percent by citations for field and year in Web of Science. Kamat was also honored in a tribute issue to him in one of the four journals of *The Journal of Physical Chemistry*.

Brian Baker, the Rev. John A. Zahm Professor of Structural Biology, received the Innovation Award from the American Cancer Society's local Coaches vs. Cancer Program. The award is given to "an individual who demonstrates an innovative approach to treating or caring for cancer patients and their loved ones."

Biology professor **Gary Lamberti** was elected as a fellow of the Society for Freshwater Science.

Norman Dovichi, the Grace-Rupley Professor of Chemistry and Biochemistry, received the inaugural College of Science research Award, which is given to a faculty member who has demonstrated sustained excellence in research.

Freimann Professor **Ani Aprahamian** has been named the chair of the Science Advisory Committee to the Facility for Rare Isotope Beams at Michigan State University. Aprahamian was also invited to serve as a member of the U.S. Liaison Committee to the International Union of Pure and Applied Physics.

Tan Ahn, assistant professor of experimental nuclear physics, co-organized the first conference on Nuclear Physics for the Next Generation, which was held at the Notre Dame International Gateway in London.

Biology professor **Jennifer Tank** and physics professor **Graham Peaslee** were both honored with a Media Legend Award from the Office of Media Relations for their excellence in communicating with the press and others.

Physics professor **Dan Bardayan** was re-elected to the User Organization Executive Committee for the Facility for Rare Isotope Beams at Michigan State University.

Alex Perkins, Eck Family Assistant Professor of Biological Sciences, and **Sean Moore**, research assistant professor of biological sciences, were accepted to join the Vaccine Impact Modeling Consortium. The consortium "aims to deliver a more sustainable, efficient, and transparent approach to generating disease burden and vaccine impact estimates."

Jennifer Tank, the Galla Professor of Biological Sciences, was honored with the 2019 Ruth Patrick Award from the Association for the Sciences of Limnology and Oceanography. Each year, the Ruth Patrick Award is presented to a scientist for outstanding research in the application of basic aquatic science principles to the identification, analysis, and/or solution of important environmental problems.

Mathematics professor **Karsten Grove** received a Best Paper Award from the 2018 International Congress of Chinese Mathematicians for his paper he co-authored with Fuquan Fang and Gudlauger Thorbergsson.

Claudia Polini, the Glynn Family Honors Collegiate Professor of Mathematics, was elected as a 2019 Fellow of the American Mathematical Society.

Anand Pillay, the William J. Hank Family Professor of Mathematics, was awarded a Focused Research Grant from the National Science Foundation. Pillay works on problems in model theory, one of the most active areas of mathematical logic.

Student Accolades

Neuroscience and Behavior students, sophomore **Olivia Jazbutis** and junior **Bendu Konneh**, were selected as Gilman Scholars for summer 2018 along with junior science and business major **Maria Gomez**. The Gilman Scholarship allows outstanding students to pursue international study and research.

College of Science graduate students **Daniel Erickson** and **Cynthia Schreiber** were named 2018 Berry Family Foundation Graduate Fellows. Notre Dame's Advanced Diagnostics and Therapeutics (AD&T) sponsors the fellowships, which funds graduate students' research on issues that are of interest to AD&T.

Science-business and junior **Margo Waters** received the first Woodward Family Endowment for Excellence in NDnano Undergraduate Research. Her research focused on nanoparticles that target different cancer tumors and antimicrobial nanoparticles.

Chemistry and biochemistry graduate student **Chen Dai** was awarded a first place prize for his research on breast cancer metabolism at the annual Cancer Research Day hosted by the Indiana University Simon Cancer Center.

Neuroscience and behavior student **Jahlecia Gregory** and science computing major **Deandre Tomlinson** were awarded the Benjamin A. Gilman International Scholarship to study abroad in the 2018-19. The two juniors participated in Notre Dame International's program in Puebla, Mexico.

Sofia Carozza, a neuroscience and behavior major in the College of Science with a supplemental major in theology, has been named Valedictorian for 2019. Also, seniors **Carozza** and **Katie Gallagher** were named 2019 Marshall Scholars. The Marshall Scholarships support highly skilled Americans to study at the graduate level in the U.K. in any area of study.

Carozza and Gallagher are Notre Dame's eighth and ninth Marshall Scholars.

The following College of science alumni received Fulbright grants to study or teach abroad in 2018-2019: **Amelia Lindstrom '18**, **Anthony Nguyen '18**, **Jasmine Feder '18**, **Luke Maillie '18**, **Michael O'Connor '18**, **Quinn Brown '18**.

In Memoriam

Timothy O'Meara, provost emeritus and trustee emeritus of the University of Notre Dame, passed away in June 2018. The Kenna Professor of Mathematics Emeritus, O'Meara served as the chairman of Notre Dame's mathematics department twice and as its first lay provost from 1978 to 1996.

If you receive an award between May and April, and wish to be included in the next issue, please email science@nd.edu ATTN: Editor



2nd Annual

Gold Mass and Lecture

Stephen Meredith, M.D., PhD., is a professor in the University of Chicago's departments of pathology, biochemistry and molecular biology, and neurology. A founding member of the board of the Society of Catholic Scientists, he is also an associate faculty member in the University of Chicago divinity school.

Ivan Karamazov asked whether we can accept a world in which God allows children to suffer. His question is a powerful version of the ancient question: if God exists and is both perfect and all powerful, whence comes evil? Sick children—and adults, for that matter—put this question into sharp focus but also add another, seemingly paradoxical, dimension to it. If we are made in the image of God, and if being fully human means to be true to our natures, then how can we account for the occurrence of deadly diseases and the suffering that results from them? In this talk, Dr. Meredith turns to the philosophy of Thomas Aquinas to help address these questions.

History of the Gold Mass

In a 1988 letter to the Rev. George V. Coyne, S.J., director of the Vatican Observatory, His Holiness John Paul II wrote, "Science can purify religion from error and superstition; religion can purify science from idolatry and false absolutes.

Each can draw the other into a wider world, a world in which both can flourish." This planted the seed for the founding of the Society of Catholic Scientists and the first ever Gold Mass.

The Gold Mass, which follows in the tradition of special Masses for members of different professions, was selected because gold is the color of the hoods worn by individuals graduating with a Ph.D. in science. It is also the color associated with the patron saint of scientists St. Albert the Great.

The oldest Mass for professions, the Red Mass for lawyers and lawmakers was begun in the 13th century. The first White Mass for health care professionals and Blue Mass for law enforcement were introduced in the 1930s. The first Gold Mass for scientists and engineers was held at the Massachusetts Institute of Technology on Nov. 15, 2016.

Notre Dame is continuing the tradition of celebrating the Gold Mass on St. Albert's feast day. ■



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LAST FALL, THE HILLEBRAND CENTER FOR COMPASSIONATE CARE IN MEDICINE INVITED THE MONKS OF THE LABRANG TASHI KYIL MONASTERY IN DEHRA DUN, INDIA, TO JORDAN HALL. THE MONKS SPENT NEARLY A WEEK CREATING A WORLD PEACE SAND MANDALA. PICTURED HERE ARE DOMINIC VACHON, PH.D., JOHN G. SHEEDY M.D., DIRECTOR OF THE HILLEBRAND CENTER AND YESHI RABGYAL WALKING TO ST. MARY'S LAKE. THERE THE MONKS RETURNED SOME OF THE SAND BACK TO THE WATER, SYMBOLIZING HUMANITY'S INTERCONNECTEDNESS.