**Front cover, clockwise from top left:**

**Sossina Haile,** materials science and engineering, explores innovations in fuel and solar cells, research that may lead to breakthroughs in sustainable energy. Read more about Haile’s work on page 32.

**Joel Mokyr,** Robert H. Strotz Professor of Arts and Sciences and professor of economics and history, examines the challenges and dynamics of economic growth. See page 38.

**Sarah Rice,** cell and molecular biology, uses structural biology and biochemistry to determine how regulatory mechanisms, such as phosphorylation and ubiquitination, alter molecular motors and their cargoes. See page 43.

**Morris Levy,** librarian and metadata and discovery services, researches and reconstructs ballet music from 19th-century Italy. See page 35.
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DEAR FRIENDS AND COLLEAGUES,

Bold, collaborative discovery is a hallmark of Northwestern’s research enterprise. Our advances over the past year demonstrate our continued success in producing high-impact knowledge that delivers great social benefit. The engine for this progress is the University’s innovative ecosystem, which encourages cross-disciplinary engagement and provides rich opportunities for faculty and students to pursue research that is transformative and careers that are profoundly meaningful.

This unique environment attracts talented people with a passion for transcending conventional ways of framing, pursuing, and solving some of humanity’s most urgent challenges. We like to say that Northwestern is an “and/and” place, where diverse ideas come together in exciting ways. Our community invites and nurtures those who want to make the world better by charting their own path — what we call taking a “Northwestern Direction.”

This past year has been a remarkable one for Northwestern. We received major gifts from donors who recognize our ongoing success and who know that we will amplify the power of their philanthropy so that it drives world-changing discoveries and produces the next generation of thought leaders. We have developed students who are launching their careers with renowned fellowships, including Marshall and NSF scholarships and Fulbright grants. We discovered new knowledge that changed our understanding of the world. We continue to attract some of the most talented students,
post-docs, and new faculty — people whose contributions will significantly enhance the University and the world, now and for decades to come. And we achieve all this in learning spaces that are inspiring, beautiful, and historic: consider Harris or Swift Hall, or new construction such as the recently opened Ryan Center for the Musical Arts on the Evanston campus Arts Green. We also have world-class laboratories and more than 60 core facilities, which provide amazing instrumentation to enable groundbreaking discoveries. Importantly, we also have the experts to manage these facilities and to teach our students to best use the equipment in the facilities.

Each of these elements is a vital part of sustaining and growing a University that every day strives to build a better society.

**Ideas with Impact:**
**Northwestern Research Excellence**

In this *Annual Report*, you can learn more about the global impact of Northwestern research. In our “Excellence in Research” feature, you will meet some of our outstanding faculty whose ideas shape discourse in their disciplines and whose scholarship attracts and develops the best students and post-docs. Many of these faculty members are incredibly collaborative. They bring ideas from their knowledge domains to influence the work of colleagues in other fields. They engage with the best minds in other arenas to generate research that incorporates new insights and that results in outcomes greater than the sum of their parts.

A collaborative culture has long defined Northwestern, but we have
further increased its role, including by designing spaces that co-locate faculty from the Department of Economics and the Kellogg School. Similarly, we have made it easier for the McCormick School’s engineering faculty to interact with colleagues from the Weinberg School’s physics, chemistry, life sciences, and geological sciences departments. Then, too, Feinberg School medical faculty engage in research with the University’s social scientists. Such relationships extend across our campuses, and beyond. They include partnerships between Northwestern engineers and the Rehabilitation Institute of Chicago. Our chemists work with materials scientists at Argonne National Laboratory. And our social scientists are ever more involved with the primary and secondary schools in Evanston and Chicago.

Record-Breaking Funding Spurs Fundamental Progress

This culture certainly contributes to Northwestern’s successful research growth. Over the past year, we once again enjoyed a record volume of awards, totaling more than $620 million. The University has been on an incredible run: For more than a decade, we have seen steady awards growth — in excess of 60 percent — during a time when federal research funding has remained essentially flat.

Our research growth stems from Northwestern’s commitment to creating a vibrant ecosystem for discovery, into which we hire exceptional faculty and attract great students. We also provide excellent facilities, such as libraries and scientific equipment, and staff members who help researchers flourish by leveraging the University’s resources to maximum advantage. Our researchers are then immersed in and help further develop an environment where excellent research questions are asked and answered. Most of our faculty’s work is “fundamental” research. These are investigations that pursue answers to important questions without particular concern for the application of the knowledge discovered. Fundamental research is the cornerstone of progress. It is research that discovers truths that have always been present, but had remained obscure until we revealed them. It is research that broadens our understanding and allows the development of previously unanticipated applications.

For example, Joe Moskal, biomedical engineering, conducted fundamental research that produced a better understanding of a brain protein — the NMDA receptor. This work led to the development of a molecule that interacts with that receptor. That molecule is now the basis for a new anti-depression drug currently advancing through clinical trials.

Fundamental research also is at the heart of a new center on synthetic biology, led by Milan Mrksich, biomedical engineering, and Michael Jewett, chemical and biological engineering. In this center, researchers use biological structures to manufacture materials. Fundamental research similarly has increased our understanding of structure and function on the nanometer-scale, such that Northwestern is now home to newly funded centers dedicated
to nanomaterials and next-generation nano-based cancer treatments. **Chad Mirkin**, chemistry, is leading both of these endeavors. Fundamental research has long been the basis for HIV treatment, too. Northwestern has now opened the Third Coast Center for AIDS Research, led by **Brian Mustanski**, medical social sciences, to study the interactions among numerous factors that continue to influence the AIDS epidemic in parts of the United States. Fundamental research also is key to understanding the impacts caused by wars. Such scholarship is occurring, for example, in the Buffett Institute’s Center for Forced Migration Studies, led by **Galya Ruffer**, political science. Other impacts, such as those brought about by new educational initiatives, are studied by **David Figlio**, education and social policy and economics, and colleagues in the Institute for Policy Research and elsewhere at the University.

**Investment in Discovery**

Northwestern’s research progress is only possible because of broad-based support for our work. The educational ecosystem in the United States drives our new knowledge discovery. It is within this ecosystem that a student first learns basic skills and how to conduct research. Most students leave academia upon graduation and enter the workforce, where they typically contribute mightily to their organization and society. Some students gain advanced knowledge and become faculty members who write proposals to frame and pursue new research questions. When funded, these scholars create new knowledge and train the next generation. Throughout, the research is significantly supported by grants that often are funded by US citizens via federal funding agencies and conducted in facilities and with funding from generously supportive donors. Every element of this ecosystem is vital to progress. Undoubtedly, each of you reading this message is a part of this ecosystem, contributing to its success. I want to thank you for the part that you play in making Northwestern’s research community one of the most important engines for progress in modern society.

All the best,

Jay Walsh
Vice President for Research
Professor of Biomedical Engineering
Northwestern’s exemplary global reputation is founded on the outstanding thought leadership of the University’s faculty members. In the laboratory and classroom, these scholars and scientists advance the boundaries of their fields. This devotion to enhancing understanding is made even richer through cross-disciplinary collaboration that leads to breakthroughs that strengthen science and society. At the same time, our faculty demonstrate a profound commitment to teaching. They prepare today’s students for tomorrow’s challenges — and for career opportunities that will let them make high-impact contributions to create a better world.

**MEMBERS OF NATIONAL ACADEMIES AND SOCIETIES**

The Annual Report offers insight into individual faculty accomplishments over the past year as well as the financial measures that inform Northwestern’s research excellence. These measures include awards for sponsored projects, expenditures, and submitted proposals. For comparison with peer institutions, we include a reference to a cohort derived from the American Association of Universities (AAU), a select group of the nation’s top universities. These institutions are regarded as outstanding because of their robust research and teaching programs. Northwestern has been an AAU member since 1917.

The research impact of the University’s distinguished faculty is measured in many different ways, including through publication in top academic journals. Northwestern’s faculty publish in some of the world’s most prestigious science journals, and their work is cited extensively. The University’s scientific output is recognized through a variety of awards and honors at both the national and international levels. These accolades underscore the University’s commitment to excellence and its role as a leader in the advancement of knowledge.

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Source: National Academy of Sciences www.nasonline.org

### NATIONAL ACADEMY OF ENGINEERING MEMBERS

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Source: National Academy of Engineering www.nae.edu
journals; through awards from preeminent grant and fellowship programs; and by membership in prestigious national academies and societies. In fact, one of the highest honors for faculty members is election to these societies, such as the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Medicine. These organizations harness the expertise of scholars in all areas of scientific, humanistic, and technological endeavor. The faculty members contribute their knowledge to help solve critical national challenges, while providing advice to the federal government and the public. Northwestern faculty elected in 2015 are:

**Chris Abani**, English: fellow, American Academy of Arts and Sciences

**Luis Amaral**, chemical and biological engineering: fellow, American Physical Society

**Guillermo Ameer**, biomedical engineering: fellow, Biomedical Engineering Society

**Peter Dinda**, electrical engineering and computer science: fellow, Institute of Electrical and Electronics Engineers

**Timothy Feddersen**, managerial economics and decision sciences: fellow, American Academy of Arts and Sciences

**Peter Kahrilas**, medicine-gastroenterology and hepatology: elected member, Association of American Physicians

**Thomas Meade**, chemistry: fellow, American Association for the Advancement of Science

**Miheea Popa**, mathematics: fellow, American Mathematical Society

**Jennifer Richeson**, psychology: member, National Academy of Sciences

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Source: Institute of Medicine www.iom.edu

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Source: National Science Foundation www.nsf.gov/awardsearch
CAREER AWARDS FROM THE NATIONAL SCIENCE FOUNDATION

Over the course of their professional lives, Northwestern faculty members contribute to high-impact discoveries that advance their fields, educate the next generation of scholars, and improve the world. Early in their faculty lives, some of the most promising talent is supported through prestigious award programs, such as the National Science Foundation’s “Faculty Early Career Development Program.” The CAREER Award recognizes and supports the development of teacher-scholars and helps create the foundation for decades of research and education excellence. In 2015, this award was bestowed upon the following Northwestern faculty members.

Yarrow Axford, earth and planetary sciences (Oct. 2015)
Oliver Cossairt, electrical engineering and computer science
Dana Freedman, chemistry (Oct. 2015)
Nikos Hardavellas, electrical engineering and computer sciences
Michael Horn, electrical engineering and computer science
James Rondinelli, materials science and engineering
Evan Scott, biomedical engineering
Keith Tyo, chemical and biological engineering

CITATIONS

The following Northwestern faculty have been recognized for the significant impact of their published work as determined using the Scopus (Elsevier) database, which assesses a broad set of publications from many sources. However, Scopus collects citations only since 1996. As a result, only faculty members whose main publication activity has occurred since that date are well represented in the survey.

