A&S marquette

THE MAGAZINE FOR MARQUETTE UNIVERSITY
KLINGLER COLLEGE OF ARTS AND SCIENCES
2018

THE DISCOVERERS

Conducting research with professors, Arts and Sciences undergraduates pursue breakthroughs and unlock their futures.

FROM THE DEAN

Dr. Richard C. Holz
Dean, Klingler College of Arts and Sciences

I am pleased to introduce our inaugural issue of the Helen Way Klingler College of Arts and Sciences magazine. I routinely remind people that our college is the "heart and soul" of Marquette University, and the articles contained in this magazine exemplify this point exactly. You will find stories highlighting student, faculty and alumni milestones and accomplishments, showing how the outstanding work of this college enriches the lives of students and advances the mission of Marquette.

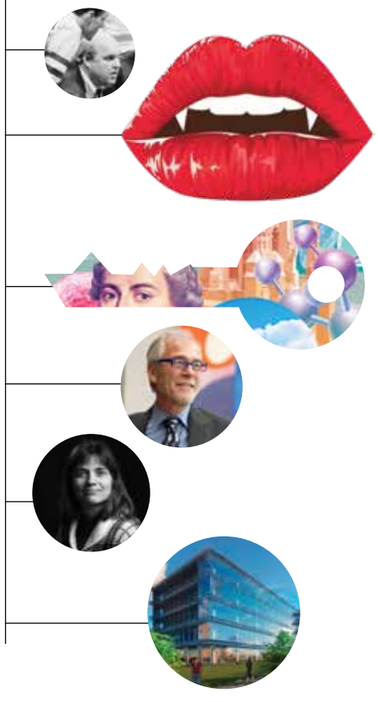
I am confident you will enjoy reading the feature stories that reveal the breadth and impact of our college and provide a small snapshot of the compelling things we do here. We were the first university in Wisconsin to add an undergraduate major in data science, and the magazine takes an in-depth look at the expansion of data science at Marquette, helping to provide technical and ethical leadership to a growing field. We also established the Center for Cyber Security Awareness and Cyber Defense, along with several exciting innovative majors such as cognitive science and environmental studies.

DID YOU KNOW? ***Total A&S graduate and undergraduate enrollment is 2,927.***

> ***"I routinely remind people that our college is the 'heart and soul' of Marquette University. … The outstanding work of this college enriches the lives of students and advances the mission of Marquette."***

The pride of our college is our students. This year's cover story features undergraduates conducting high-level research on topics ranging from enzymes that may play a role in cancer and diabetes treatment to how an 18th-century German philosopher's model for cultivating civil discourse fares during our polarized times. Such experiences are a hallmark of the college, made possible by caring faculty members serving as research mentors.

I want to leave you with the words of Tim Kochis, Arts '68, our college's 2017 Distinguished Alumnus of the Year award recipient, who shared during his acceptance speech, "An education in the liberal arts is all about developing a moral compass through a strong understanding of the human condition and an acceptance of ambiguity and an appreciation for differing perspectives." Tim's comments on the value of a liberal arts education are a fitting description of the types of stories we tell in this inaugural edition of the college magazine. Thank you for taking the time to read it.



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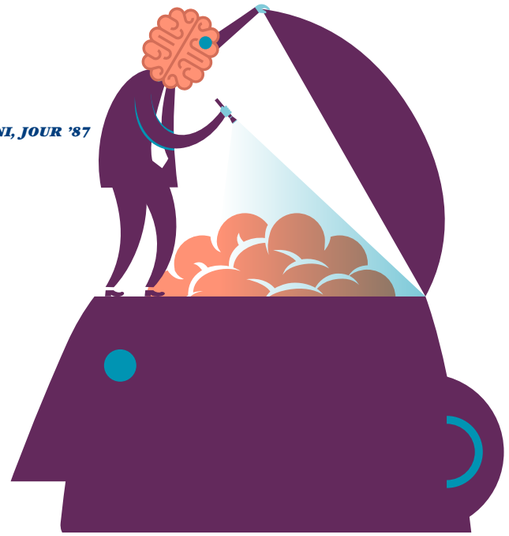
INSIDE ARTS AND SCIENCES

FEATURES

BRAIN MEETS MIND

A NEW MAJOR UNITES THE SCIENCES AND HUMANITIES TO BETTER UNDERSTAND HUMAN COGNITION.

BY JOE DIGIOVANNI, JOUR '87



Which has more to offer in explaining human nature and cognition — philosophy or the sciences? That question has fueled late-night campus debates for ages.

But in recent decades, scholars from psychology, philosophy, computer science, neuroscience, linguistics and other related fields have supplied a novel answer: both, please. They've crossed disciplinary boundaries, joining forces in their drive to better understand cognition.

By launching an interdisciplinary cognitive science major this academic year, Marquette joined the leading institutions in the United States in recognizing that the study of the mind requires more than one set of methodologies and concepts. With this collaborative effort of philosophy and psychology faculty, Marquette became the first Jesuit university in the nation to offer students the opportunity to major in this fast-growing area, studying the mind as it relates to reasoning, learning, memory, decision-making, perception, action and language.

"The new major will enable students to use various conceptual tools and problem-solving skills to approach fundamental questions about cognition," says Dr. Corinne Bloch-Mullins, an assistant professor of philosophy who directs the new major and helped develop it with four fellow faculty members from her department and two from the Department of Psychology. (See full list below.)

Cognitive science majors are encouraged to declare a second major in one of the fields integrated into the curriculum for the major, including anthropology, biological sciences, English, mathematics and computer science, philosophy, psychology and sociology.

Driven by her interest in neuropsychology, Marquette senior Sara Pardej originally planned to major in psychology and minor in neuroscience. But something was missing, and the new major filled the void. Now she's majoring in psychology and cognitive science with a minor in family studies. "Because cognitive science has so many disciplines intertwined within it, I feel like I can separate myself from other applicants when I apply to graduate school. I'm going to have a background in computer science and linguistics and a philosophical background in cognitive science," she says. "I have an edge because I have all these other fields I'm familiar with and can talk about."

Another benefit of the major is the opportunity it presents faculty in the different departments to collaborate on research projects. "It can bolster and highlight Marquette's strength in neuroscience and its academic stature and visibility," Bloch-Mullins says.

What careers are open to students with this new major? Research, marketing and communication, user interface, industrial design, software development, information technology, education, psychology, medicine and law are among possibilities that extend almost as far as the mind can imagine.

Mind meld — *the interdisciplinary team behind the new major:* Dr. Nakia Gordon, associate professor of psychology, and Dr. Kristy Nielson, professor of psychology; Dr. Anthony Peressini, professor of philosophy; Dr. Corinne Bloch-Mullins, Dr. Yoon Choi, Dr. Katherine Rickus and Dr. Ericka Tucker, assistant professors of philosophy.

> **A** ***By launching this interdisciplinary major, Marquette joined the leading institutions in the United States in recognizing that the study of the mind requires more than one set of methodologies and concepts.***
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BEING MUSLIM IN MOTOWN

A TRIP TO DETROIT IMMERSES STUDENTS IN MUSLIM AMERICAN EXPERIENCES AND PERSPECTIVES.

BY LAURA MERISALO

Just six hours after leaving Milwaukee last spring, eight Marquette University students found themselves immersed in Detroit-area communities with concentrations of Muslims second only to the Middle East, South Asia and Africa, and unparalleled in the United States.

Learning new perspectives at mosques, the Arab American National Museum, and meetings with civic leaders and Muslim American college peers, the five-day experience countered often negative characterizations of people of the Islam faith.

"We are in a time when we look at Muslims as the enemy, and it was just the opposite," says Stephanie Hood, Grad '17, then a master's student in clinical mental health counseling. "It was very humbling. It is a beautiful culture. It's very misunderstood."

The spring break 2017 trip, "Encountering Muslims, Countering Islamophobia: Islam in America Immersion," was led by Dr. Louise Cainkar, associate professor of social and cultural sciences, who received a Marquette Strategic Innovation Award for this and future trips to Dearborn and Hamtramck, Michigan.

Sitting down with a dozen Muslim students from the University of Michigan–Dearborn, the Marquette contingent learned firsthand about being feared, shunned or labeled a terrorist because of your faith, culture or clothes. It was a lively exchange, revealing similarities while exploring differences.

At one point, a girl who had been quiet suddenly spoke up to explain why she voluntarily wears a hijab. "She views herself as beautiful, and she doesn't have to show off her hair and body to have that outside validation," says Claire Keyes, a senior majoring in psychology and social welfare and justice. The message became clear: To this young woman, a hijab is not a symbol of oppression but one of empowerment.

The visiting students also observed customs and practices at area mosques, including an imam chanting the call to prayer in Arabic. Only some mosques broadcast the call to prayer over a loudspeaker — a practice akin to the use of church bells at Christian churches but one that proved controversial because some non-Muslim Detroiters questioned and feared what was being broadcast in Arabic. "All it is saying is come pray together," says Nadja Simmonds, a senior in theatre and digital media.

Immersion, says Cainkar, is the best way to make such discoveries. "You have to live it to get it."

"Differences are important ... and don't need to lead to hatred," says Alexis Garcia, a junior majoring in history and secondary education. "You can keep your culture intact without having those differences divide people."

> ***"We are in a time when we look at Muslims as the enemy, and it was just the opposite. It was very humbling. It is a beautiful culture. It's very misunderstood."***
>
> **STEPHANIE HOOD, GRAD '17**

An immersion trip highlight: Marquette students open up with Muslim students from the University of Michigan–Dearborn.

