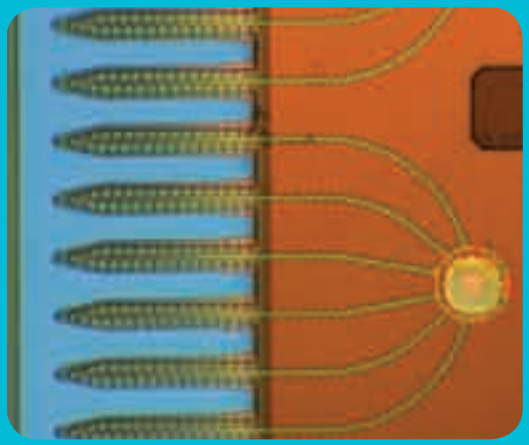
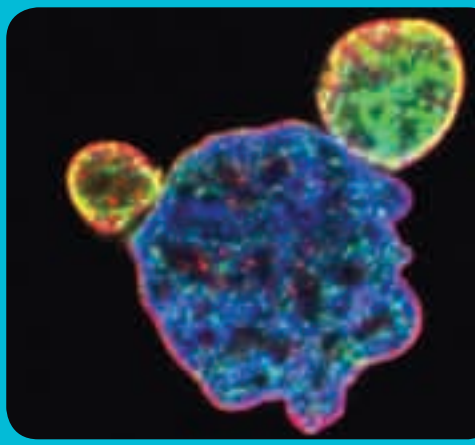
NORTHWESTERN UNIVERSITY

Creating New Knowledge

OFFICE FOR RESEARCH ANNUAL REPORT 2007





ON THE FRONT COVER

Left: Sample of *Partimenti.* Research by Robert O. Gjerdingen, School of Music.
See page 22.

Center: Image from the work of Horacio D. Espinosa, McCormick School of Engineering and Applied Science, showing microfabricated one-dimensional array of nanofountain probes and 2-D arrays of patterned gold nanoparticles. (B. Wu, et al., *Langmuir*, 23:17, 2007; K-H. Kim, et al., *Advanced Materials*, 20, 2008).
See page 18.

Right: An image of the nucleus located in the center of a cell obtained from a biopsy of a patient suffering from Progeria, a rare early onset premature aging disease of children. The highly lobulated and abnormal shape of the nucleus typifies this disease, which is caused by a mutation in the human nuclear lamin A gene. This cell was processed by a technique known as indirect immunofluorescence and the image was obtained with a high resolution confocal microscope. Nuclear lamin A appears in red, DNA in blue and chromatin, the protein/DNA complex that forms chromosomes, is seen in green. The disease results in changes in nuclear lamin organization, which causes accelerated aging leading to death by heart attacks and strokes at an average age of 13. Image courtesy of Anne Goldman, senior research associate from the laboratory of Robert Goldman, Feinberg School of Medicine. See page 24.

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Editors
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Kathleen P. Mandell, Office for Research Planning, Finance, and Communication
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David A. Hull, Susan G. Ross

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C. Bradley Moore, Vice President, retired November 2007
Joseph (Jay) T. Walsh, Vice President

and the Office for Research Planning, Finance, and Communication
Meg A. McDonald, Executive Director,
Joan T. Naper, Director of Research Communications

Address correspondence to
Office for Research
Northwestern University
Rebecca Crown Center, 1-209
633 Clark Street
Evanston, Illinois 60208-1108

E-mail: research@northwestern.edu

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Contents

Creating New Knowledge

C. Bradley Moore and Joseph (Jay) T. Walsh

Vice President's Letter

The Office for Research promotes, facilitates, and enhances research at Northwestern University.

November, 2007

Dear Colleagues,

In academic year 2007, as in past years, Northwestern has made tremendous progress in our research program as proposed and executed by our faculty and supported by our research administrative units.

This year, we gained national attention as the home institution for two recipients of the 2005 National Medal of Science, Jan D. Achenbach, of McCormick School of Engineering and Applied Science, and Tobin J. Marks, of both Weinberg College of Arts and Sciences and McCormick. Achenbach and Marks, the first Northwestern recipients of the nation's highest award for lifetime achievement in fields of scientific research, received their medals from President George W. Bush at a White House ceremony on July 27. (See the full story and photos on page 9.)