Zdeněk P. Bažant, civil and environmental engineering
Al B. Benson III, medicine: hematology oncology
Robert O. Bonow, medicine: cardiology
David Cella, medical social sciences
Mihai Gheorghiade, medicine: cardiology
Francis Joseph Giles, medicine: hematology oncology
Robert Goldman, cell and molecular biology
Jordan Henry Grafman, physical medicine and rehabilitation
Philip Greenland, preventive medicine
Stephen B. Hanauer, medicine: gastroenterology
Brian M. Hoffman, chemistry
Yonggang Huang, civil engineering
Joseph Hupp, chemistry
Merceouri Kanatzidis, chemistry
Robert Lamb, molecular miosciences
Kiang Liu, preventive medicine
Donald M. Lloyd-Jones, preventive medicine
Tobin Marks, chemistry
Patrick M. McCarthy, surgery
Herbert Y. Meltzer, medicine: psychiatry
Marek-Marsel Mesulam, neurology
Richard J. Miller, pharmacology
Chad A. Mirkin, chemistry
Richard I. Morimoto, molecular biosciences
Milan Mrksich, biomedical engineering
SonBinh Nguyen, chemistry
Eric G. Neilson, medicine: nephrology
Thomas V. O’Halloran, medical social sciences
Alfred W. Rademaker, preventive medicine
Mark A. Ratner, chemistry
George C. Schatz, chemistry
Robert P. Schleimer, immunology
Michael H. Schmitt, physics
Paul T. Schumacker, pediatrics-neonatology
Sir J. Fraser Stoddart, chemistry
Samuel Isaac Stupp, materials science and engineering
Dalton James Surmeier Jr, physiology
James David Thomas, medicine: cardiology
Richard P. Van Duyne, chemistry
Michael R. Wasielewski, chemistry
Steven M. Wolinsky, microbiology
2015 FACULTY RECOGNITION AND HONORS

Northwestern's Office of Administration and Planning, in conjunction with the faculty honors committee, compiles a comprehensive list of faculty awards and honors. The faculty honors committee then selects those faculty members with the most prestigious honors for University recognition. At this year's faculty recognition dinner, hosted by President Morton Schapiro and Provost Daniel Linzer on September 28, the following individuals were honored for scholarship and research that has brought particular distinction to Northwestern.

*Chris Abani*, English: fellow, American Academy of Arts and Sciences; Edgar Awards — Best Paperback Original, Mystery Writers of America; 2014 USA Ford Fellow, United States Artists

*Jan Achenbach*, civil and environmental engineering: 2014 Monie A. Ferst Award, Sigma Xi

*Karen Alter*, political science: Best Book Award for 2014, International Studies Association International Law Section

*Luis Amaral*, chemical and biological engineering: fellow, American Physical Society

*Guillermo Ameer*, biomedical engineering: fellow, Biomedical Engineering Society

*Zdeněk P. Bažant*, civil and environmental engineering: Mindlin Medal, American Society of Civil Engineers; foreign member, Royal Society of London for Improving Natural Knowledge, award created in his honor, Zdeněk P. Bažant Medal for Failure and Damage Prevention; foreign member, Academia Europaea

*Kevin Boyle*, history: Andrew Carnegie Fellow, Carnegie Corporation; Public Scholar Program, National Endowment for the Humanities

*Peter Carroll*, history: 2015-2016 fellow, National Humanities Center

*Timothy Carroll*, biomedical engineering: Lucien Levy Research Award, American Society of Neuroradiology

*Jennifer Chan*, emergency medicine: Humanitarian Service Award, Global Emergency Medicine Academy

*Deborah Cohen*, history: Morris D. Forkosch Prize, American Historical Association; Stansky Book Prize, North American Conference on British Studies

*Noshir Contractor*, industrial engineering and management sciences: fellow, International Communication Association

*Oliver Cossairt*, electrical engineering and computer science: Faculty Early Career Development, National Science Foundation

*Isaac Daniel*, civil and environmental engineering and mechanical engineering: Gold Medal of Excellence, American Society for Composites

*Laura DeMarco*, mathematics: fellowship, Simons Foundation

*Peter Dinda*, electrical engineering and computer science: fellow, Institute of Electrical and Electronics Engineers

*Ryan Dohoney*, music studies: fellowship, American Council of Learned Societies

*Daniel Dombeck*, neurobiology: McKnight Scholar Award, McKnight Foundation

*Charles Dowding*, civil and environmental engineering: Civil Engineer of the Year, Illinois Section of the American Society of Civil Engineers
Horacio Espinosa, mechanical engineering: Murray Medal, Society for Experimental Mechanics
Omar Farha, chemistry: Environment, Sustainability and Energy Division Early Career Award, Royal Society of Chemistry
Timothy Feddersen, managerial economics and decision sciences: fellow, American Academy of Arts and Sciences
Danna Freedman, chemistry: Sloan Research Fellowship, Alfred P. Sloan Foundation
Dedre Gentner, psychology: David E. Rumelhart Prize, Robert J. Glushko and Pamela Samuelson Foundation
Rebecca Gilman, radio, television, and film: Harold and Mimi Steinberg/ATCA New Play Award, American Theatre Critics Association
Frank Gonzalez-Crussi, pathology: Premio Letterario Merck, Merck KGaA
Kathleen Green, pathology: Albert Kligman Award, Society for Investigative Dermatology; Humboldt Research Award, Alexander von Humboldt Foundation
Nikos Hardavellas, electrical engineering and computer science: Faculty Early Career Development, National Science Foundation
Yongchao Ma, pediatrics: Hartwell Individual Biomedical Research Award, The Hartwell Foundation
Hani Mahmassani, civil and environmental engineering: Kitamura Award, Transportation Research Board of the National Academies
Tobin Marks, chemistry: Luigi Sacconi Medal, Italian Chemical Society; Materials for Industry - Derek Birchall Award Winner, Royal Society of Chemistry
Mary McGrae McDermott, medicine-general internal medicine and geriatrics and preventive medicine: elected member, Association of American Physicians
David McGill, music performance: Theodore Thomas Medallion, Chicago Symphony Orchestra
Thomas Meade, chemistry: Fellow, American Association for the Advancement of Science
Chad Mirkin, chemistry: Centenary Prize, Royal Society of Chemistry; Honorary Degree, Federal University of Rio Grade do Sul
Adilson Motter, physics and astronomy: Fellowship, Simons Foundation
Matthew Notowidigdo, economics: Hicks-Tinbergen Award, European Economic Association
Gregory Olson, materials science and engineering: Honorary Doctorate, KTH Royal Institute of Technology in Stockholm
Monica Olvera de la Cruz, materials science and engineering: Visiting Miller Professorship, University of California, Berkeley
Michael Peshkin, mechanical engineering: fellow, National Academy of Inventors
Mihnea Popa, mathematics: fellow, American Mathematical Society; Fellowship, Simons Foundation

Monica Prasad, sociology: fellowship, John Simon Guggenheim Foundation

Christina Pugh, School of Professional Studies: fellowship, John Simon Guggenheim Foundation

Lincoln Quillian, sociology: Jane Addams Award, American Sociological Association

Janice Radway, communication studies: 2015-2016 Fellow, National Humanities Center

Jennifer Richeson, psychology: fellowship, John Simon Guggenheim Foundation; Member, US National Academy of Sciences

James Rondinelli, materials science and engineering: Faculty Early Career Development, National Science Foundation

Heather Schoenfeld, human development and social policy: Distinguished Article Award, Sociology of Law

Evan Scott, biomedical engineering: Faculty Early Career Development, National Science Foundation

Ramille Shah, materials science and engineering: Featured in "40 under 40," Crain’s Chicago Business

Toru Shiozaki, chemistry: Sloan Research Fellowship, Alfred P. Sloan Foundation

Elizabeth Son, theatre: Career Enhancement Fellowship for Junior Faculty, Woodrow Wilson National Fellowship Foundation

Lynn Spigel, radio, television, and film: ICA Fellows Book Award, International Communication Association

J. Fraser Stoddart, chemistry: Alan G. MacDiarmid Medal, University of Pennsylvania

Neil Stone, medicine, 2014 Physician of the Year, American Heart Association

Samuel Stupp, materials science and engineering: foreign member, Royal Academy of Engineering of Spain

David Tolchinsky, AMFA in Writing for the Screen and Stage: Best Director, Riant Theatre's Strawberry One-Act Festival

Keith Tyo, chemical and biological engineering: Faculty Early Career Development (CAREER), National Science Foundation

Richard Van Duyne, chemistry: Theophilus Redwood Award, Royal Society of Chemistry

Jane Wang, mechanical engineering: International Award, Society of Tribologists and Lubrication Engineers

Ellen Wartella, communication studies: Outstanding Achievement Award, University of Minnesota; B. Aubrey Fisher Mentorship Award, International Communication Association

Julia Weertman, materials science and engineering: Ellen Swallow Richards Diversity Award, Minerals, Metals, and Materials Society

Arnold Widen, medicine: 2015 Outstanding Volunteer Clinical Teacher Award, American College of Physicians

James Yao, surgery: René Leriche Prize 2015, International Society of Surgery

Mary Zimmerman, performance studies: Career Achievement in Professional Theatre Award, Association for Theatre in Higher Education
RESEARCH FELLOWSHIPS

For the 10th consecutive year, Northwestern was among the very top producers of US Fulbright grant recipients, ranking No. 3 nationally for the 2014-15 academic year. The University had 26 students or alumni who accepted the prestigious award, which is funded by the nation’s premier international exchange program. An additional three grants were offered but declined. This year’s total recipients approached the University’s 2008-09 record of 32 grant winners.

The Northwestern Fulbright awardees were chosen from among 124 total applicants from the University. The recipients — who use the award support to teach, conduct research, study, or participate in service organizations — come from a variety of academic backgrounds, ranging from biomedical engineering and mathematics to journalism and political science.

The Fulbright US Student Program was designed to increase mutual understanding between Americans and the citizens of other countries and provide support for individually designed study/research projects or for English Teaching Assistant programs. Candidates succeed based upon their academic merit and leadership potential.

Northwestern students also perform well in the National Science Foundation Graduate Research Fellowship program (GRFP). For the 2014-15 academic year, 20 of the University’s students earned this distinction, placing Northwestern in the top 10 among its peer institutions (see table). The GRFP is a highly competitive award that recognizes outstanding students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based master’s and doctoral degrees.

Note: Since 2014, the NSF no longer lists a student’s expected graduate institution, so only the person’s undergraduate listing is available for this ranking. In addition, a broader accounting of these metrics — such as that performed by our Office of Fellowships as well as by certain peer institutions — reveals even greater Northwestern success in this survey. This alternate analysis considers the following categories: students who successfully applied for NSF fellowships as Northwestern seniors; those who applied as graduate students elsewhere, but who received their undergraduate education at Northwestern; and those currently enrolled at Northwestern as graduate students. Employing this framework reveals a total of 52 NSF fellowship winners affiliated with Northwestern for 2014-15.

### NATIONAL SCIENCE FOUNDATION GRADUATE RESEARCH FELLOWSHIPS

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Source: National Science Foundation www.fastlane.nsf.gov/grfp/Login.do
Scott Kelly has a habit of floating through the workweek.

For nearly a year the American astronaut has orbited Earth inside the International Space Station as part of an audacious NASA experiment.

The 342-day mission’s unprecedented duration and ambitious scientific endeavor — 10 parallel projects involving Scott and his Earthbound twin, Mark — will allow researchers to investigate the effects of space on the human body over time.
Northwestern’s foray into NASA’s Twins Study began about two years before Scott Kelly was launched into space on March 27, 2015.

“The Year in Space mission had already been planned, but the scientific aspects had yet to be completed,” says Fred Turek, director of Northwestern’s Center for Sleep and Circadian Biology (CSCB) and the Charles E. and Emma H. Morrison Professor of Biology, recalling his 2013 visit to the Johnson Space Center in Houston. “We saw a calendar that accounted for every 10-minute segment of Scott’s time and were asked to design research proposals related to the Twins Study that could fit within that demanding schedule.”

Turek, along with CSCB deputy director Martha Vitaterna and collaborators from Rush University Medical School and the University of Illinois at Chicago, comprise the research team studying how space affects the 1,000 or so species of bacteria — the microbiota — living inside the stomach and intestines, or gastrointestinal tract.