AFTER THE BUZZER:

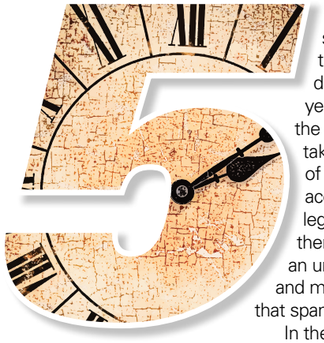
SCHOLARSHIP EXTENDS MAJERUS' LEGACY.

Among the first in his family to attend college, Rick Majerus, Arts '70, Grad '79, had a celebrated men's basketball coaching career, including time at Marquette and Saint Louis University, where he resigned shortly before heart failure took his life in 2012. Recognizing his generous embrace of the Jesuit ideal of care of others in mind, body and spirit, the Majerus Family Foundation in 2015 gave $1 million to create the Rick Majerus Endowed Scholarship. As the university works toward a fully endowed value of $2 million, the scholarship is already providing tuition support to first-generation students in the Klingler College of Arts and Sciences. For more, visit muconnect.marquette.edu/majerus-scholarship.

ACCELERATING THE COLLEGE CLOCK

FROM UNDERGRADUATE STUDY TO MASTER'S DEGREE IN RECORD TIME.

BY GUY FIORITA



From high school graduation to a master's degree in five years? Students in the college can now take advantage of programs that accelerate the college clock to allow them to earn both an undergraduate and master's degree in that span.

In the last three years, six of these new accelerated degree programs have debuted in Arts and Sciences disciplines, specifically history, philosophy, political science, Spanish, computer science and chemistry. And in the more established Applied Economics program, enrollment has climbed. Three students are currently in their fifth year of the program while eight undergraduates are enrolled in classes that will count toward their master's in applied economics once they enter the program. With accelerated study established as a university-wide priority, Carl Wainscott, graduate school assistant dean, expects programs and enrollees to "grow significantly in the coming years."

Dr. Joseph Daniels, professor and chair of economics, says that apart from the time advantage, the accelerated program is attractive for other reasons. "Financial aid is available to students in this program, and we have a strong record of placement thanks to our network of supporting alumni who offer internship and employment opportunities to our students."

And as interest in accelerated study spreads to students at four-year colleges, partnerships led by economics and other departments meet that demand. "We have two students from St. Norbert College where they do not have a master's program. The partnership was a natural because it gives their students the opportunity to participate in our applied economics master's program," says Dr. Farrokh Nourzad, professor of economics and director of graduate studies. The University of the Pacific in California, UW–Oshkosh and Wisconsin Lutheran College are partners as well.

For students, the difficulty level exceeds that of undergraduate work, yet manageably so. "There is a greater expectation for graduate students with more focus on students developing their own ideas," says Jared Sutsko, Arts '17, a philosophy student in the second year of the graduate portion. "With the help of my professors, I was able to get over the hump. Earning a bachelor's and a master's in five years is a great incentive. Plus it's great preparation for future graduate work." With the tools and momentum gained from the five-year program, he plans to next pursue advanced degrees in theology.

> ***"With the help of my professors, I was able to get over the hump. Earning a bachelor's and a master's in five years is a great incentive. Plus, it's great preparation for future graduate work."***
>
> **JARED SUTSKO, ARTS '17**

URBAN CENTER

With its location west of downtown Milwaukee, Marquette benefits from the area's rich cultural diversity. At the same time, the city presents a number of realities that demand informed attention. So it was a natural fit for the college to establish the Center for Urban Research, Teaching and Outreach (CURTO) in 2017. Under Dr. Robert Smith, Harry G. John Professor of Urban Studies, who joined Marquette earlier this academic year in part to lead and launch the center, CURTO initially will cultivate a series of collaborative research agendas and programs with the shared expertise of campus researchers and community scholars.

CELEBRATING THE WRITTEN WORD

I don't remember learning,
but by age twenty-two I have become proficient
at breathing — too bad it's not a resume builder.

Don't ruminate about it unless you yearn
to taste suffocation — fretting is frivolous;
your autonomic nervous system
will keep your tocker ticking.

If you need tactile validation,
place left hand on heart,
right on stomach.

If visual learning is the only way for you,
try standing face to face
with your reflection.

My favorite is auditory —
ear pressed to a lover's chest.

Breathe by Alexis Worden, Arts '17, from the 2017 edition of the *Marquette Literary Review* (marquette.edu/english/litreview). Published with support from the English Department, Marquette's official literary magazine and creative writing journal presents the work of talented student writers in forms ranging from creative essays to short fiction and visual art.

GROWING RICE IN DAIRYLAND

With newsmaking experiments on the flat roof of Marquette's Wehr Life Sciences Building, Dr. Michael Schläppi, associate professor of biological sciences, demonstrated that small plantings of cold-tolerant rice plants could survive Wisconsin's short and often cool growing season and yield a harvest. Then last summer, Schläppi took a giant step in exploring the potential of water-rich Great Lakes states to serve as an alternative to drought-prone rice regions such as California. With support from a $500,000 U.S. Department of Agriculture grant and Strategic Innovation Funds from Marquette, he put a strain of Russian rice under cultivation on a flat, flooded one-acre parcel in suburban Mequon, Wisconsin — consulting with local Hmong immigrants with rice-growing expertise from their native Laos on planting and harvesting techniques and challenges such as geese invasions. To hear Schläppi interviewed on this promising project, search "Schlappi WPR interview."

Biological sciences graduate student Yao Shi helps harvest rice using both modern cultivation methods and traditional methods in partnership with Hmong immigrants from Laos. (Photo by Michael Schläppi)

THE REMARKABLE DR. HENRY KWAN

It's a long way from Hong Kong — which Dr. Henry K.H. Kwan, Arts '71, left at 17 for Marquette with a rudimentary command of English and no cold-weather shoes or jacket — to his prodigious career as a pharmaceutical scientist leading the development of remedies such as Claritin and Nasonex that bring relief to millions. One of a handful of international students when he arrived, Kwan found a welcoming heart (and a source of winter gear) in the late Rev. John Naus, S.J., experiencing a sense of home at Marquette that has never left him. To learn more about Kwan's brilliant career and his generosity that touches every freshman chemistry student, search "Kwan Marquette YouTube."

WIN-WIN INTERNSHIP

Responding to students' growing interest in internships and recognizing the academic and career advantages they provide, the college's new internship office is building partnerships in the Milwaukee area. Students from all academic disciplines are being placed in local businesses, startup companies, nonprofit agencies and government departments. The internship office also oversees the Career Ready Internship Program. This program, funded by the Great Lakes Higher Education Guaranty Corp., has financially supported over 185 Arts and Sciences students and provides opportunities to many students who could not otherwise afford to participate in unpaid internships. "The students' contributions to the workplace and the professional experience they gain are invaluable for them and the employer partners — a true win-win situation," says Sarah Curry, Grad '16, internship coordinator. To read more online, search "Marquette career ready on the job."

VAMPIRE SLAYER, SCHOLARS' MUSE

WITH A CONFERENCE AND SCHOLARLY ACTIVITY, MARQUETTE HELPS FUEL STUDY OF A BELOVED CULT TELEVISION HEROINE.

BY ANN CHRISTENSON, CJPA '90

It's late afternoon in Sensenbrenner Hall, and Dr. James South (top photo), professor of philosophy, and Dr. Gerry Canavan (bottom photo), assistant professor of English, are seated at a conference table amiably discussing the philosophical, moral and sociological implications of a teenage vampire huntress from fictional Sunnydale, California.

Yes, you read that correctly. Avid television viewers from the late 1990s and early 2000s will recognize this heroine as Buffy Summers, who spent eight seasons with friends from the "Scooby Gang" on the cult hit *Buffy the Vampire Slayer*, navigating the travails of high school and the growing presence of evil around her. (Sunnydale High sits atop the gate to, well, hell.)

The conversation between South and Canavan, however, reveals the show is registering with another audience — serious scholars. South is a 22-year faculty veteran specializing in Medieval and Renaissance philosophy and pop culture; Canavan's writing on and teaching of contemporary American literature are informed by interests in comics and science fiction and fantasy. Across the table, they weave in references to fictional demons, vampire love stories and academic conferences devoted to a show that has transcended its adolescent milieu and inspired more scholarly articles than any other series on television. (The culture and politics site Slate.com stopped counting the number of journal articles on Buffy at 200.)

The duo co-organized Marquette's wildly successful "Buffy at 20" conference, a one-day campus event last spring boasting panels on feminism, psychoanalytic interpretations and teaching Buffy as a TV text. The event attracted over 100 people, many simply Buffy fans. Of the 20 academic scholars who attended, one was a prominent California professor who studies science fiction in the context of theories of modern forms of social control and power dynamics.

What makes a show that ran on the teen-friendly former WB Network fruitful ground for doctorate-educated scholars? The show's creator, Joss Whedon. He presents a "consistent vision," says South, "that found ways to add political and philosophical allusions — a distrust of government and authority figures, the metaphor about education not being as good as it should have been, the idea that you choose your family."

The show "amassed such narrative weight," adds Canavan.

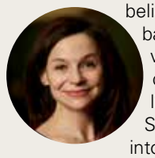
Across the table, they weave in references to fictional demons, vampire love stories and academic conferences devoted to a show that has transcended its adolescent milieu and inspired more scholarly articles than any other series on television.

The Marquette conference was both substantive and quick-witted, with lectures such as "Are You There Vlad, It's Me, Margaret: Feminism and Monster Hunting in a Post-Buffy World" that appealed to mainstream fans as well as academic followers of *Slayage*, the peer-reviewed online journal of Whedon Studies. South doesn't see the screen going dark anytime soon on Buffy scholarship, to which he's contributed as co-editor of *Buffy Goes Dark*, a 2009 book analyzing the show's final two seasons. In fact, as a follow-up to the Marquette conference, South and Canavan are putting together a special issue of *Slayage*. Says South: "There are lots of ways of interpreting Buffy, with themes still to explore."

RESCUING ANTIQUITY

A MARQUETTE SCHOLAR HELPS MOUNT AN AMBITIOUS DIGITAL PROJECT TO PRESERVE AN IMPERILED ANCIENT LANGUAGE'S PRECIOUS CULTURAL HERITAGE.

BY GEORGIA PABST



As a dialect of Aramaic, Syriac is a branch of the language believed to have been spoken by Jesus Christ. And based on its rising influence during the centuries when the Gospels first spread, Syriac is also considered the third great language of ancient literature and Christianity, after Latin and Greek. Still, those distinctions haven't spared it from fading into near obscurity.

Dr. Jeanne-Nicole Mellon Saint-Laurent, assistant professor of theology, is helping to shepherd a project to digitally rescue and preserve the Syriac cultural heritage that has faded as well.

Syriac flourished in the fourth through seventh centuries, although a modern variant is still spoken in parts of Turkey, Syria, Iraq and Iran. The deadly wars in Syria and Iraq, however, have threatened remaining Syriac communities, along with their cultural heritage. Some experts have feared the culture and language could be lost forever.

Before that happens, Saint-Laurent and colleagues are using "the tools of digital humanities" to build Syriaca.org — a portal where databases on subjects such as Syriac geography, saints, authors and other notable persons are freely accessible to historians, theologians, archeologists, students and others.

The contents are gathered from books, manuscripts, museums, monasteries, obscure collections and the internet. Saint-Laurent and colleagues edit, vet, footnote and proof the information to ensure accuracy, relying on an intimate knowledge of ancient Syriac vocabulary and grammar to extract meaning from these sources.

Saint-Laurent's specialty is hagiography, or narratives of the lives of the saints venerated in the Syriac tradition. The information on the website, however, is not meant to be exhaustive or as incisive as traditional scholarship; instead, it's a starting point for further research, she says.

Saint-Laurent and project founder Dr. David Michelson, an assistant professor of early Christianity at Vanderbilt University, fostered their shared interest in all things Syriac while studying together as graduate students. Now numbering six core members, the project team has seen its funding exceed $1 million. Renowned Princeton University professor emeritus Peter Brown donated to the project half of the $950,000 prize money he received in winning the 2011 Balzan Prize for Ancient History. Citing Syriac's "huge legacy," Brown has called it "an entire third voice of the ancient Christian church."

Once obscure, Syriac continues to generate growing interest, says Saint-Laurent. "Syriac study opens people's eyes to the larger history of Christianity. It also illustrates the complicated history of the Middle East."

Based on its rising influence when the Gospels first spread, Syriac is considered the third great language of ancient literature and Christianity, after Latin and Greek.

GLOBAL GATHERING

Preserving the Syriac language is no solo task. Last May, Dr. Jeanne-Nicole Mellon Saint-Laurent co-hosted a conference at Marquette that drew about 30 collaborators — students, faculty members and librarians. Scholars came from as far away as Germany and France, bringing with them a variety of religious perspectives and academic backgrounds.

The Syriaca.org online database project connects these people, making the preservation effort a collaborative one. "You have everything from the history of science, to the history of philosophy, to theology and poetry, so people find different angles from which they find this interesting," says Dr. Dan Schwartz, co-host of the conference and history professor at Texas A&M University.

ENERGY WATER

CAN TINY POROUS STRUCTURES HARNESS THE SUN TO CREATE HYDROGEN POWER FROM WATER?

BY ERIK GUNN

Dr. Jier Huang, assistant professor of chemistry, has launched a five-year project to understand the interactions of sunlight, water and some complex organic-metal structures. Complicated and obscure? Yes, but Huang takes the long view: "The final goal is trying to solve the global energy problem and climate change," she says.

Her project employs solar power in generating hydrogen and aims to test whether this method can beat previous technologies in efficiency and cost. It's shown enough promise that Huang received a $555,636 CAREER grant from the National Science Foundation — the NSF's most prestigious award for non-tenured faculty — to support it. Five Marquette scientists have been awarded CAREER grants in the past five years, three received by chemistry faculty alone.

Huang's work is part of a much larger quest for cheap, clean fuel. If it succeeds, it would be an early step in a much longer journey to the long-promised "hydrogen economy." As far back as 1970, scientists and engineers have suggested hydrogen, the power at the core of the sun and the stars, as an emissions-free alternative to dirty petrochemical fuels. Hydrogen is everywhere, but it's locked inside water, a combination of two hydrogen atoms and one oxygen atom in every molecule. The stumbling block has been extracting it.

Passing electricity through water can split H_2O molecules, releasing hydrogen, "but that has not been very sustainable," Huang says. Solar power — light energy — offers an alternative but requires a catalyst to speed up the process. And the usual materials used to gather sunlight are expensive and unstable — "easy to make and easy to break," says Huang.

Huang and her research team are now testing the use of stable, less-expensive, light-absorbing semiconductor materials in combination with an efficiency-promoting catalyst. One possible catalyst is a crystalline framework that links cobalt-based metal nodes with organic molecules. That creates a porous structure and potentially a double benefit: Materials for absorbing sunlight can be embedded within the empty spaces, and water can pass through the structure. If immersed and energized, the material holds promise that it could effectively separate water molecules to produce hydrogen.

Even if this method succeeds, she observes, her project is just the first step in a series that includes developing practical applications and finding safe methods of storing volatile and explosive hydrogen gas. Huang is confident that these problems will get the necessary attention in time "if we can really build a device that is efficient, cheap and stable."

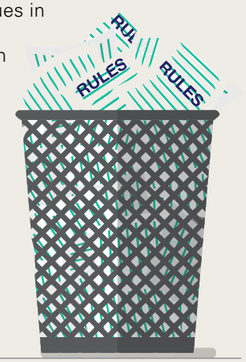
And with that, she gets back to work.

FIRST-TIME FELLOWSHIP

Spain passed its first immigration law in 1985, and it's been a quarter century since immigration figured prominently in public debate in the European nation. Dr. Jeffrey Coleman, assistant professor of Spanish, recently completed a six-month Career Enhancement Fellowship for Junior Faculty to examine the portrayal of immigration in Spanish plays since 1992. Coleman, who specializes in 20th-century and contemporary peninsular Spanish literature, is the first faculty member at Marquette to receive the fellowship, which is awarded by the Woodrow Wilson National Fellowship Foundation.

THROWING OUT THE RULE BOOK

How should the world — and our own military leaders — consider a president who breaks the mold and flouts conventions long taken for granted in foreign policy and military affairs? Dr. Risa Brooks, associate professor of political science, first addressed these issues in a *Washington Post* commentary in March after a U.S. military action in Yemen. Then-editors of the *Post's* "Monkey Cage" section, which "connects political scientists and the political conversation," sought out Brooks for related insights after President Donald Trump announced his Afghanistan strategy. Search "Risa Brooks Three Rules Monkey Cage" for her analysis.



A VIEW INSIDE A CANCER FIGHTER

BY PAULA WHEELER AND STEPHEN FILMANOWICZ

In the drive to realize the cancer-fighting potential of magnolia bark extract (MBE) — a remedy long used in traditional Asian medicine for its reported anti-bacterial, anti-inflammatory and digestive health effects — it's hard to imagine a better research nexus than the Medical College of Wisconsin and Marquette University in Milwaukee.

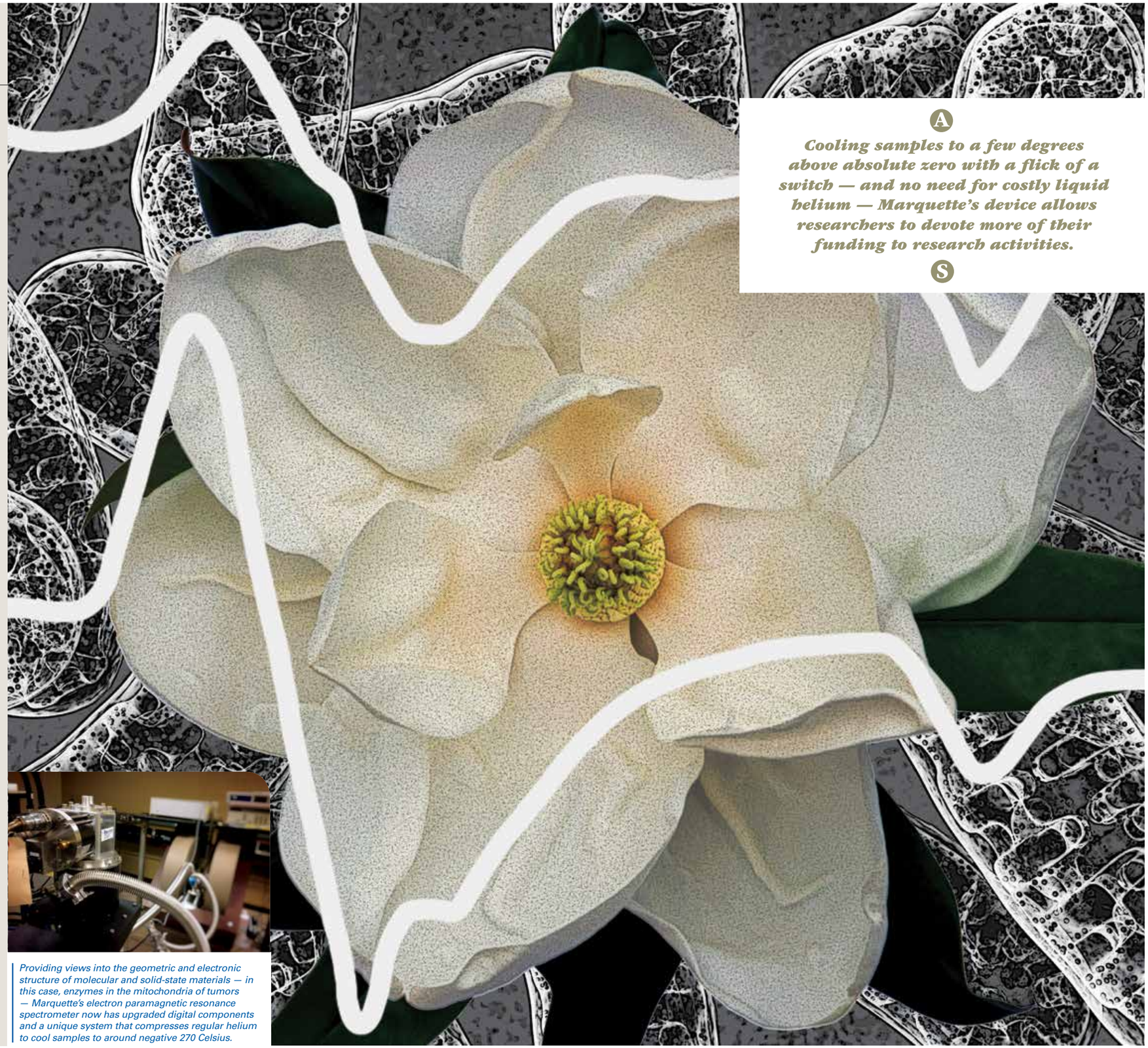
MCW's highly regarded Cancer Center is one of several world research sites to observe MBE's ability to shrink animal tumors. Leading the search for the mechanism at work is Dr. Balaraman Kalyanaraman, MCW professor and chair of biophysics and a foremost expert in the intracellular metabolic processes by which MBE is suspected of weakening and killing tumor tissue.