The diverse microorganisms that inhabit the GI tract influence a person’s normal physiology and susceptibility to disease. Despite the clear importance of the microbiota for maintaining overall health on Earth, how the rigors of spaceflight affect the gut remains unknown.

Combined Effort

NASA’s Twins Study has been designed to integrate Turek and Vitaterna’s work with nine other projects centered on ‘omics,’ the characterization and quantification of large pools of biological molecules that result in the structure, function, and dynamics of an organism.

The data-rich biology projects, led by researchers throughout the nation, will also examine bone and muscle loss, vision problems, and more.

“In the months after Scott’s return to Earth in March 2016, we should be able to determine the sequence of events that occurred within his body while he was in space and compare that with similar data collected on his twin brother, Mark, a retired astronaut,” says Vitaterna.
Experts on circadian rhythms, Turek and Vitaterna opted to pursue gut research with NASA following publication of their 2014 *PLOS ONE* article, “Circadian Disorganization Alters Intestinal Microbiota.” That study showed for the first time that while the microbiome was affected when the circadian clock — the internal regulation of our day-night cycle — was disrupted, the effects were greatly amplified by a high-fat, high-sugar, Western-style diet.

**Of Mice and Men**

In June, the multi-institutional team began planning for a follow-up to the Twins Study that will involve sending mice to the International Space Station. Preliminary terrestrial research will occur in the coming months to establish a protocol, with the experiments in space beginning in two to three years.

“It’s an honor to be among NASA’s first life science projects funded since the completion of the International Space Station and the rejuvenation of America’s space biology program,” says Turek.

The researchers will study genetically identical mice in space and on Earth. The project aims to examine the effects of long-term spaceflight on hundreds of different microbes in the animals’ GI tracts, as well as the impact of microbiota changes on physiology and behavior.

The mouse study will allow researchers to examine physiological systems that cannot be investigated in the Kelly twins because of limitations placed on human studies.

As longer-duration space missions are anticipated — a trip to Mars and back is expected to take about two to three years — understanding how the gut microbiota might be altered in zero gravity will be important to support crew health and performance for future voyages. Such research can also shed light on other environmental factors associated with humans in space, such as increased exposure to radiation in different forms. Turek and Vitaterna’s research may also reveal how humans might overcome GI problems here on Earth.

“It’s clear that altering the microbial ecology has implications for immune function, digestive health, metabolic health, circadian rhythms, and stress responses, but we aren’t yet able to predict the optimal state for coping with such health challenges,” says Vitaterna. “Our results are certainly going to provide some surprises, but ultimately they will teach us how to maintain a healthy microbiota in space, and therefore, healthy lifestyles on Earth.”

— Roger Anderson
What if the difference between going to Princeton and going to prison was influenced as much by conditions at conception as by circumstances in the following years?

At Northwestern, research at the intersection of economics, education, race, and health is offering new insights into the role each plays throughout a person’s life.

“The impact of things like socioeconomic status and a parent’s educational background is a very real factor as a child develops and eventually contributes to society,” says economist David Figlio, director of the Institute for Policy Research (IPR).

For Figlio, the Orrington Lunt Professor of Education and Social Policy, the bidirectional relationship between health and human capital (a person’s contributions to society) has become the focal point for many of his collaborations.

That’s because what’s discovered in one discipline — the effect of education on health, for example — can help to inform others’ work on the effect of health on education.

As the engineer of one of America’s first large-scale efforts to match birth and education records, Figlio has spent a decade analyzing the histories of more than 2 million Floridians.
The resulting dataset has, for the first time, allowed researchers to study topics such as the effects of neonatal health on educational outcomes and human capital formation. In 2013, a team of researchers led by Figlio and economist Jonathan Guryan, human development and social policy, discovered that healthier newborns maintain an academic edge for years. Figlio, together with IPR research associate Krzysztof Karbownik and researchers from MIT and the University of Florida, also showed that family disadvantage harms everyone, but especially boys.

“A growing body of evidence has begun to show that the effects of disadvantage and poverty in early childhood can have long-lasting effects,” says Guryan, who also chairs IPR’s Program on Education Policy. “This highlights the need for policies to reduce poverty and its consequences, particularly with respect to children.

“As students age, not finishing high school often becomes intertwined with involvement in the juvenile justice system. I am interested in learning whether there are policies that might lead students down a path that includes school and future economic well-being rather than incarceration and poverty.”

A number of interventions studied by Guryan have proven successful. The “Becoming a Man” initiative, a dropout and violence prevention program for at-risk boys in grades 7 through 12, is credited with a 44 percent reduction in violent crime arrests for participating Chicago Public Schools students. Meanwhile, intensive individualized instruction for at-risk CPS high school students increased math scores and reduced failing grades by half.

Adding to the discussion is labor economist Kirabo Jackson, human development and social policy, who is studying when and why certain policies improve student outcomes through rewarding those involved for classroom achievement.

Jackson found that Texas schools offering students and teachers a monetary incentive for passing Advanced Placement test scores saw large increases in the number of students taking and passing these exams. In follow-up research that tracked students through college, he found that affected students pursue higher education in greater numbers, are more likely to remain in college beyond their freshman year, have higher college GPAs, are more likely to graduate from college, less likely to be unemployed, and earn higher wages.

“Our evidence suggests that offering monetary incentive for students or teachers, individually, isn’t an effective approach,” says Jackson. “In order to produce successful policy, a well-designed pay-for-performance system needs to account for both sides of the equation, aligning the goals of students and teachers to maximize results.”

**Varied Approach**

In recognizing patterns that affect human capital, Northwestern researchers are discovering new ways they might affect social policy.

“We put a high premium on quantitative tools that help us determine causal inference,” says Figlio, emphasizing the impact of work done at IPR’s Quantitative Methods for Policy Research Center. “And we work with governmental and other organizations to try to establish interventions in ways that are testable.”

Also informing Figlio’s scholarship is research by Joseph Ferrie, economics, who uses historical data to determine the link between early-life circumstances and later-life
outcomes. Meanwhile, Seema Jayachandran, economics, explores the effect that parental investment has on childhood health and education outcomes in the developing world.

“All these investigations fit within the IPR framework, which encourages our researchers to approach similar questions in a variety of ways,” Figlio says. “Joe, Seema, and I are all economists, but the special thing about IPR is that we learn from experts like Chris Kuzawa, a biological anthropologist, and Emma Adam, psychobiologist, who are exploring how health affects well-being and cognitive development.” Kuzawa was part of a multinational team whose investigations, using data from the Philippines, demonstrated that women with high stress-hormone levels give birth to smaller babies.

“Our data will help further our understanding of which factors in a mother’s life predict birth outcomes and long-term health in their offspring,” says Kuzawa, who is collaborating with Greg Miller, psychology, and Thomas McDade, anthropology.

Miller, alongside Edith Chen, psychology, is also studying how stressors like education and socioeconomic status affect a child’s likelihood of developing chronic diseases as an adult.

Biology and Beyond

McDade, who directs Cells to Society: The Center on Social Disparities and Health at IPR, is exploring the long-term effects of early environments and the integration of biological measures into population-based social science research.

His investigations are helping to determine the role of social status and neighborhood factors as sources that affect mental and physical health in young adults.

The disadvantage of circumstance is proving to be an ever-expanding field. Recent studies by Adam, human development and social policy, found that the stress of racial discrimination is difficult to ignore and suggests that black and Hispanic adolescents see their health affected by discrimination.

“Subtle discriminatory acts matter for your biology and also for your health,” says Adam. “It’s a costly societal problem that really needs to be addressed.”

“The basic science informs us on our own biology, allowing us to help develop ways to improve the human condition,” says Figlio. “We need to understand that education, cognitive capacity, socioeconomic background, and much more have distinct effects on every life.”

A National Audience

By helping to understand the impact of human biology, the work of Adam, Kuzawa, Miller, and other Northwestern investigators has provided important information for legislators to consider.

In late September, Leemore Dafny, strategy, testified before a Senate subcommittee.

The Herman Smith Research Professor in Hospital and Health Services traveled to Washington to talk about the recent trend of health insurer mergers and their impact on premiums. Appearing alongside the CEOs of major health insurers, she expressed skepticism that large mergers will produce benefits for consumers.
“I am not aware of any peer-reviewed, published research that suggests insurance mergers benefit consumers,” says Dafny. “My own studies find exactly the opposite: premiums increase when fewer insurers participate in an insurance market. This is true even though mergers appear to result in lower payments to hospitals and healthcare workers.”

Dafny, an IPR associate and member of the Congressional Budget Office’s Panel of Health Advisers, testified about her research on the impacts of a mega-merger at the turn of the century (the acquisition of Prudential by Aetna). The resulting increase in premiums can be extrapolated to estimate the impact of insurance consolidation in recent years on premiums. Dafny and her coauthors found that the consolidation between 1998 and 2006 alone resulted in a long-term per-capita increase in premiums of $200.

“We are paying a premium on our premiums because of limited competition,” she says. Noting that federal subsidies for private policies are projected to rise from $32 billion in 2015 to $84 billion by 2020, she argued that “given the current stakes, there is a substantial public benefit to critically evaluating any significant changes in industry market structure.”

If medical insurance were made more affordable, one downstream effect of better health could be better education outcomes.

“One of the challenges is that we need to not only conduct the research but also connect with individuals who have the ability to influence people’s lives,” Figlio says. “If 100 people read a paper in an academic journal, that will not have the broad social impact that can take place if hundreds of policymakers see it or tens of thousands of people read the findings in the New York Times.”

Guryan and Diane Schanzenbach, human development and social policy, saw their research reach a national audience in 2015 when it was included in a report by the President’s Council of Economic Advisers.

Schanzenbach studies policies aimed at improving the lives of children in poverty, including education, health, and income support. Published by the Brookings Institution, her study “The Impacts of Expanding Access to High-Quality Preschool Education” outlined some of the continual educational gains by children who were enrolled in preschool.

Schanzenbach and Elizabeth Cascio at Dartmouth College estimated the value of increased future earnings from preschool programs is between $2.70 and $7.20 for every $1 spent.

“We know that pretty much the worst thing for society is someone dropping out of high school, committing crime, and going to prison,” Figlio says. “At IPR, the goal is to integrate diverse inquiry, rather than merely examine an isolated part of a question, in order to understand and address the many factors that influence who we become as individuals.”

— Roger Anderson
When Larry Ellison donated $3 million in the earliest phases of the 2016 presidential election, he joined a small but powerful minority reshaping American politics.

The former chief executive of technology giant Oracle, Ellison was among the 158 benefactors who accounted for $176 million in political donations more than a year before Election Day.

It would take 158 average Americans making $29,000 per year — the national median income according to the Social Security Administration — nearly 40 years to raise that sum, and that’s if they donated every penny earned.

“The reality is that ordinary citizens have little or no independent influence on policy,” says Benjamin Page, the Gordon Scott Fulcher Professor of Decision Making and one of the world’s leading experts on American politics. “By contrast, economic elites have an ability to influence politics with little or no accountability.”
“The tension between oligarchy and democracy in America comes down to the contest between wealth power and participation power,” says Jeffrey Winters, founding director of Northwestern’s Equality Development and Globalization Studies program, which funds research on post-colonial societies. “What compounds material inequality is that rising wealth in the hands of a few confers tremendous influence in society.”

In America, the richest 1 percent maintain about 40 percent of the nation’s net wealth, according to statistics cited in President Obama’s 2014 State of the Union address. The unequal wealth distribution took on new meaning when the Supreme Court ruled in Citizens United v. Federal Election Commission that political spending is protected under the First Amendment. The ruling meant that corporations, unions, and individuals could legally spend unlimited amounts on political activities as long as those contributions were made independently of a party or candidate. These donations are typically made to political action committees, or PACs, organizations that use contributions to campaign for or against candidates or ballot measures.