But that research wouldn't be complete without the contributions of Dr. Brian Bennett (left), Wehr Distinguished Professor of Physics and physics chair at Marquette, who has both the expertise and technology to help put these theories to the test, using electromagnetic snapshots to reveal MBE's disruptive effects on mitochondria, the cells' chief energy source, in the tumor.

Bennett's special weapon in this anti-cancer fight is an electron paramagnetic resonance spectrometer in the basement of the Wehr Physics Building, originally donated to the university in 2013 and then upgraded significantly through a federal grant secured by Bennett and Dr. Richard Holz, dean of the college. The overhaul took the instrument from analog to digital and added a state-of-the-art cooling system that eliminates the need to spend $2,000 weekly on liquid helium as a cooling agent.

While many research universities have EPR spectrometers, Marquette's is the only one in the Midwest able to cool samples — at anytime with a flick of a switch — to a few degrees above absolute zero (minus 273 Celsius), as the process requires. That allows Marquette researchers from physics, chemistry and biology to devote more of their funding to research activity. With previous grant proposals, "the money required for liquid helium ate up a big share of the budget. I could only do a third of the experiments I'd planned to do," explains Bennett, who also recently used the machine to confirm with MCW researchers that non-titanium hip replacements were leaching muscle-destroying chromium into nearby tissue.

The jagged lines in the image to the right are revealing spectrometer readings from the mitochondria of oral mice tumors, both untreated (top) and treated (bottom) — with the wider zig-zagging of the lower line indicating a greater presence of destructive free radicals (also known as reactive oxygen species or ROS). "Tumor cells need ROS to a point," says Bennett. "But tumors are also known to be highly sensitive to these reactive oxygen species. This signal supports the idea that magnolia extract spurs the generation of so much ROS that it poisons the tumor." Funded by a $40,000 research grant from MCW Cancer Center's Marquette-MCW initiative, Bennett's and Kalyanaraman's findings are providing data to support a much larger inter-institutional program, including proposed trials that will explore MBE's effects on human tumors along with issues such as the ideal doses of the various active agents in MBE and levels at which those agents might prove toxic to healthy organs and tissue. "The ROS hypothesis has been tacitly accepted for years and has already informed drug-development efforts, but we hope to be the first to see it rigorously tested to find out whether it provides rational support for ROS-based cancer therapy," says Bennett.



Providing views into the geometric and electronic structure of molecular and solid-state materials — in this case, enzymes in the mitochondria of tumors — Marquette's electron paramagnetic resonance spectrometer now has upgraded digital components and a unique system that compresses regular helium to cool samples to around negative 270 Celsius.

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Cooling samples to a few degrees above absolute zero with a flick of a switch — and no need for costly liquid helium — Marquette's device allows researchers to devote more of their funding to research activities.

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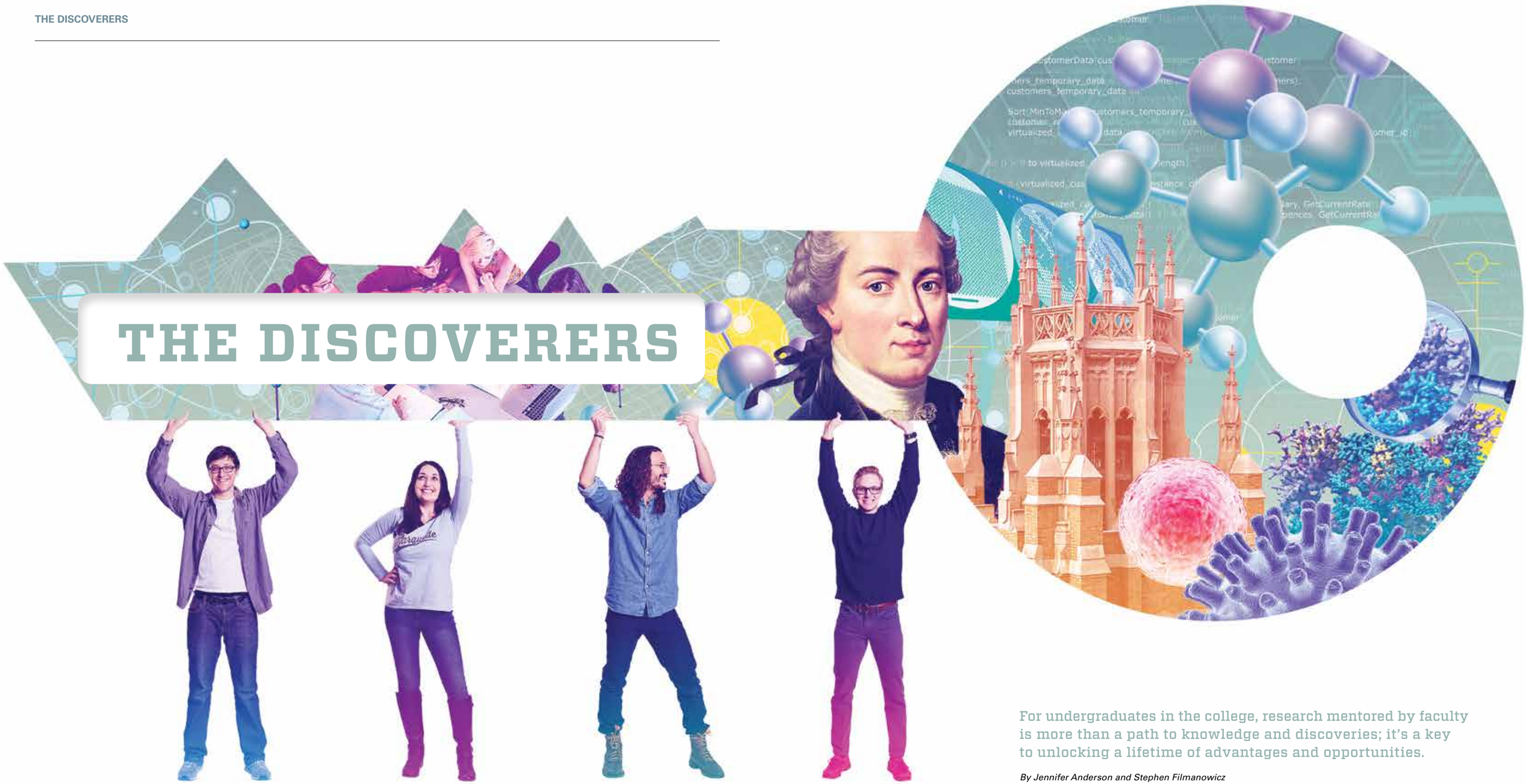
THE DISCOVERERS



For undergraduates in the college, research mentored by faculty is more than a path to knowledge and discoveries; it's a key to unlocking a lifetime of advantages and opportunities.

By Jennifer Anderson and Stephen Filmanowicz

70%

or more of students are eager to conduct research.

Source: Marquette Incoming Freshman Survey, 2016

Ben Lamb, a senior majoring in biological sciences, has already built an impressive resume. He takes a rigorous course load, makes top grades and was a student-athlete. But as he's gone through the process of applying to medical schools, one experience has stood out to interviewers — his yearlong participation in a lab-based program, the Marquette Experience in Drug Discovery and Development program, or ME(D)^3. In close partnership with Dr. Martin St. Maurice, associate professor of biological sciences and an accomplished faculty researcher, Lamb and three fellow undergraduates conducted research on a metabolically important enzyme that prior research showed may play a role in cancer and diabetes. The students tackled their own research projects and were called on for thorough presentations of their findings to the lab's professors and graduate students, an initially intimidating task that became satisfying and collegial.

Ben Lamb (top) and Dr. Martin St. Maurice

"Med school interviewers are always really impressed with the program; they're not used to seeing students coming out of undergrad with this much genuine research experience," says Lamb. "A lot of other students have research experience, but it might not be anything more than assisting graduate students or washing dishes in the lab."

The ME(D)^3 program is no anomaly. Faculty-mentored undergraduate research is a priority and a specialty of the Klingler College of Arts and Sciences, creating rich year-round opportunities for students across all of the college's disciplines. It's supported by a range of programs, including research grants awarded by the Center for Peacemaking, summer research fellowships offered by the Honors Program and 10-week summer research programs hosted by the Mathematics, Statistics and Computer Science Department and the Biological Sciences Department. And that's in addition to the many robust research experiences that St. Maurice and committed faculty mentors like him make possible each semester for one, two or a few students at a time.

If you're a student eager to conduct research — and 70 percent or more of surveyed freshmen have indicated they want just that — then the College of Arts and Sciences is a fertile place to engage in this often transformative experience. "Students engaged in research are making important contributions to our discoveries, our publications and our grant proposals. They're a critical component of our interwoven teaching and research missions," says Dr. Rosemary Stuart, professor of biological sciences and associate dean for research and experiential learning. "Student researchers get to follow their own curiosity, pose questions, come up with the experimental design and research methods, and often forge new discoveries. It's quite exciting for many students, and they get hooked."

Best of all, the value of these experiences extends way beyond having a handy topic to tout in graduate school or job interviews. Faculty-mentored research is one of those high-impact, beyond-classroom experiences through which students not only build knowledge but develop and mature in ways that help them advance in life, whatever career path they choose. So it's not surprising that surveys of graduates show that having these kinds of experiences — and the meaningful student-faculty interaction built into them — correlates with feeling more engaged on campus and satisfied in postcollege work life.

Through their research, students learn to identify and articulate problems, to deal with ambiguity and redirection, and to develop creative solutions, while honing their analytical methods and communication skills. "These are the dividends of performing mentored research, all essential skills that are important no matter what field students go into," says Stuart. "Importantly, student researchers also gain a faculty mentor who encourages them to identify and pursue their goals and recognize their strengths. There's so much value in that student-faculty connection as students discern their future career paths."

Research and scholarship in the college comes in a variety of forms, some of them quite unexpected and inventive. Just ask the students from Dr. Ryan Patrick Hanley's undergraduate seminar course on Immanuel Kant, who attended a dinner with their professor in 2015 where they began an academic journey that brought the ideas of the influential 18th-century German philosopher vividly to life.

Kant envisioned the dinner party as an ideal forum for engaging people from differing perspectives on timely topics; he even laid down specific rules for fostering respectful but lively discussion around the table. Not long after the class dinner at a traditional Milwaukee German restaurant where they first put these rules into practice, two students from that seminar — Charles Dobbs, Arts '15, and Anthony Lanz, Arts '13, Grad '17 — signed on to work closely with Hanley to give Kant's guidelines a more public test-drive. So was born the Kantian Dinner Initiative, a series of public dinner parties, each limited to nine guests per Kant's instructions, nine strangers, in this case.

Anthony Lanz (top) and Dr. Ryan Patrick Hanley

Mentored by Hanley, Mellon Distinguished Professor of Political Science, Lanz and Dobbs helped write a successful grant proposal to the Wisconsin Humanities Council. Then came extensive collaborative troubleshooting: making restaurant arrangements, advertising citywide for participants, and using Kant's cues to direct the conversation at the dinners (reminding guests of their trust-building vows to be respectful and keep what's said confidential, for instance).

The initiative proved to be an amazing learning experience. "Doing research for this initiative took school to the next level. It was a reminder that it's not just all about papers and grades," says Lanz. "It showed that there's a lot of pleasure to be found in thinking about concepts more critically."

"There was no guidebook; we had to figure it out together," says Hanley. "It was a wonderful opportunity to show students that the ideas we study have a life beyond the seminar room. Kant is this dense, difficult Prussian philosopher from 250 years ago, but he offers lessons that are important for our times."

Formulating theories to explain unexpected lab results, conducting focus groups, submitting papers for publication in academic journals, presenting findings at national conferences: Though commonly associated with graduate study, these are all challenges that undergraduate researchers at Marquette can be found tackling.

Such growth and skill development are assured given students' roles as real partners of faculty researchers — and they can be exhilarating — though St. Maurice warns of potentially long waits for eureka moments. "Research is 95 percent beating your head against a wall, with a small chance of success on the back end. It's important for undergraduate students to experience some of the tedium and frustration that is inevitably part of the research process and to learn for themselves whether the thrill of discovery is enough to keep them going."

Students recognize the skills and resilience they pick up along the way as invaluable. When Noah Greenberg started conducting research in the lab of faculty mentor Dr. Andrew Kunz, the then-junior majoring in physics quickly realized that being able to articulate the substance of his research to his mentor was almost as important as the methods and results themselves. "I definitely grew into that," he recalls.

Over a productive semester of research in Kunz's lab exploring something called "artificial spin ice," Greenberg simulated unstable patterns of molecular spin mimicking what's generated when polarized water molecules crystallize into icy lattice structures. And his assuredness grew along with his results.

THE KEY HOLDERS

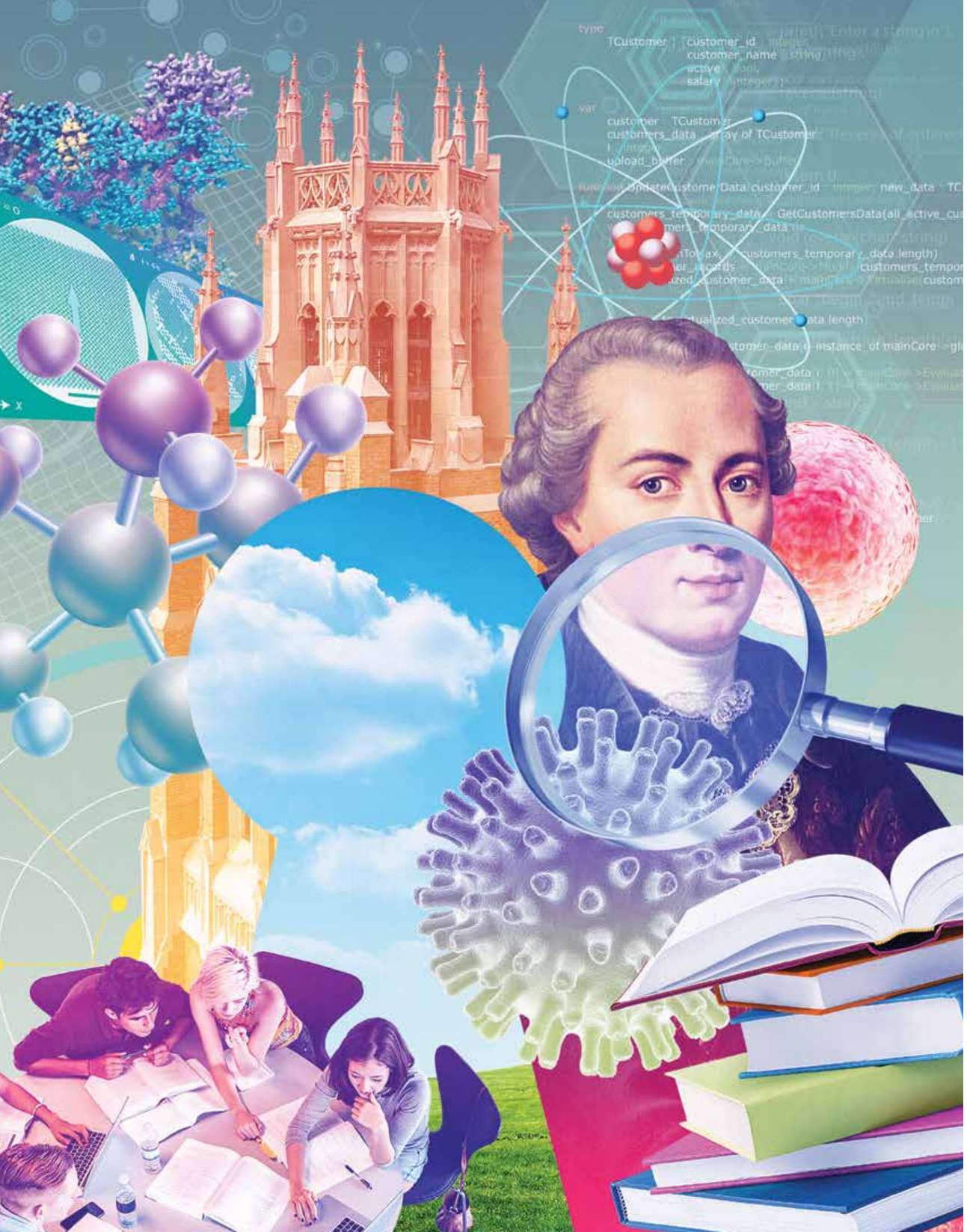
JENNIFER DIENES

ARTS 20 05

NOW: Intellectual property attorney at Morgan, Lewis & Bockius LLP in Chicago

THEN: Spent two years as a biochemistry and molecular biology major researching proteins with Dr. Pinfen Yang, professor in the Biological Sciences Department, and experiencing the thrill of presenting her work at lab meetings and conferences.

HOW RESEARCH CHANGED HER: "I gained a deep understanding and appreciation of the effort, creativity and tenacity required to conduct scientific research," says Dienes. She also learned how to speak publicly about scientific ideas and credits her overall laboratory experience with helping her land her first position as an associate after law school. "As an intellectual property attorney, you must be able to quickly learn new scientific concepts, discuss those concepts intelligently with experts in the field and then be able to explain complex concepts to people who don't have any scientific training," she says. "Research really gave me the foundation to be successful in my career."