“On the one hand, the United States is deeply committed to political equality. That means universal suffrage and one person, one vote,” says Winters. “We wouldn’t give one vote to one person and 20,000 votes to another, yet that is the ratio of wealth power between an average American and someone among the 500 richest Americans.”

Winters, an expert on oligarchical political structures, began his case study on the American political system about 10 years ago. His book, Oligarchy (Cambridge 2011), won the American Political Science Association’s 2012 Gregory M. Luebbert Award for best book in comparative politics.

“A decade ago, virtually no one spoke of oligarchs in the US context,” he says. “This election cycle, the term was mentioned in the Democratic and Republican presidential debates.”

In 2009, Winters and Page, both fellows at the Institute for Policy Research, coauthored “Oligarchy in the United States?,” a seminal paper published in Perspectives on Politics that has become a fixture in political science classrooms throughout the country.

“The United States has always had concentrated wealth and thus always had oligarchs,” says Winters. “One part of American history that’s poorly understood is that under the Articles of Confederation — the precursor to the US Constitution — participation, and therefore power, was high among those allowed to vote.”

Early in the nation’s history, this resulted in poor farmers capturing the legislatures in about half of the original 13 colonies and using legitimate democratic decisions to shift that era’s enormous debt burden from debtors to creditors. A prime motivation for delegates to gather in Philadelphia in 1787 was to build new structural safeguards into American democracy. Delegates hoped to stop average citizens from using government to redistribute wealth or push onerous economic burdens onto the rich.

Winters’s examination of Founding Father James Madison elucidated the
fourth president’s belief that America’s wealthy were an oppressed minority who needed protection against the tyranny of the majority.

“Oligarchs in America maintain a much higher social standing today,” says Winters. “We’ve learned that there are two drivers that shape how much power they wield: The first is the concentration of wealth in a few hands; the second is the ease with which wealth can be converted into political influence. On both measures, oligarchs are vastly more powerful in the United States today than ever before.”

Led by Page, researchers have also begun to reveal how the political attitudes of the wealthy differ from average citizens.

Having conducted pioneering research on the ideologies of the rich (“Democracy and the Policy Preferences of Wealthy Americans,” published in Perspectives on Politics), Page recently showed that multi-millionaires tend to have economically conservative opinions that carry disproportionate weight in the political process, even though their preferences differ widely from the general public’s on issues ranging from the minimum wage to social welfare programs (see graph).

“The Supreme Court decision opened the door not only for money-driven politics but for a distortion of democracy,” Page says.

After the Citizens United ruling in 2010, a record $6 billion was spent during the 2012 presidential election, according to an estimate by the Center for Responsive Politics.

“One of the great discussions about the American system is how so much equality—democracy—coexists stably with so much inequality of wealth,” says Winters. “As oligarchs use their wealth power to distort policies in their favor, confidence in American democracy is eroding. Seven years ago, when I first taught Oligarchs and Elites, very few Northwestern students believed oligarchy was important in American politics. Now it is hard to find students in the seminar who view the United States as a democracy.”

— Roger Anderson

WHAT IS OLIGARCHY?

Winters defines oligarchy as the politics of wealth defense. Even in democratic societies with free participation and universal suffrage, small segments of a population or community can be disproportionately empowered in a variety of ways and with different effects. Oligarchs are enabled by tremendous wealth, distinguishing them from average citizens who rely on participation power, like voting, signing petitions, or protests.

Note: Opinions of the wealthiest Americans based on a survey of 83 affluent Chicago-area households

Source: Democracy and the Policy Preferences of Wealthy Americans, Benjamin Page, political science, Larry Bartels, Vanderbilt, Jason Sewright, political science.
Law is a bedrock for economic prosperity and social stability. But developing optimal legal structures in a global market requires deep understanding of the complexities that inform these frameworks.

Around the world, various legal systems operate based upon different perspectives on the relationship between markets and law. These differences even extend to considerations about whether good governance and human rights should form an integral part of efficient government and legal systems.

For example, the United States and European Union regularly include legal and institutional mechanisms that balance political and market power with social and human rights objectives. By comparison, some countries in the Middle East have hybrid systems where
Islamic law governs certain legal issues, while secular and international law informs other issues. Meanwhile, China is implementing market reforms, yet it is not bound by regional human rights agreements. Its growing national economic clout allows China greater latitude to construct its own set of global economic arrangements.

These differences lead to some important questions that Northwestern experts are exploring: What are the different legal infrastructures around the world and across time that help markets to function effectively? What is the relationship between productive markets and political stability? What happens if economic regimes are detached from the Western goals of good governance and human rights? Does such detachment contribute to political instability?

These and related considerations are among those being addressed by the Global Capitalism and Law Research Group, created in 2015 within Northwestern’s Buffett Institute for Global Studies and made possible by Roberta Buffett Elliott’s transformative $100 million gift.

The group’s predominant goal is to investigate the political, social, legal, and normative underpinnings of successful and politically sustainable local, national, and global markets. Such information will prove vital when examining the financial crisis in Argentina, for instance. The country is currently being held in contempt of a Manhattan court for refusing to repay its $23 billion debt to a group of New York hedge funds. The dispute is of interest to the Buffett research team since the disagreement involves determining which laws are applicable in the case. Alter says there’s a necessity to “re-understand the role that law has had in capitalism’s construction, now that national and international...”

Selecting directors from across different fields was a strategic choice that aligns with Northwestern’s overarching research strengths. “We want to look historically and comparatively at how law holds together market authorities in diverse ways,” says Alter. “There really is not a single discipline that does that.”

Each director brings a particular expertise to the group. While Carruthers studies what modern derivatives markets reveal about the relationship between law and capitalism, Lafont focuses on the intersection between human rights and the laws that shape capitalism. The Buffett gift was important and timely for Alter, who says that the group presents an opportunity for her to reorient her focus on international courts towards questions of political economy, and help her integrate her existing global legal expertise with the subject of comparative capitalism. These diverse but related backgrounds, Carruthers says, make for an “obvious alliance.”

“The idea is to create a community of researchers who are already deeply invested in issues at the intersection of global capitalism and law.”

— Cristina Lafont

Bruce Carruthers, John D. MacArthur Chair and Professor of Sociology, who directs the group with Cristina Lafont, philosophy, and Karen J. Alter, political science and law.
legal institutions are holding countries accountable to global legal obligations.”

The varied definitions of law and capitalism are why Lafont, like her colleagues, believes it is important for the research team to contribute different disciplinary strengths to the enterprise: “Global governance frameworks must be addressed from multiple perspectives,” she says. “The current global economic order is plagued with problems whose long-term solution depends on coming up with creative legal developments that will allow markets to be part of the solution rather than the problem.” Lafont says that creative legal developments are urgently needed to spur solutions that efficiently tackle climate change, provide access to essential medicines for citizens of poor countries, or prevent illicit financial flows.

The complexities of such modern global challenges require purposeful cross-disciplinary scholarship. “The idea is to create a community of researchers who are already deeply invested in issues at the intersection of global capitalism and law,” says Lafont. “This is a bottom-up approach driven by researchers themselves,” she says. “We are trying to create a network so that each one of us can profit from the perspectives, knowledge, and research outcomes of those working within the other relevant disciplines.”

To help advance this goal and share knowledge more broadly, the steering committee selects experts from various fields to deliver a master class to the researchers, bringing new perspectives to familiar subjects. Harvard development economist Dani Rodrick addressed the scholars in 2015 while Duke law professor Mitu Gulati and Northwestern economic historian Joel Mokyr are scheduled to deliver master classes in early 2016.

With the research team forming in September, a temporary informal “shadow” graduate course was also created. Lafont and Alter plan to co-teach a related graduate course in winter 2016, intending to impart the high-impact value and best practices of interdisciplinary work to their students. “We want our students to be able to convey their research insights, and the importance of those insights, powerfully and to broader audiences,” Alter says.

“One of the greatest things about this initiative is that it brings a sense of intellectual excitement that’s really fun to participate in and can be extremely fruitful,” says Carruthers. Over the next three years — the term of the initial investment in the research group — the team intends to meet monthly, with the gift then funding public events and further master classes, with Alter and Lafont’s co-taught class and potential co-published papers to follow. The team also hopes that its efforts will eventually result in a full research center dedicated to the study of global capitalism and law.

For now, the research group has found the initial months of brainstorming and planning to be very productive. Alter believes the Northwestern scholars have already succeeded in creating a community across the University and beyond. “We want to attract an even wider array of talented people who are interested in this topic,” she says, “and make Northwestern a true knowledge hub for the study of this important topic.”

— Claire Zulkey

— Claire Zulkey
A New Look at Risk and Reward

The trade-off between risk and return is at the core of finance. The equity market portfolio represents systematic risk exposure, so the expected return over the interest rate — the equity risk premium — constitutes a natural measure of equity risk compensation. Recent research, however, reveals a pronounced variation in both risk and risk compensation: the quantity and price (reward) of risk shift over time, complicating measurement of expected returns and risks.

Torben Andersen and Viktor Todorov, both finance, summarize risk through two factors: the intensity of price fluctuations — volatility — and the potential for abrupt moves — jumps. While volatility can be inferred from high-frequency return data, the rare nature of jumps makes their expected intensity and size difficult to ascertain. Moreover, ex ante, investors brace themselves for myriad scenarios but observe only a single return over a given period. As a result, the expected return cannot be reliably estimated from price observations alone.

Andersen and Todorov argue that option prices reflect the probability of specific scenarios, so options with different thresholds and time-to-expiration reflect the expected return distribution as well as pricing of equity risk. They developed techniques to extract separate volatility and jump components from options, along with the pricing of each risk source. They found that the equity risk premium is linked closely to the pricing of (negative) jump risk but is unresponsive to volatility. In contrast, current volatility predicts future volatility and jumps well. Hence, equity risk pricing is associated with fear of tail events rather than with volatility per se. This is a finding that runs counter to standard perceptions.

Among many other applications, these research results support a supplementary policy-making approach, such as that articulated in a 2012 speech by Narayana Kocherlakota, president of the Federal Reserve Bank of Minneapolis: “Policymakers can achieve better outcomes by basing their outlooks on risk-neutral probabilities derived from the prices of financial derivatives.”
An Exploration of the Human Spirit

Ever since Montaigne used the term *essai* to denote idiosyncratic, exploratory writing that engages in a “trial, test, or attempt,” the literary essay has provided a loose genre for bent conventions, vernacular criticism, unorthodox scholarship, punk philosophy, and DIY theory. The work of Eula Biss, English, arises from the personal essay tradition, which has long insisted that the personal is political, the vernacular is poetic, and knowledge is multivalent.

Biss’s collection *Notes from No Man’s Land: American Essays* (Graywolf Press, 2009) is a personal exploration of the legacy of racial oppression in the United States. It opens with a litany of lynchings and closes with an interrogation of the limits of apology; other essays engage in both narrative memoir and cultural critique. *Notes* won the National Book Critics Circle Award for criticism, and *Salon* called it “the most accomplished book of essays anyone has written or published so far in the 21st century.”