Noah Greenberg (top) and Dr. Andrew Kunz

After writing code that functioned flawlessly as spin ice and manipulating it to show what happens when specific parts of the artificial lattice are removed, Greenberg was ready for a step that Kunz, an associate professor of physics, relishes offering students as they progress in his lab — presenting their findings to top researchers at a national physics conference.

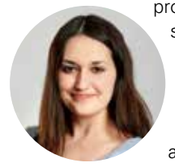
In Greenberg's case the setting was the annual conference of the American Physical Society in New Orleans last March, where he happened to spot a titan in the field — the acknowledged inventor of artificial spin ice — in the audience for his presentation. That expert, Dr. Peter Schiffer of Yale University, even stopped Greenberg on his way from the podium, startling him a bit, to offer a tip about an article that would help corroborate the Marquette team's findings. The episode taught Greenberg a lasting lesson. "Attending conferences and dialoguing with people in the field teaches you things you can't get from reading or researching on your own," he says.

Greenberg's case also reveals how these research experiences act as springboards to attractive opportunities: internships, prestigious fellowships, graduate study, job offers. Since presenting in New Orleans, Greenberg has linked together summer and fall research fellowships at two renowned research centers: the Institute for Quantum Computing in Waterloo, Ontario, and the Princeton Plasma Physics Laboratory in New Jersey. And Kunz points to a roster of former student researchers who have gone on to successful doctoral study in physics and related fields, and faculty positions at research universities.

It's logical, of course, that challenging experiences guided by wise mentors open doors to new ambitions and achievements, but it helps to know that data back up this conclusion. An extensive Gallup-Purdue Index survey in 2015 identified what researchers call "the Big Six," a core set of college experiences strongly linked to graduates feeling well prepared for their lives and careers. Did you have a professor in college who made you feel excited about learning? Then you experienced one of the Big Six. How about a professor who cared for you as a person? Having one is another factor contributing to a sense of feeling better prepared for life after college, as is having a mentor who encouraged you to pursue goals and dreams, and participating in a project that took a semester or more to complete.

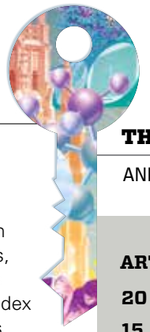
Involved faculty members have looked at this list of six and noted a very close match with what students encounter through mentored research, at least five of the Big Six experiences. And testimonials from former student reseachers attest to the dividends they reap as they move beyond Marquette. (See "Key Holders," starting on p.15.)

When she was a sophomore majoring in writing-intensive English and French literature, Megan Knowles, Arts '17, didn't yet know how many of these key experiences were there waiting for her when she enrolled in Ethnography of the University, a course created by Dr. Beth Godbee, assistant professor of English, to engage students in academic scholarship while harnessing their passions for examining relevant campus issues.



Megan Knowles (top) and Dr. Beth Godbee

Using her research to wrestle with a question that gnawed at her as she observed peers' reluctance to contribute in class — do students today see higher education as an obligation or an opportunity — Knowles saw her project evolve in fortuitous ways. After writing a research paper for the course based on observational field notes and student interviews, she received



THE KEY HOLDERS

ANDREW THOMPSON

ARTS
20
15

NOW: A third-year doctoral student in political science at Northwestern University

THEN: As an undergraduate majoring in political science and philosophy, Thompson became a McNair Scholar and led a summer research project examining the framing of terrorist attacks in the U.S. mainstream media. A second summer of research followed at Ohio State University, where he examined state building in sub-Saharan Africa and its pertinence to international relations.

HOW RESEARCH CHANGED HIM: Thompson doesn't mince words: "My undergraduate research experience made an immense difference in the trajectory of my life. I would not be pursuing my Ph.D. or a career in academia were it not for the training I was provided through the Honors Program, the McNair Scholars Program and a research seminar taught by Dr. Astrida Kaugars, associate professor of psychology." These experiences taught Thompson organization and promptness and helped him sift through what interested him and what did not. In addition to giving him tools for his graduate career, "The Marquette research experience," says Thompson, "showed me a new world that I have been able to thrive within."

a $3,500 undergraduate research grant from the college to spend the summer diving deeper — surveying students, hosting focus groups and conducting a literature review. Another grant covered her travel to a national conference in Houston, one of two where she presented an academic poster summarizing her findings.

"When I entered Marquette, I never expected research to play such a big part in how I'd develop skills during my undergraduate years and in my path toward a career in writing and editing," says Knowles. Less than a year after receiving her bachelor's degree, she is building a career as a writer-reporter for a major health care publisher in Chicago's Loop, where she regularly finds herself grateful for Godbee's course and mentoring.

"At work, I'm constantly refining my writing process, thinking of ways to ask better questions and working to better communicate with my sources and co-workers — all skills Beth helped me develop," she remarks. "Even though I'm new to the team, I don't feel nervous about speaking to high-up professionals in a public setting — another skill I can thank Beth's course for."

For Godbee, such outcomes are gratifying, validating a course design that challenges traditional models of college instruction based on "conceptions of teachers as experts, students as sponges, and schools as places of sitting quietly in one's seat. Instead, students are acting as agents over their own learning, fired up by curiosity and commitments."

With 35 percent of Arts and Sciences graduates reporting having engaged in faculty-mentored research as undergraduates, far above the university average of 19 percent, the college is already a good place to benefit from these opportunities. But there's always room for improvement. To reduce the chance that high-achieving students fail to get research on their radar screens until late in their undergraduate careers, the new MU4Gold Scholars program matches high-achieving freshmen with faculty mentors and research projects. Supported by a grant from the Marquette Strategic Innovation Fund, it helps a freshman cohort get on track to apply for prestigious scholarships such as Rhodes or Fulbright fellowships, or aim for attractive graduate programs. See "Researchers From Day One" on opposite page. After all, the benefits of undergraduate research are too important to leave finding them to chance. "We hear it again and again from graduates who are doing impressive things in their careers," says Stuart. "The faculty-mentored research they did as undergraduates stands out as something pivotal in their Marquette experience and their personal development that prepared them to forge a meaningful path through life and their careers."

BIG SIX

Take it from college graduates: Undergraduate experiences make a huge difference in determining how prepared one feels for post-college life. Here are six key ones closely linked with feeling a sense of well-being and engagement after graduation:

- Had one or more professors who made you feel excited about learning
- Had professors care about you as a person
- Had a mentor who encouraged you to pursue your goals and dreams
- Worked on a project that took a semester or more to complete
- Had an internship or job where you applied what you learned in class
- Were very active in extracurricular activities

Source: Gallup-Purdue survey of 30,000 college graduates (2015)

THE KEY HOLDERS

CIARA J. MCHUGH

ARTS 2013

NOW: Program associate and adjunct instructor at Marquette's Center for Peacemaking

THEN: Introduced to research by Dr. Sarah Gendron, associate professor of French, McHugh wrote a paper on propaganda against women in French-speaking Rwanda and co-presented findings at a conference in Lisbon, Portugal. She then received two Center for Peacemaking fellowships to travel to Northern Ireland, which led to a master's in gender-sensitive police reform in post-conflict societies from Queen's University Belfast.

HOW RESEARCH CHANGED HER: "These projects introduced me to peacemaking on an international scale and deeply influenced my subsequent academic and professional interests," says McHugh. Solidifying her interest in applied research and guiding her to a career in academia, the projects also introduced her to mentors she continues to rely on today. "To have ended up back at Marquette University, the institution that first cultivated my interests, I feel that my journey has come full circle," she says.

"We know a lot of really high-achieving students are interested in doing faculty-mentored research as undergraduates. That's something we have quite a lot of happening all over campus."

DR. ROSEMARY STUART

KATE GUSTAFSON

Researchers From Day One

A new College of Arts and Sciences program draws high-achieving freshmen to Marquette and grooms them for research experiences.

As valedictorian and a *summa cum laude* graduate of her 500-member senior class in Normal, Illinois, and a member of the National Honor Society and two other honor societies, Kate Gustafson had few worries about the many college acceptance messages she'd receive, but when financial considerations put her top choice out of reach, her heart sank.

Around the same time, however, she heard something from another school in her top three — Marquette — that changed her college calculations. Invited to apply to join MU4Gold Scholars, a small College of Arts and Sciences cohort embedded in the University Honors Program and focusing on faculty-mentored research, she wrote an essay and submitted her application. She learned of her acceptance a few days before the deposit due date, just in time to choose Marquette. "I was originally kind of bummed. Then I got into MU4Gold Scholars," says the freshman psychology major. "It was definitely a nice bonus, and it made me feel that this was where I was supposed to be."

Stories like Gustafson's are what academic leaders had in mind in piloting this strategic bid to attract high-achieving students, introduce them early to Marquette's research opportunities, and support them in higher research ambitions. "We know a lot of really high-achieving students are interested in doing faculty-mentored research as undergraduates," explains Dr. Rosemary Stuart, professor of biological sciences and the Klingler College's associate dean for research and experiential learning. "That's something we have quite a lot of happening all over campus. So we thought that should be something we can market to these high-achieving students to encourage them to select Marquette."

Gustafson and seven other Honors freshmen in MU4Gold Scholars' inaugural class are participating in a one-credit course led by Stuart that acquaints them with the research landscape — and leading faculty researchers — while grooming them for this spring's highlight: a match with a faculty mentor and a multi-semester research project in a discipline of their choosing.

Aiming to inspire challenge-ready students and ultimately strengthen the research culture on campus, Stuart and University Honors Program Director Amelia Zurcher, associate professor of English, also launched MU4Gold Scholars to combat a too-common scenario: undergraduates discovering a passion for research and an interest in prestigious opportunities such as Fulbright or Critical Language scholarships and Peace Corps service too late to put together credible applications. "The early introduction to research provided by MU4Gold Scholars means that by the time students begin thinking about applications to prestigious scholarships and service programs in their junior year, they have lots of useful experience under their belts," says Zurcher of the pilot, currently funded for three years by Marquette's Strategic Innovation Fund. "And the close mentoring relationships the program fosters are not only rewarding in themselves but are a springboard for successful competition for these opportunities." Like the quest for Olympic medals, the pursuit of research gold requires patient preparation in a supportive environment — like Marquette.

By Stephen Filmanowicz

ISSUING A RALLYING CRY

By Paula Wheeler

Tim Kochis, Arts '68, accepted the Klingler College of Arts and Sciences 2017 Distinguished Alumnus of the Year award with a brief but memorable rallying cry for the liberal arts.

"An education in the liberal arts is all about developing a moral compass through a strong understanding of the human condition and an acceptance of ambiguity and an appreciation for differing perspectives," Kochis told the awards ceremony audience in 2017. "The measure of success in the humanities is an awareness of the unavoidable uncertainty in human affairs, and developing a sense of values that permits us to navigate our way through that uncertainty."

If it seems incongruous that a career wealth manager and investment planning expert would champion the humanities, Kochis — the former chairman and CEO of the independent investment management firm Aspiriant and current consultant to financial planning firms — is quick to point out what he sees as an obvious connection.

"Being a personal financial adviser is about genuinely understanding people, understanding their values and objectives and motivating them to take appropriate action to accomplish those objectives," explains Kochis, who says the most powerful reward of his life's work has been the interpersonal connections forged with clients. "For that, a humanities education is hugely relevant. It helps you to accept and even relish the nuances of individual decision-making, as well as the ambiguities that are always present in human affairs."

Kochis, a native of south suburban Chicago, engaged broadly in the humanities as a Marquette undergraduate, majoring in philosophy and sociology, and minoring in political science and psychology. He entered law school at the University of Michigan in fall 1968, but was drafted into the U.S. Army and stationed in Vietnam for two years before returning to complete his law degree.

Recruited with other newly minted lawyers to help start a financial advisory practice at Continental Bank in Chicago, Kochis discovered he loved the work and enrolled in an evening MBA program at the University of Chicago. After enduring Chicago's punishing late-1970s winters — the worst on record for the city — he decided it was time to turn his California dreaming into reality, and he moved to San Francisco.

Kochis eventually co-founded a company that later was part of the merger that created Aspiriant in 2008. For just under two years, he led the company, which prioritizes personalized service and refers to itself as "the leading wealth management firm." After a brief sabbatical, he returned in 2010 as president of Aspiriant's international ventures division. In 2012 he founded Kochis Global to provide strategic consulting to personal advisory firms domestically and overseas, primarily in Asia.

His passion for his profession has led Kochis to share his expertise as the author of five books, as a leader in industry organizations and as a financial planning educator at the University of California–Berkeley, which established an annual teaching excellence award in his name.

Kochis' commitment to higher education extends to his philanthropic endeavors, including a scholarship fund at Marquette that honors his parents. "They never went to college, but all five of (their children) did go, and three of us to Marquette," Kochis says. "We established the fund in their names to both honor them and make the same kinds of opportunities available to others that they helped make available to us."

Of the causes supported by Kochis and his wife, filmmaker Penelope Wong, he explains, "Educational institutions are among our most important beneficiaries, because of the leverage involved. By helping people open their minds to develop skills and patterns of careful thought, you benefit not just them, but everyone around them."

Now in what he calls "the emeritus phase" of his career, Kochis acknowledges he is busier than ever with consulting, board membership with five organizations (including the University of San Francisco, the Schwab Strategic Trust and The Asia Foundation) and frequent speaking engagements in his field.

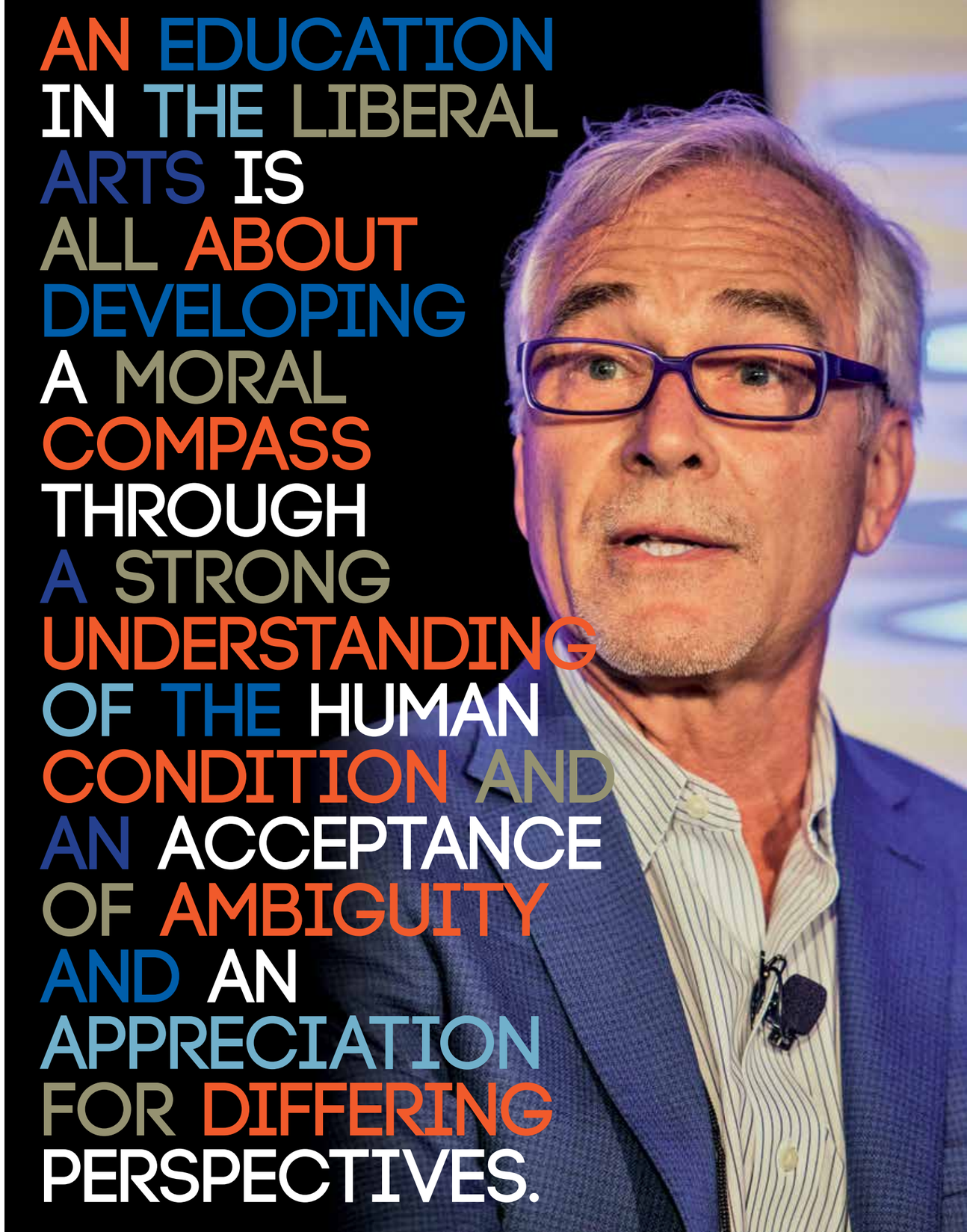
It is Kochis' eloquent endorsement of liberal arts education that Dean Richard Holz intends to carry forward in his own public speaking engagements. "His comments were right on the mark," Holz says. "It's the best I've ever heard anyone capture the essence of the importance of a liberal arts education in today's world."

Forward for the Humanities

Tim Kochis gained a fellow champion of the liberal arts — an institutional one — in October when Marquette established the Center for the Advancement of the Humanities.

"The humanities play a central, pivotal role in the education we provide," said Provost Daniel Myers in announcing the center and articulating its mission to develop, enhance and disseminate new approaches to the humanities, while supporting teaching and research within the disciplines.

As director, Dr. James South, professor of philosophy and associate dean for faculty in the college, will emphasize interdisciplinary collaboration, with plans to keep the center "at the forefront of debates that require humanistic knowledge to enhance the common good of society."



Dr. Shion Guha, assistant professor of mathematics, statistics and computer science, joined Marquette's faculty in 2016, bringing both expertise in data science and a conviction that the world needs holistic data scientists able to think critically, act ethically and understand computer science.

THE ULTIMATE QUEST

By Daniel Simmons

AS SWELLING INFORMATION STREAMS BRING HUGE OPPORTUNITIES AND RISKS, DATA SCIENCE AT MARQUETTE EXPANDS TO PROVIDE TECHNICAL AND ETHICAL LEADERSHIP.

Dr. Shion Guha likes computer scientists who can write code, crunch data sets and develop algorithms. But he loves computer scientists who can do all those things plus think critically, act ethically and understand human behavior. That quest for a total-package computing approach led him from Cornell University in New York, where he earned his doctorate, to a position at Marquette in 2016 as assistant professor of mathematics, statistics and computer science.

"I strongly believe that computer scientists should have a rigorous liberal arts background," he says. "Marquette's Jesuit history fused with a unique common core accomplishes this for every student." Guha was recruited to grow Marquette's expertise in data science, a specialization within computer science that aims to sort and make sense of the seemingly endless flood of electronic information now available. Students now can major in data science, as Marquette in 2016 became one of just a handful of universities nationally to offer the major to undergraduates. The major stands at the intersection of computer science, statistics and mathematics, which made Marquette a logical place for it since those disciplines are already joined here. That department, within the Klingler College of Arts and Sciences, is also the nexus of a variety of new (or novel) efforts — centers, research partnerships, graduate programs, a certificate offering to benefit computer science professionals in the field — that represent the university planting its flag in this fast-emerging field.