Her recent book, *On Immunity: An Inoculation* (Graywolf Press, 2014), is a long essay about fear and physical vulnerability that asks what we, as members of a collective, owe to each other. In an extension of her thinking in *Notes*, this book explores how a majority might participate in the protection of a minority. Its point of entry is childhood vaccination, which allows the book to range from questions of parenting to feminism to environmentalism to science fiction to political power. Each of the essay’s 30 short sections are distinct (with moments of memoir, literary criticism, historical overview, and *ars poetica*, among others), but no single section is complete or stands alone; the book’s inquiry depends on interaction among all the sections. In this way, the book’s form mirrors its central argument about the essential interdependence of the human species.
Most plays performed in theaters may be categorized as psychological realism. Thomas Bradshaw, communication, finds that these plays are primarily concerned with how people should behave rather than how they would actually behave in real life. Characters in these dramas are often profoundly self-aware and hyperrational: They think rationally about their actions and the effects these actions might have on other people.

Contending that theatrical creators who actually believe they are presenting “reality” on stage are fooling themselves, Bradshaw seeks to bring a strong dose of reality to the theater through what he calls hyperrealism. The nature and structure of the dramatic form demand all sorts of artifice, yet this does not prevent a play from revealing a deeper and more meaningful essence of truth than what is often experienced in everyday life. In Bradshaw’s scripts, characters are relentlessly honest, often acting on pure id. He usually avoids elaborate or decorative language, and his plays—including Fulfillment, which premiered at New York City’s Flea Theater in September—offer very little subtext. There is unity in everything the characters are saying, thinking, and doing.

Bradshaw observes that in most plays the moral view is crystal clear—the playwright shows the audience who the “good guys” and “bad guys” are and succinctly conveys the play’s message. He believes that human beings are capable of almost anything, given the right set of circumstances, so instead of writing his scripts from a “place of judgment,” he always writes from a perspective that embraces a broader understanding.

In Bradshaw’s view, audiences identify more with characters who are deeply flawed and who do not necessarily live up to the expectations of society—or themselves. As an artist, Bradshaw seeks to broaden the palette of what is considered mainstream and acceptable in the American theater.
The Evolution of Legionnaires’ Disease

How do novel disease agents arise? This question has long intrigued Nicholas Cianciotto, microbiology-immunology — beginning with the discovery of Legionella pneumophila, the bacterium that emerged as the agent of Legionnaires’ disease in 1976. Its significance persists today, as evidenced by a widespread, deadly outbreak in New York City in 2015.

Cianciotto has played a major role in identifying how L. pneumophila survives in water systems, is transmitted by aerosols, and grows in lungs to cause pneumonia. He and his colleagues found that L. pneumophila survives in water by infecting and growing in amoebae and other unicellular microbes that ordinarily feed on smaller bacteria. The Cianciotto lab helped to further demonstrate that the bacterial factors mediating infection of amoebae also potentiate infection of lung macrophages, a cell type that normally acts as a front-line immune defense by ingesting and destroying inhaled microbes. By adapting to an ordinarily hostile intracellular niche in nature, L. pneumophila acquired the capacity to flourish in human cells. For L. pneumophila, it turns out that human macrophages are not dissimilar from amoebae.

The mode of evolution first exemplified with L. pneumophila has proven relevant to other pathogens. Cianciotto is currently engaged in deciphering a protein secretion “machine” that helps Legionella survive in water and releases dozens of enzymes into its host cells. The research team is also exploring how L. pneumophila scavenges iron from its environment by secreting metal-chelating molecules. Cianciotto has expanded this analysis to include another environmental bacterium, Stenotrophomonas maltophilia, that has recently arisen in the clinical arena, in part through its antibiotic resistance.

Understanding these secretion systems may help researchers make them new targets for disease prevention or treatment.

This research is funded by the National Institute of Allergy and Infectious Diseases at the National Institutes of Health.
Seeking a Global Cure for HIV

Richard D’Aquila leads the Northwestern HIV Translational Research Center’s efforts to develop a cure for HIV that can be deployed globally.

Because HIV persists within latent cellular reservoirs and can “rebound” quickly if treatment stops, patients must continue antiretroviral therapy (ART) for life. However, ART does not prevent HIV-induced abnormal inflammation, which can lead to cardiovascular disease and other morbidities, such as early impaired cognition.

D’Aquila’s research team wants to achieve a cure that blocks HIV’s rebound when ART stops. They sought, and discovered, boosters of APOBEC3G (A3), a cellular defense against HIV that they learned is more robust among the small number of HIV-infected individuals who control the virus naturally without ART. They posit that strengthening this defense for a time after discontinuing ART could prevent HIV’s rebound among the rest of the infected population. Since A3s are also implicated in cancer and autoimmune disorders such as lupus, the boosters have wider potential as well.

In addition, the team is pursuing candidate medicines that block HIV’s access to sugar and other nutrients it needs to grow but that do not harm critical immunity-orchestrating host cells. Any cure would also need to halt smoldering virus growth during ART, as such growth is now thought to trigger the inflammation that accelerates aging-associated disorders.

Annually, 50,000 Americans still become infected with HIV, and in recent years new cases have increased among certain groups. A cure could stop transmission from those who are infected and miss treatment doses. In addition, these new types of medicines might prevent infection if used by those at risk for HIV.

The NIH-funded, Chicago-wide Third Coast Center for AIDS Research (CFAR) that D’Aquila leads will help disseminate research on improving prevention and treatment — as well as achieving a cure — to the broader community, thereby spurring greater engagement and education.

D’Aquila’s research is supported by the National Institutes of Health and Northwestern Medicine.
Designing Cross-Cultural Messaging for Healthy Interventions

Car accidents are Qatar’s leading cause of death, with fatality rates particularly high among Qatari men between the ages of 18 and 25. Susan Dun, communication, recruited a team of student researchers to create a message campaign to change behaviors and promote safe driving.

Dun’s research focuses on health communication and designing message interventions to encourage healthy behavior. When she began examining Qatari attitudes about driving, she encountered an unexpected obstacle.

In North America, Dun would study her target audience through focus groups. In Qatar, however, the local population has limited experience with sharing views in a clinical group setting. Furthermore, the culture’s defined social structure does not permit open and deep discussion between a female Western researcher and young Qatari men.

Social interactions among local Qatari commonly take place in the context of a majlis, a single-sex environment with a strong custom of hosting and easy conversation. So to solve her research problem, Dun and her team created a culturally contextualized focus group that simulated the look and feel of a majlis — with male Qatari student researchers in national dress welcoming participants and serving the customary coffee and sweets.

Conversational markers indicated that participants regarded the situation as a majlis and oriented themselves accordingly. They were relaxed, quick to share their thoughts, and reluctant to leave at the end of the session.

The culturally contextualized focus group revealed important insights into the attitudes of young Qatari men. Based on these findings, the research team created a humorous campaign to promote seatbelt use — including a short video that they will test in future majlis-style focus groups.

This research was made possible by a UREP award [UREP 16-087-3-019] from the Qatar National Research Fund (a member of The Qatar Foundation). The statements made herein are solely the responsibility of the authors.
Breakthroughs in Next-Generation Energy

The pursuit of sustainable energy has become a major investigative priority for researchers across many disciplines. Sossina Haile, materials science and engineering, explores innovations in fuel cells — devices that convert chemical energy such as hydrogen into electricity — and in solar fuels, which conceptually involve transforming the Sun’s energy into fuel that can be stored and used on demand. Together, such devices could provide sustainable energy for the entire planet many times over.

The Haile lab has made two breakthroughs that make this vision seem possible. The first is in developing a new type of proton-conducting electrolyte. A fuel cell requires this component to convert the chemical energy of a fuel like hydrogen into electricity — and in solar fuels, which conceptually involve transforming the Sun’s energy into fuel that can be stored and used on demand. Together, such devices could provide sustainable energy for the entire planet many times over.

The Haile lab has made two breakthroughs that make this vision seem possible. The first is in developing a new type of proton-conducting electrolyte. A fuel cell requires this component to convert the chemical energy of a fuel like hydrogen into electricity; the electrolyte effectively forces the hydrogen to separate into protons and electrons so that the electrons can follow an electrical path that is then used for power generation. Haile’s group introduced what are called “superprotonic” electrolytes, which combine the high conductivity of liquid and polymer electrolytes with the mechanical and structural advantages of solid electrolytes.

The second breakthrough is founded on the recognition that a surprisingly simple process using certain reactive oxides can convert the Sun’s thermal energy into fuel. This process involves heating the oxide — basically a ceramic — to temperatures of around 2,500 degrees Fahrenheit, then exposing it to steam (H₂O). Through these steps, which rely on solar concentration to heat the ceramic and the steam to the reaction temperatures, the process splits water into hydrogen (a fuel) and oxygen. Haile’s research seeks to improve these two classes of compounds, superprotonic electrolyte and reactive oxides, so that the vision of sustainable energy can become a reality within our lifetimes.

This research is supported by grants from the National Science Foundation and the Advanced Research Projects Agency-Energy.
Discovering Ways to Solve the Progesterone Paradox

In social conversations and scientific experimentation, female hormones are often described as “complicated.” Indeed, when a hormone can do different things depending on the cell type, its neighbors, and the external cues transmitted within the cell, many things — understandably — can go wrong, leading to an unfavorable physiologic response with dire consequences.

Julie Kim, obstetrics and gynecology, is exploring the complex role of one hormone, progesterone, in controlling reproductive tissues. Progesterone is essential during pregnancy to prevent early labor and prepare the breast for lactation, yet it is also involved in endometrial cancer and can trigger uterine fibroids or promote breast cancer.

Kim’s laboratory team studies how progesterone functions and how this hormone and its receptor can be harnessed to help women with endometriosis, endometrial cancer, uterine fibroids, and breast cancer. Exploring drug targets for disease treatment and intervention, the lab is pioneering the use of tissue engineering to develop novel culture systems that mimic the complete reproductive tract, providing ways to test the role of specific genes and drugs in a well-controlled and high-throughput system.

So far, the lab’s research has identified a mechanism by which progesterone resistance develops in endometrial cancer; an exciting new signature for responding to antiprogestins related to breast cancer; and growth-regulating pathways in uterine fibroids. With this knowledge, the Kim lab can use its experimental systems to test drugs that target the progesterone receptor, the AKT pathway, or oxidative stress systems. Using tissue engineering technology, Kim and members of her team have built a uterus mimic that responds to estrogen and progesterone throughout a 28-day cycle — progress that lays the groundwork for new discoveries about progesterone and its effects.

This research is supported by National Institutes of Health’s Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Cancer Institute, National Center for Advancing Translational Sciences, Office of Research on Women’s Health, National Institute of Environmental Health Sciences, and Common Fund.
Exploring American Literature

Can literature written in a language other than English be considered “American” literature? Is literature published in Japanese outside Japan truly Japanese? Andrew Leong, English and Japanese, addresses these questions by exploring an archive of literary works lost in the no-man’s land between common understandings of what makes a national literature. Leong translates and interprets poems, plays, and stories that were written in Japanese by and for a Japanese immigrant readership in the United States.

In introducing some of these works to an English-reading audience, Leong worked with a team at Kaya Press to publish Lament in the Night, a critical edition of his translations of two novels by Nagahara Shoson, a writer active in Los Angeles during the mid-1920s. The project’s original aim was to translate only the title novella. But while conducting research in the Japanese American National Museum’s microfilm archives, Leong discovered Shoson’s serial novel The Tale of Osato, which was published in more than 140 installments in the Rafu Shimpo (Los Angeles Japanese Daily News).

Written in an unflinching naturalist style, Shoson’s two novels portray the struggles of people on the lowest rungs of Japanese immigrant society: desperate vagrants and petty thieves, delinquent youths and aging gamblers, live-in maids and speakeasy waitresses, failed artists and nameless suicides. Shoson’s hardboiled depictions of Southern California anticipate by more than a decade such later English-language novels as Raymond Chandler’s The Big Sleep (1939), John Fante’s Ask the Dust (1939), and James M. Cain’s Mildred Pierce (1941).

Building on his Lament in the Night translations, Leong is writing a book exploring how works like Shoson’s novels can provide new insights about both American and Japanese literature.
Uncovering Details of 19th-Century Italian Ballet

Morris Levy, librarian, researches ballet music from 19th-century Italy. Italian ballet was originally performed in 16th-century royal courts but soon moved into public theaters as diversions between the acts of operas. By the early 19th century, Italian ballet had grown so greatly in length and complexity that a single ballet could serve as an evening’s entertainment. Italian dancers, choreographers, and teachers were in demand throughout Europe, and major Italian cities established their own dance companies and schools.

Unfortunately, few primary sources have survived; ballet music was rarely published except as excerpts arranged for piano, and there are very few extant examples of choreographic notation from the time. Theaters often published scenarios describing the action of the ballets, but many of these were written in an impressionistic style, and the connections between the descriptions and the musical scores are not always clear.

Levy received the 2009–10 John M. Ward Fellowship in Dance and Music for the Theatre from Harvard University’s Houghton Library to review the Harvard Theatre Collection’s holdings relating to 19th-century Italian ballet. For this project he also transcribed the holograph score of *Furio Camillo* (1838), the last ballet written by Wenzel Robert Graf von Gallenberg (1783–1839), the Vienna-born house ballet composer to the royal theater in Naples. The ballet’s choreographer was Salvatore Taglioni (1789–1868), who cofounded the Naples ballet school.

While no choreographic notation exists, the ballet’s published scenario survives. By comparing it with the holograph score, Levy was able to reconstruct the work. The publication of the score (Musikproduktion Höflich, 2014) represents the first “revival” of *Furio Camillo* in 175 years. The ballet is one of just a few Gallenberg works that have been published since his death.
Leadership is a critical component in nearly all social groups and organizations. Whether leadership is formal (a company’s CEO) or informal (the family member who makes decisions about where to gather for a holiday), leaders help others coordinate actions and achieve important goals. It is precisely because leaders are so important that we need to understand why some politicians, businesspeople, and teachers behave in corrupt and unethical ways.

Failures of leadership can have devastating consequences for organizations and society. Collaborating with his students, Jon Maner, management and organizations, identifies factors that determine leadership success or failure. His research has demonstrated that people who adopt a dominant “command-and-control” leadership style are often willing to sacrifice their group’s well-being in exchange for increasing their personal power within the organization. For example, dominant leaders often feel threatened by fellow team members who are highly talented and respected, so the dominant leaders suppress, subordinate, and ostracize such individuals rather than helping them rise through the organization’s ranks.

At the same time, Maner’s research has identified ways to promote positive forms of “servant leadership” — an effective style of managing teams and organizations in which people lead from behind and prioritize the organization’s success, even if it means relinquishing some of their own power and privilege. His research ultimately helps groups operate more effectively and cohesively, promoting the success and well-being of organizations and their members.

In prior research, Maner explored why leaders are sometimes motivated to generate divisions, not cooperation, among their highly talented subordinates. Assuming that such behavior can serve to protect the leader’s own power, Maner demonstrated that leaders will stop suppressing in-group bonding once they are assured it will not reduce their power.
Pushing the Boundaries of Ultra-Sensitive Cameras

Some 1,400 years ago, a particle of light bounced off a rock surface on the exoplanet Kepler 452b, moved through its atmosphere, and began its journey to Earth. It carried precious information about the atmosphere of a world that is often called “Earth 2” because of its similarities to our planet, including its orbit around a star much like our Sun. If scientists had cameras that were sensitive and fast enough to capture the small number of light particles arriving from such exoplanets, they could know far more about these distant bodies. For example, we could measure their atmospheric composition and even discern if a particular exoplanet could sustain life.

With his research group, Hooman Mohseni, electrical engineering and computer science, develops nano-devices that manipulate the interaction of light and matter to make better light sensors. Inspired by the detection mechanism in the rod cells of the human eye, the team has developed a new type of light sensor and recently demonstrated a camera that is about a hundred times more sensitive at a given temperature than the best available cameras. Theoretical models show that even higher sensitivities are possible, and the team is now pushing the boundaries of nano-manufacturing to produce an ultra-sensitive camera. If successful, the resulting product will be installed in a telescope in Hawaii, enabling the first direct imaging of exoplanets in the so-called “habitable zone” of their stars’ planetary systems.

Mohseni’s group has also used the new light sensor to improve a commercial medical imaging system’s sensitivity by about a thousand times. And the team is developing a 3-D camera so compact and power-efficient that it can be used in mobile phones to capture images for applications such as medical point-of-care, gesture recognition, and gaming. It will also enable the development of powerful 3-D machine vision for autonomous vehicles and drones.

Mohseni’s research on advanced photon detectors is supported by the W.M. Keck Foundation, Defense Advanced Research Projects Agency (DARPA), Army Research Office, and National Science Foundation.
History Through an Economics Lens

Why does economic history look like a hockey stick? For millennia, economic growth anywhere on the planet was imperceptibly slow. Suddenly, in the 19th century, the economies of the Western world became increasingly prosperous and sophisticated, and today the human condition — at least from a purely material viewpoint — is better than it ever was. This riddle has occupied economic historians for generations. In his new book *A Culture of Growth: Origins of the Modern Economy*, Joel Mokyr, economics, examines this age-old problem and advances some startling conclusions.

He begins his exploration from a premise emphasizing the importance of institutions. The institutional “bend” in economic history, as pioneered by Nobel Prize–winning economic historian Douglass North, has been widely accepted as a primary explanation for economic performance. But which institution mattered in Europe before the Industrial Revolution launched the continent’s current rise in prosperity? Mokyr’s book identifies “the Republic of Letters” — a transnational network of European intellectuals, dating back to the early 16th century, who read and critiqued each other’s work.

Mokyr analyzes the significance of the Republic of Letters through the tools of economics. He observes that Europe, because of its fragmented political structure and its multiple competing religions after the Reformation, enjoyed the best of all possible worlds. Nations reaped the benefits of a competitive market system while maintaining a continent-wide scholarly community. The Republic of Letters created what, even today, remains a magnificent institution for studying nature: all new information is made transparent and public, with no “sacred cows” and little content controlled by the government; evidence trumps authority. This institutional apparatus was in place by about 1700, and a few decades later, the Industrial Revolution began in earnest — which in Mokyr’s view was no coincidence.
Although the rate of HIV infections in the United States has remained stable in recent years, rates are significantly increasing among gay/bisexual men in the youngest age groups (13 to 24 years), especially young black men. Brian Mustanski, medical social sciences, and his team at Northwestern’s new Institute for Sexual and Gender Minority Health and Wellbeing are working to understand what drives these health inequities and to create innovative programs for addressing this growing epidemic.

Mustanski first looked at data from Project Q2 — the longest-running longitudinal study of lesbian, gay, bisexual, and transgender adolescents ever conducted. It showed that young black men were actually engaging in fewer HIV risk behaviors than young white men. Since individual behavior was not producing the inequities, Mustanski examined network and neighborhood factors. His study revealed that young black gay/bisexual men had denser sexual networks and were more likely to have sexual partners from Chicago neighborhoods with more HIV cases. Both factors helped explain the racial disparities. Mustanski is now advancing this multilevel perspective in a large study that draws on faculty from multiple Northwestern schools to examine HIV in young gay men through the “lenses” of genetics, development, networks, and neighborhoods.

Mustanski prioritizes his results by using such studies’ findings to inform new services, but reaching young gay and bisexual men through HIV prevention programs can prove challenging. As a solution to this hurdle, Mustanski has pioneered the use of new media and technology. For example, his Keep It Up 2.0 program is an online HIV prevention program developed specifically for diverse young gay/bisexual men. The program includes video soap operas, interactive games, and educational animations. Early evidence demonstrated that the program works, so Mustanski has begun evaluating it in a randomized controlled trial in Atlanta, Chicago, and New York City that involves nearly a thousand young gay/bisexual men.

Research on multilevel influences on HIV and substance use in a YMSM cohort is supported by a grant from the National Institute on Drug Abuse, 1U01DA036939. Research on the efficacy of Internet-based HIV prevention is supported by a grant from the National Institute on Drug Abuse and National Institute of Mental Health, 1R01DA035145.

Innovative Solutions to Health Inequities
Is Justice Biased?

As a sociologist of law, Laura Beth Nielsen explores the relationships among law, legal institutions, and inequality. Nielsen, sociology, is a leading scholar in studies of legal consciousness — how people understand, invoke, and fail to invoke the law. In her first book, *License to Harass: Law, Hierarchy, and Offensive Public Speech* (Princeton University Press, 2004), Nielsen compared the exposure of women, people of color, and white men to offensive public speech and then analyzed their attitudes about legally regulating such speech. The book remains central to ongoing debates about hate speech on college campuses and in other contexts.

Recently Nielsen has turned to legal consciousness in the workplace through a large-scale empirical study of employment civil rights litigation in the United States. Nielsen and her research team assembled two large quantitative datasets: 1.6 million EEOC complaints and a random sample of 1,722 employment civil rights cases filed in federal court. In addition, they compiled qualitative data from detailed, in-person interviews with some 100 plaintiffs, defendants, and their lawyers selected from the larger case-filings database. In a series of articles and the book manuscript *Rights on Trial*, Nielsen and her colleagues rebut several common misperceptions about employment civil rights litigation. Despite considerable evidence of ongoing workplace discrimination, only a small number of those targeted by such discrimination seek legal recourse to complain. Those who do are typically subjected to denigration by their employer, often gain little or nothing materially from the legal process, and frequently experience serious negative consequences (such as joblessness, depression, divorce, and alcoholism). Employer-defendants also are unhappy with employment civil rights litigation, tending to see plaintiff claims as frivolous and litigation as an unjustified business cost.

One of the project’s breakthroughs has been to capture the voices of employment civil rights through digital recordings of interviews. The plaintiffs’ stories are sometimes heartbreaking, sometimes triumphant.

*Nielsen’s work has been supported by the American Bar Foundation, the National Science Foundation, the Ford Foundation, and the Searle Foundation.*
Complex diseases, such as cancer, diabetes, and neurological disorders, arise from the combined action of many genes, environmental factors, and risk-conferring behavior. These illnesses exert an increasingly devastating toll on populations worldwide. Developing treatments for such disorders is challenging principally because it requires understanding the interplay among disparate factors such as genetics, diet, infectious agents, environment, behavior, and social structures. In turn, achieving such understanding demands the expertise of nontraditional teams: those with perspectives and skills that span diverse scientific communities and technology domains.

Laura Pedraza-Fariña, law, is interested in understanding the role of informal norms and of patents, grants, tax credits, and other incentives in assembling teams that bridge technological domains. Her research explores how people from distinct scientific communities, often with conflicting commitments to different interpretive frameworks and research tools, come together to define and work on shared problems. In addition, she examines the role of those norms and incentives in fostering collaboration.

In her recent article “Patent Law and the Sociology of Innovation,” Pedraza-Fariña called for a sociological understanding of innovation, a framework that shifts the focus from the individual scientist to the community in which that scientist is situated. Her current project, “Scaffolding Innovation,” draws on original empirical research about the formation of cross-disciplinary teams while also integrating insights from network and evolutionary theories of innovation. The research explores how informal norms in scientific and technological communities often isolate the knowledge necessary for solving complex problems. Her work introduces the term “innovation scaffolding” to synthesize one of her key empirical findings: creating teams that cross technological domains may require using policy instruments to develop temporary bridges between domains. As knowledge sharing and trust increase, the connections can become self-sustaining.