Guha gets occasional groans from freshmen in his Introduction to Computer Science course when he tells them how much they'll need to write. "We came here to learn code," they tell him. By junior year, students thank him, by now in upper-level courses and well aware why writing matters even in a discipline defined by zeros and ones.

"We're trying to train holistic computer scientists," he says.

Not that the technical stuff isn't important, too. The previous 15 years have brought an explosion in the amount of data created, collected and stored by companies, universities, governments and individuals. By 2009, companies with at least 1,000 employees had an average of 200 terabytes of stored data, twice what global giant Walmart had just a decade earlier, according to a report by McKinsey & Company.

"The increasing volume and detail of information captured by enterprises, the rise of multimedia, social media, and the Internet of Things will fuel exponential growth in data for the foreseeable future," the report's authors write.

One problem: There aren't nearly enough people trained to handle all that data, which holds potential for massive economic opportunity but also unprecedented challenges related to privacy, security and intellectual property. The news of big data's downsides isn't hard to find: a breach of credit bureau company Equifax that exposed sensitive financial data of 43 million Americans, for example, or the alleged spread of "fake news" stories on social-media networks that may have influenced voters in the 2016 federal elections.

To help fill that talent gap, the university has taken bold steps in recent years. In addition to adding the undergraduate major in data science, the Mathematics, Statistics and Computer Science Department also established the Center for Cyber Security Awareness and Cyber Defense, hiring Dr. Despoina Perouli, a cyber security expert and assistant professor of mathematics, statistics and computer science, to help launch and develop it.

"We started pursuing these areas because that's where the action is," says Dr. Tom Kaczmarek, the center's director who also is director of Marquette's master of science in computing program.

Adds Perouli: "Cyber security is an important problem that our nation and the world faces today; Marquette has the ethical duty to respond to this problem and has taken the steps to do so. Our university has a unique opportunity to play a leading role in the state of Wisconsin by training the cyber security experts of tomorrow."

The twin developments have brought new faculty, courses for both students and area businesses, degree offerings and fresh scholarly research opportunities, too. For example, Perouli secured a $175,000 grant from the National Science Foundation to study social robots — think Amazon Echo or Google Home or the new generation of mobile assistants offering to roam your home with you — and how to develop algorithms to detect when they're overstepping their roles and violating users' security and privacy. The grant will enable both undergraduate and graduate student research opportunities.

"The social robots differ from more traditional computing devices, such as laptops and smartphones,

Dr. Despoina Perouli, cyber security expert and assistant professor of mathematics, statistics and computer science, joined Marquette in part to help launch and develop the new Center for Cyber Security Awareness and Cyber Defense. She also has a grant from the National Science Foundation to study the security issues raised by newly marketed social robots.

Dr. Aleksandra Snowden, assistant professor of social and cultural sciences, and Dr. Amber Wichowsky, associate professor of political science, have explored the interdisciplinary reach of data science, obtaining a Mellon Foundation grant with Guha to hold a mini-course on spatial analysis focusing on crime mapping in Milwaukee.

on several aspects: Mobility, sensors, use and computing power are some of them," Perouli says. "Therefore, relying on current security practices is not going to necessarily solve all the important problems."

Guha, Dr. Amber Wichowsky, associate professor of political science, and Dr. Aleksandra Snowden, a criminologist and assistant professor of social and cultural sciences, were awarded an Andrew W. Mellon Foundation grant to start a three-day mini-course on spatial analysis that focused on studying the possibilities and pitfalls of crime mapping in collaboration with the Milwaukee Police Department.

"We've heard a lot of criticism about Milwaukee being a segregated city and unfair outcomes due to over-policing," Guha says. "A lot of (policing decisions) are driven by quantitative analysis of crime. If the quantitative work is not done in the best way it could, that might lead to unfair outcomes."

The expansion of data science is leaving its mark on graduate-level offerings, also. Two years ago, the university started offering a specialization in data science to graduate computer science students. About a dozen are now pursuing it, Kaczmarek says. Responding to an exploding demand for data analysis in health care, the department in collaboration with the College of Nursing this semester launched a graduate certificate in data science and a master's in health care analytics.

Guha says there are discussions underway about adding joint master's degrees with a data focus — with crime analytics and with media analytics. To facilitate easily adding data techniques to any discipline, the department has created a 15-credit data sciences core that can be worked into the curriculum of any other master's program, with students earning the other 15 credits in the chosen discipline.

Then there's the undergraduate level, where the year-old data sciences major was joined this fall by an undergraduate major in bioinformatics, a joint offering from the Biological Sciences and Mathematics, Statistics and Computer Science departments.

"I believe (data science) has a huge potential to improve people's lives over the next few decades," says Marielle Billig, a senior majoring in computer engineering and data science. "We are entering an age where everything from your watch to your refrigerator to traffic lights collects data, but we will need people to analyze this data for it to be useful."

Billig spent a summer interning as a software developer at NASA's Jet Propulsion Lab and is working with Guha on a research project related to algorithmic ethics.

In 2016, Kaczmarek, with Dr. Theresa Tobin, Arts '97, associate professor of philosophy, and Dr. Katherine Rickus, assistant professor of philosophy, hosted the college's first Ethics of Big Data symposium, bringing the academic community together with local business leaders to share best practices. Now in its third year, the symposium this spring will be hosted at Northwestern Mutual in downtown Milwaukee. Kaczmarek also credits Rev. Joseph Coelho, S.J., a graduate student in his department, with facilitating the meetings.

As Marquette moves into this broad new field that's rich with opportunities for faculty and students alike, it does so with an accompanying sense of caution, knowing that a strong focus on ethics must remain at the core, a way to stay true to the university's heritage and also distinguish itself from many other programs nationally.

"That's a result of us being a Jesuit university," says Kaczmarek. "Even in our graduate programs, I think it makes sense to pay attention to all aspects of using technology, not just the mechanics of analysis."

"I STRONGLY BELIEVE THAT COMPUTER SCIENTISTS SHOULD HAVE A RIGOROUS LIBERAL ARTS BACKGROUND. MARQUETTE'S JESUIT HISTORY FUSED WITH A UNIQUE COMMON CORE ACCOMPLISHES THIS FOR EVERY STUDENT."

Dr. Shion Guha

SETTING A COURSE FOR BIODISCOVERY

By Martina Ibáñez-Baldor, Comm '15

Through an inclusive, rigorous 18-month process, Marquette's campus master plan created a road map for Marquette's capital improvements over the next 10 to 20 years.

And among the plan's major priorities is a project promising to redefine the south edge of campus as a visionary BioDiscovery District serving the needs of two key academic departments, biological and biomedical sciences. To replace outmoded research spaces siloed in separate buildings, the district is envisioned offering modern collaborative laboratories for two disciplines that together accounted for 36 percent of research funding at Marquette in fiscal year 2017, says Dr. Richard Holz, dean of the Klingler College of Arts and Sciences. Collaborative opportunities would extend to student research and teaching in a modern complex that could look like the renderings on these pages. "This is going to have a huge impact on our undergraduates. We want to make sure we have first-rate facilities for our students and faculty," says Holz.

6M

LEADING THE RESEARCH EFFORT Together, biological and biomedical sciences combine for $6 million in annual grant-funded research. With the two departments under one roof, those numbers would be expected to climb significantly, in support of Marquette's goal of doubling research efforts university-wide by 2020 and into the future. "It's really exciting that we could be able to solve problems that are currently unsolvable because the right people aren't together in the room," says the dean.

FULLY EQUIPPED Replacing Marquette's Service and Wehr Life Sciences buildings, the district would be a combined research and teaching facility with laboratories equipped to support the entire spectrum of student-faculty learning and research uses. "We're trying to have an open concept so students can interact across disciplines and that can spur new and innovative research directions and ideas," says Holz.

TAKING THE NEXT STEP Dr. Edward Blumenthal, chair and associate professor of biological sciences, and Dr. John Mantsch, chair and professor of biomedical sciences, have led a working group of professors from the two colleges to explore research themes with high potential for valuable collaboration, including biology in human health, response to a changing environment and response to stress, topics with much relevance to major problems facing our society. "The response to stress theme is very broad," says Blumenthal, "covering everything from the response of ecosystems such as tropical rain forests to stress, to how humans and animals respond to stress. That's something many of us in the two departments are working on." When completed, the BioDiscovery District would bring these like-minds together. "We're all scientists," says Mantsch. "When you're assigned the task of addressing real-world problems, when you get people who can really think about it in that way and can work collaboratively, there's real potential here."

12%

A CROSS-COLLEGE COLLABORATIVE NEXUS
The new complex would bring together two of the university's biggest undergraduate programs. Biomedical sciences in the College of Health Sciences is the most popular major on campus, while biological sciences* in the Klingler College ranks 11th with 250 students. Together, they account for 12 percent of Marquette's 8,000 undergraduates. Championing the project with his counterpart, Dr. William Cullinan, dean of the College of Health Sciences, Holz also notes that approximately one in six undergraduates takes biology courses that would bring them into the facility.

Biological sciences is home to the majors: biological sciences, physiological sciences and interdisciplinary programs in biochemistry and molecular biology, environmental studies and bioinformatics.

The anticipated location of the complex is near the corner of 16th and Clybourn streets, where it would be highly visible from I-94 and help to form a modern southwest gateway to the Marquette campus.

Interested in supporting the development of the BioDiscovery District? Contact Kelli Rael at kelli.rael@marquette.edu.

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