Normatively, adequately incentivizing the most socially desirable innovations will require rethinking legal incentives to include a scaffolding component. It is only by incorporating a sociological perspective that patent law can optimize its ultimate goal of incentivizing socially beneficial innovation.
Our limbs allow us to interact with the world through diverse endeavors, such as running a marathon, carving a sculpture, and holding a child. These activities require regulating the mechanical properties of our arms and legs in a task-appropriate manner to optimize the transfer of energy and information between the body and the environment. Although we often take these abilities for granted, injury to our neural or musculoskeletal systems can lead to profound impairments that compromise motor performance and independent living.

With his research group, Eric Perreault, biomedical engineering, studies the neural and biomechanical factors contributing to the regulation of human limb mechanics as well as how these abilities are compromised by neuromotor pathologies, such as stroke and spinal cord injury. The team’s goal is to provide a scientific basis for understanding normal and pathological motor control, insights that then can guide rehabilitative strategies for addressing motor deficits.

Perreault’s most recent biomechanics research used computational models to identify how mechanical properties intrinsic to muscles enable and constrain the actions performed by the nervous system. Those models can also be used to help engineer and design rehabilitation interventions.

Through collaborations with colleagues Levi Hargrove and Elliott Rouse at the Rehabilitation Institute of Chicago’s Center for Bionic Medicine, Perreault has explored improving amputee locomotion by designing prosthetic limbs that replicate the mechanics of an intact human leg — with promising initial results. In collaboration with Matt Tresch and Kevin Lynch from Northwestern and with Bob Kirsch from Case Western Reserve, he has also used his understanding of limb mechanics to help restore arm control to individuals with high cervical spinal cord injuries.

*These research projects have been supported by R01s from the National Institutes of Health and the National Science Foundation’s Cyber-Physical Systems program.*
Using Molecular Motors to Stop Disease

Sarah Rice, cell and molecular biology, uses structural biology and biochemistry to examine how regulatory mechanisms, such as phosphorylation and ubiquitination, alter the fates of molecular motors and their cargoes.

Because the kinesin motor protein Eg5 is essential in cell division, drug inhibitors of Eg5 have been proposed as potential anticancer therapeutics. The Rice lab made the surprising discovery that Src kinase, a canonical oncogene (a gene with the potential to turn a cell cancerous), regulates the Eg5 motor by phosphorylating the same surface loop where the inhibitors bind. Intrigued that a drug-binding site coincides with a natural phosphoregulatory site within Eg5, the lab sought to determine whether the same phenomenon occurs with other proteins. The lab’s findings suggest that phosphorylation may affect drug binding and efficacy for a significant fraction of drug target proteins, including Eg5.

Cells regulate the movement, distribution, and clearance of mitochondria to meet their energy demands. The Miro protein is both a regulator of mitochondrial movement and a target of the mitochondrial clearance machinery. The E3 ligase PARKIN ubiquitinates Miro and other substrates on the outer mitochondrial membrane to signal the clearance of damaged mitochondria. The Rice lab recently elucidated the first x-ray crystal structures of Miro. These structures will enable a pioneering detailed examination of how PARKIN interacts with and selects its substrates.

Rice is also collaborating with Alexander Statsyuk, chemistry, using a new set of tools that his laboratory developed to simplify quantitative studies of PARKIN E3 ligase activity in vitro. The Rice lab has used these tools to evaluate the kinetic process of PARKIN ubiquitination of its substrate Miro in real time. The two labs together have earned a Michael J. Fox Foundation grant to adapt the same tools for high-throughput screening of PARKIN activator compounds, which may lead to Parkinson’s disease therapies.

*Rice’s research is supported by the National Institutes of Health (grant R01 GM107209) and the Michael J. Fox Foundation.*
Museums have changed dramatically in the last two decades. While many of the objects in these institutions might be the same, how they are displayed and the stories the museum tells about them have evolved. A boom in museum construction and remodeling since the 1990s has resulted in highly interactive, media-saturated environments that encourage visitors to use all their senses as part of the museum experience. This move toward an increasingly immersive communication environment has also opened up new and dynamic opportunities for rearranging collections and revising how they are interpreted. The museum of the 21st century is a reimagined public space for experiencing art, science, history, and culture.

In his current research, Ramón Rivera-Servera, performance studies, is concerned with museums’ emergent communication strategies. He is especially interested in how these technologies and approaches enable new, critical, and imaginative engagements with the idea and history of race and racial difference across North America. From 2004 to 2015 he conducted fieldwork at history, archeology, and anthropology museums in Mexico, the United States, Canada, and the Caribbean to document how museums have adjusted their communication strategies in response to important critiques about their collections of indigenous, African and Afro-diasporic, and Asian cultural artifacts. In particular, his research examines how these collections came to be acquired in the context of European colonization and what role museums played in establishing racial hierarchies that endure today.

Rivera-Servera’s book in progress, *Exhibiting Performance: Race, Museum Cultures, and the Live Event*, documents and analyzes the communications of museum curators, exhibition designers, docents, tour guides, and public program coordinators as key to museums’ important revision of racial history.

*The Smithsonian Institution has helped support Rivera-Servera’s research.*
Probing the Quantum Properties of Materials

Physicists have developed exquisite control of individual, isolated components of matter. By exploiting the counterintuitive rules of quantum mechanics, researchers can harness single particles of light — photons — to control atoms, molecules, and materials for achieving sensitive metrology, modulation, and manipulation of information. Progress in nanoscience and nanotechnology has generated a vibrant array of rationally designed materials and structures whose tailored properties have applications in energy and information technologies. Can these methods of control be extended to learn more about, and eventually harness, the designer features of these new low-dimensional materials for future quantum applications?

Distinct from isolated atoms or the chemical configurations of molecules, the symmetry of a crystalline material allows novel electronic phenomena to be engineered. If these properties can be subjected to quantum control using photons, then new opportunities will emerge for exploring interesting, and potentially useful, phenomena when materials interact with light.

Nathaniel Stern, physics and astronomy, studies the interactions of light and matter at the smallest-length scales and at extreme intensities. He and his research team develop optical tools to probe the quantum properties of materials approaching the fundamental limits of size — just a few atoms thick. At these scales, the material properties depend strongly on the atomic-level details of their composition and configuration. Stern is exploring how high-level characteristics such as degeneracy, dimensionality, and symmetry are manifested in the optical response of materials rationally designed at the atomic scale. His group is particularly interested in subjecting these materials to new physical regimes in which their dynamics depend on interaction with just a single photon, thereby enabling precise control of their quantum state.

Stern’s research is supported by the US Department of Energy, the National Science Foundation, and the Alfred P. Sloan Foundation.
Justice System Overlooks Role of Consent

Deborah Tuerkheimer, law, explores the gaps and disconnections between sex-related cultural norms and the criminal justice system’s response to rape. On college campuses, the need for institutional reform to address the problem of sexual assault is widely acknowledged. But as Tuerkheimer explains, outside the university setting the legal treatment of nonstranger rape reflects a doctrine out of step with modern conceptions of sex. The Model Penal Code — the rape statute offered as a model for legislatures and courts — and a majority of states still retain a physical-force requirement, misconceiving or entirely overlooking the role of consent. (The American Law Institute, of which Tuerkheimer is a member, is in the process of reforming the Model Penal Code provisions on sexual assault.)

Increasingly, campus efforts to codify affirmative consent standards (“yes means yes”) raise the question of whether criminal law should develop in this same direction. A few states have required affirmative consent for decades. In forthcoming work, Tuerkheimer surveys the case law in these jurisdictions to assess the functioning of an affirmative-consent standard. This analysis begins to fill a descriptive void that has hindered discourse on criminal law reform.

In a related project, Tuerkheimer examines the under-enforcement of rape law. The latest empirical evidence on police practices, including the shelving of rape kits, suggests that gender biases permeate the common decision to “unfound” allegations of nonstranger rape. Although the under-enforcement of rape law remains a pervasive reality, it is not inevitable. Recent involvement by the federal government in Missoula, Montana, demonstrates how the US Department of Justice can use its “pattern or practice” enforcement authority to catalyze rape-law policing. Tuerkheimer’s study of this groundbreaking intervention applies what we know about the under-enforcement of rape law to elaborate on the meaning of equal protection.
Spatial Thinking a Key to STEM Growth

Elon Musk, CEO of SpaceX and Tesla Motors, often asks job candidates, “I walk one mile south, one mile west, and one mile north and end up in the same place I started. Where am I?” The answer is the North Pole.

Perhaps Musk asks this question to assess an ability that is particularly valued in the STEM fields: spatial thinking. The interviewee may have visualized a map of possible locations and imagined walking in different directions. That experience involves forming a mental picture, then thinking about how the picture could be transformed. For example, a chemist developing a new drug might imagine various sites where the drug could bind to targets in the body, then mentally rotate the molecule to explore different potential binding sites.

The ability to perform such spatial visualization tasks strongly predicts who will pursue a career in the STEM fields, even after accounting for the effects of other strengths, such as mathematical and verbal abilities. Understanding whether and how spatial thinking can be improved could help address the shortage of STEM workers in the United States.

David Uttal, psychology, synthesized hundreds of studies about improving spatial thinking; his 2013 meta-analysis showed that spatial thinking responds quite well to training. With Robert Kolvoord of James Madison University and Adam Green of Georgetown University, Uttal studies how computer-based software can facilitate high school students’ spatial thinking. The students map out solutions to complex, real-world problems, such as determining the best locations for wind farms or which areas of a city are most at risk of flooding. In doing so, they are learning to think spatially. Uttal and his colleagues are now exploring whether these effects can be detected through brain imaging to identify how the brain processes spatial information.

*This work was supported by National Science Foundation Grant SBE0541957 (The Spatial Intelligence and Learning Center) and by National Science Foundation Grant DRL1420599 (Cognitive and Neural Indicators of School-based Improvements in Spatial Problem Solving).*

David Uttal

Professor of Psychology

WEINBERG COLLEGE OF ARTS AND SCIENCES

Photo courtesy of David Uttal
Fresh Insights on Islamic Intellectual History

“Believers can live a long time in a land of no faith, but they cannot last long in a land of injustice.” These words of Ibrahim Niasse (1900–75), an influential Senegalese Islamic scholar, testify to the unheralded role Muslim intellectuals in sub-Saharan Africa have played in preserving and expanding a deep tradition of Islamic humanism throughout the continent and beyond.

Even as global media remain fixated on exclusivist versions of modern political Islam in the Middle East, networks of classical Islamic scholarship (encompassing mysticism, literature, and philosophy) exert an enduring appeal for millions in West Africa. Yet academics sometimes fail to consider the depth of the Islamic identities in Africa. The field of Islamic studies tends to overlook the contributions of black African scholars, while African studies specialists are often unequipped to appreciate the intellectual activities of Africans writing in Arabic.

Focusing on Islamic intellectual history in sub-Saharan Africa, Zachary Wright, history and religious studies, continues Northwestern’s unique legacy in the field of African Islam through the Institute for the Study of Islamic Thought in Africa. Methodologically, Wright depends on close reading of Arabic manuscripts in dialogue with their oral transmission in “learning circles” over time. Wright’s recently published book, Living Knowledge in West African Islam: the Sufi Community of Ibrahim Niasse (Brill, 2015), situates the spread of what is arguably Africa’s largest religious community within the context of social upheavals, evolving notions of scholarly authority, and internal dialogue between knowledge specializations through almost a thousand years of African and Islamic history.

Wright has also translated several West African Arabic writings, allowing broader access to works of which many of the original manuscripts are unavailable outside Northwestern’s renowned Herskovitz collection. Wright’s current research has turned to the theme of Islamic humanism and religious revival in 18th-century North Africa and Arabia.
SPONSORED RESEARCH AWARDS

In 2015, Northwestern University’s research enterprise enjoyed a record-breaking year, with a total of $620.9 million awarded in research grants and contracts through the end of the fiscal year. This marks a 4.5 percent increase ($27.0 million) compared with FY2014 and represents the sixth consecutive year that Northwestern has achieved more than a half-billion dollars in sponsored research funding.

Over the past five years, Northwestern has received more than $2.7 billion in external research grant funding. The increased dollar volume of research funding in 2015 derives from several sectors, including federal agencies (4 percent increase, $17.6 million), foundations (27 percent, $7.7 million), and voluntary health organizations (15 percent, $2.6 million). At the same time, awards from industrial sponsors declined by about 3 percent ($2.8 million) over the past year.

In FY2015 the total number of awards (2,960) represents a 4 percent increase over FY2014 (2,852); the average award increased to $209,777, up from $208,305.

Notable award totals include the following: The dollar volume of awards managed by the McCormick School of Engineering reflected a decrease of 16 percent ($10.7 million) from the prior year, while awards managed by the Feinberg School of Medicine grew by 3 percent ($12.8 million). The increase in University Research Center Funding is a reflection of Northwestern’s collaborative culture — each center involves faculty from multiple schools. This increased center activity also can (negatively) impact school-level funding. Awards to the Weinberg College of Arts and Sciences rose by 8 percent ($4.9 million).

THE AMOUNT AWARDED IN FY 2015 WAS $620.9 MILLION, A 4.5 PERCENT INCREASE OVER LAST YEAR.
### FEDERAL AND NONFEDERAL AWARDS

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#### Fiscal Year Breakdown

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### AWARDS by Administrative Unit

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<th>FY 2013</th>
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### AWARDS BY ADMINISTRATIVE UNIT

- **Feinberg** ($402,726,471)
- **Weinberg** ($64,853,181)
- **McCormick** ($57,648,044)
- **Research Centers** ($53,374,734)
- **Other Schools** ($32,216,312)
- **School of Communication** ($10,121,788)
The dollar volume of proposals submitted in FY2015 was $2.5 billion, an increase of 7 percent ($168.6 million) over the total reported in FY2014. The number of proposals submitted (3,386) increased 2 percent over FY2014 (3,314).

Feinberg proposal activity reflected an increase of 12 percent ($179.4 million), while proposals from Weinberg rose by about 7 percent ($17.1 million). McCormick proposals declined by 7 percent ($21.7 million).

Proposal activity for Research Centers and Institutes increased 3 percent ($6.0 million).

At the end of August 2015, the dollar volume of proposals submitted to federal agencies had grown by 7 percent ($135.6 million) compared to 2014. Similarly, submissions to industrial sponsors rose by 16 percent ($15.3 million). Proposal activity to voluntary health organizations increased by 18 percent ($10.4 million).
PROPOSALS by Administrative Unit

66.4%
Feinberg School of Medicine
$1,664,784,576

12.3%
Robert R. McCormick School of Engineering and Applied Science
$307,382,963

10.7%
Weinberg College of Arts & Sciences
$267,965,872

12.3%
Weinberg College of Arts & Sciences
$267,965,872

7.4%
Research Centers and Institutes
$184,539,450

1.4%
School of Communication
$36,214,556

1.3%
School of Education and Social Policy
$32,223,101

0.5%
Other schools
$14,011,481
EXPERIENCES

Northwestern is distinguished by its vibrant interdisciplinary research culture. In encouraging such collaborative discovery, the University has streamlined and enhanced interactions among departments, centers, and schools.

At the same time, ensuring appropriate credit helps further strengthen our thriving research ecosystem. Tracking investigator expenditure credit helps determine the proper distribution of facilities and administrative cost recoveries. In addition, this practice informs decisions about space and other resource allocations.

The following numbers represent dollars actually spent on sponsored programs. These funds are spent on personnel, equipment, consumables, and graduate student support. Since expenditures follow awards, as our awards have increased so have expenditures.

In 2015, total expenditures increased 1.9 percent year-over-year, from $488.5 million to $497.9 million. Expenditures grew by 14.7 percent (to $43.0 million) for University research centers and by 3.3 percent for Feinberg (to $310.8 million). Expenditures for McCormick decreased by 11.4 percent (to $56.9 million) and declined by 0.3 percent for Weinberg (to $62.0 million).
INNOVATION AND NEW VENTURES OFFICE

Inventive activity at Northwestern during FY2015 remained robust

The leadership and staff of the Innovation and New Ventures Office (INVO) help create a vibrant knowledge ecosystem at Northwestern by bringing together faculty, students, and postdoctoral researchers. In doing so, INVO advances innovation and entrepreneurship across the University. The former Technology Transfer Program is managed through this office.

In fiscal year 2015, INVO executed 121 license agreements (up from 81 in 2014). Licensing is one of the most commonly used mechanisms by research institutions to transfer innovation to the public. Licenses allow commercial institutions to develop, manufacture, and distribute these innovations. INVO also launched 12 start-up companies and processed 211 invention disclosures — compared with 207 in 2014. The office filed a total of 417 patents, with 138 patents being issued. By comparison, 328 patents were filed during the previous fiscal year. Revenues from these activities resulted in $32 million for Northwestern and its inventors, with an additional $3.145 million in equity sales.

Northwestern inventions include a broad array of innovation, including medical devices; drug discovery/therapeutics; materials and manufacturing; research tools; and diagnostics and biomarkers. Primarily driving these discoveries are the thought leaders affiliated with the McCormick School of Engineering (36 percent), the Feinberg School of Medicine (29 percent), and the Weinberg College of Arts and Sciences (27 percent). Importantly, collaboration and invention among the faculty of these schools is producing additional innovation.

The following table reflects licensing income from 2009-2013, the last year for which these data are available.

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Source: Association of University Technology Managers
EXTERNAL METRICS

Based on 2014 federal data, Northwestern enjoyed a relatively stable year in terms of its position in federal awards rankings. In total volume of awards for universities, Northwestern remained 34th in the National Science Foundation (NSF) rankings and dropped one place — to 22nd — in the National Institute of Health (NIH) rankings.

Viewed over time, the trend in research volume at the University continues to be robust at both the NSF and NIH. In 2014, NSF awards totaled more than $42 million, while NIH awards totaled in excess of $217 million.

1 Data from federal agencies lag by one year

NATIONAL INSTITUTE OF HEALTH AWARDS IN THOUSANDS

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Source: National Institutes of Health report.nih.gov/award/trends/findorg.cfm
## NATIONAL SCIENCE FOUNDATION AWARDS IN THOUSANDS

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Source: National Science Foundation dellweb.bfa.nsf.gov/Top50Inst2/default.asp
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**Reporting to Jian Cao**
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- iCET: Institute for Cellular Engineering Technologies; Horacio Espinosa and Jack Kessler
- MRC: Materials Research Center; Mark Hersam
  - NU-ACCESS: Northwestern University/Art Institute of Chicago Center for Scientific Studies in the Arts; Francesca Casadio and Kathy Faber
- NUANCE: Northwestern University Atomic & Nanoscale Characterization Experimental Center; Vinayak Dravid
- NIMSI: Northwestern Initiative for Manufacturing Science and Innovation; Jian Cao
- COFI: Institute of Fundamental and Interdisciplinary Physics of the Americas; Mayda Velasco

**Reporting to Rex Chisholm**
- CLP: Chemistry of Life Processes Institute; Thomas O’Halloran
- CDT: Center for Developmental Therapeutics; Andrew Mazan
- CMIDD: Center for Molecular Innovation and Drug Discovery; Karl Scheidt
- PCE: Proteomics Center of Excellence; Neil Kelleher
- PS-OC: Chicago Region Physical Sciences-Oncology Center; Thomas O’Halloran
- CSB: Center for Synthetic Biology; Milan Mrksich and Michael Jewett
- ISGMH: Institute for Sexual and Gender Minority Health and Wellbeing; Brian Mustanski
- SQI: Simpson Querry Institute; Samuel Stupp and Melina Kibbe
- CRN: Center for Regenerative Nanomedicine; Samuel Stupp
- CBES: Center for Bio-Inspired Energy Science; Samuel Stupp and Monica Olivera de la Cruz

**Reporting to Lewis Smith**
- BUFFETT: Buffett Institute for Global Studies; Bruce Carruthers
- PAS: Program of African Studies; William Reno
- EDGS: Equality Development and Globalization Studies; Jeffrey Winters
- ISITA: Institute for the Study of Islamic Thought in Africa; Sean Hanretta
- CFMS: Center for Forced Migration Studies; Galya Ruffer
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- CAPFS: Center for Applied Psychological & Family Studies; William Pinsof
- CRS: Center for Reproductive Science; Teresa Woodruff
- CSCB: Center for Sleep and Circadian Biology; Fred Turek
- IPR: Institute for Policy Research; David Figlio
- C2S: Cells to Society; Thomas McIade
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- CCR: Center for Clinical Research; Lewis Smith
- NSRC: Northwestern Synchrotron Research Center; Michael Bedzyk and Alfonso Mondragón
- DND-CAT: DuPont – Northwestern – Dow Collaborative Access Team
- LS-CAT: Life Sciences Collaborative Access Team
- SILC: Spatial Intelligence and Learning Center; Dedre Gentner

**Reporting to Jay Walsh**
- IIN: International Institute for Nanotechnology; Chad Mirkin
- CCNE: Center for Cancer Technology Excellence; Chad Mirkin
- SHyNE- Soft and Hybrid Nanotechnology Experimental Resource; Vinayak Dravid
- ISEN: Institute for Sustainability and Energy at Northwestern; Michael Waisielewski, Yip-Wah Chung, Mark Ratner and Brad Sageman
- ANSER: Argonne/ Northwestern Solar Energy Research Center; Michael Waisielewski
- CAMEE: Center for Advanced Materials for Energy and Environment; Mercouri Kanatzidis
- CCSS: Center for Catalysis and Surface Science; Kenneth Poeppelmeier
- SOFI: Solar Fuels Institute; Dick Co
- NAISE: Northwestern / Argonne Institute of Science and Engineering; Pete Beckman and Peter Voorhees
- CHiMaD: Center for Hierarchical Materials Design; Co-Directors: Peter Voorhees and Gregory Olson
- NCW: Northwestern Center for Water; Aaron Packman
- SIS: Science in Society; Michael Kennedy
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Michael Roloff, Chair
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NORTHWESTERN UNIVERSITY ADMINISTRATION,
ACADEMIC YEAR 2015-2016
Andrew Leong, English and Japanese, examines the elements that define a national literature. He translates and interprets poems, plays, and stories that were written in Japanese by and for a Japanese immigrant readership in the United States. See page 34.

Jay Walsh, vice president for research (far right) engages with members of the Chemistry of Life Processes Predoctoral Training Program: Amanda Bayer, Emma Coughlin, and Gokay Yamankurt (left to right), photographed inside the lab of Thomas Meade, chemistry, in Silverman Hall. Read the vice president’s message on page 2.

Deborah Tuerkheimer, law, explores the gaps and disconnections between sex-related cultural norms and the criminal justice system’s response to rape. See page 46.

Thomas Bradshaw, radio/television/film, creates what he calls “hyperreal” stage dramas that present a new kind of performance and psychological insight. See page 28.

Ramón Rivera-Servera, performance studies, studies how emergent communication strategies in museums enable new, critical, and imaginative engagements with concepts of race and racial difference. See page 44.