A materials science experiment designed by a Northwestern professor traveled on board the space shuttle Endeavor to the International Space Station in August. Peter Voorhees, materials science and engineering, began working on the project with NASA in 1986, when he was a postdoctoral researcher. The success of his first two experiments convinced NASA to perform the current experiment on the International Space Station. Knowledge gleaned from the experiment could help improve the design of a variety of materials such as steels and aluminum alloys. Voorhees says that the downlinked thermal data show encouraging results, but he won't know if the experiments worked until the samples are returned.

Northwestern University's Feinberg School of Medicine received a $9.6 million, 6.5-year contract from the National Institutes of Health (NIH) to participate in the largest study of health and disease in Hispanic/Latino populations living in the United States. The Chicago branch of the study is conducted under the leadership of Martha L. Daviglus, preventive medicine and principal investigator. A multidisciplinary team of health experts from Northwestern and the University of Illinois at Chicago collaborated to obtain the highly competitive award (see page 26).

Teresa Woodruff, obstetrics and gynecology and chief of Feinberg's newly created fertility preservation division, will head a landmark national research, clinical, and education program that targets fertility threats posed to women by cancer treatment. The Oncofertility Consortium consists of an interdisciplinary team from Northwestern and the University of California–San Diego, the University of Pennsylvania, the University of Missouri–Columbia, and the Oregon Health and Science University. Its research will include a thorough examination of the scientific, medical, psychological, legal, and ethical issues surrounding fertility and cancer.

"Northwestern's emphasis on multidisciplinary research and education programs positions us to make critical contributions to society."

Henry Bienen, President
Northwestern University
State of the University Speech
March 1, 2007

Feinberg also has received a seven-year, $32 million contract from the National Institute of Child Health and Human Development to be the Chicago study center of the National Children's Study, the largest study of child and human health ever conducted in the United States. Northwestern researchers will follow 4,000 children in Cook County from before birth to age 31. Jane Holl, pediatrics, preventive medicine, and health care studies, and an attending physician at Children's Memorial Hospital, is principal investigator on the study.

Wayne Anderson, molecular pharmacology and biological chemistry, will be leading a national project that will map 375 proteins from deadly infectious diseases over the next five years. The project will be housed at the Feinberg School's new Center for Structural Genomics of Infectious Diseases and is being funded by a $31 million contract from the National Institute of Allergy and Infectious Diseases, part of the NIH. The payoff could be a wave of new medicines to wipe out some of the deadliest scourges to infect the human race (see p. 12).

With achievements such as these, it came as no surprise that in FY2007, Northwestern's research volume exceeded $400 million for the first time, increasing 8 percent to $416 million from $384 million in 2006. This new total award volume is the highest in University history and comes in a year in which federal funding was tightening.

Five-year Perspective

As economists and other social scientists can attest, one year's data are not enough to predict a trend; a longer view of five years gives a more useful picture of Northwestern's research enterprise. When I arrived at Northwestern in May 2003, the picture was not as promising. Research volume remained flat in 2003 increasing only 1.1 percent to $328.1 million from $324.5 million in 2002. FY2007's new high of $416 million represents nearly a 27 percent increase in research awards since 2003.

Increased collaboration with leading Chicago-area research institutions has been a major feature of the past five years. Northwestern now shares with the University of Chicago and other institutions the responsibility for management of the Argonne National Laboratory and FermiLab. This provides access to a wide range of new programs and facilities and has led to joint appointments of Northwestern faculty at the national labs. The Chicago Biomedical Consortium, a collaboration among Northwestern, the University of Chicago, and the University of Illinois at Chicago, has received major funding from the Searle family and initiated important collaborative work. Industry-sponsored research has more than doubled over the last five years. This activity bodes well for the development of a globally competitive knowledge economy to rival those on the East and West coasts.

Northwestern's strong strategic focus on interdisciplinary research and education is reflected in the rapid evolution of its research centers that involve faculty from more than one school or college. Since 2003 the University has added 10 such centers, bringing the total to 20.

Two of the 10 new centers represent an expansion of our understanding and development of nanotechnology, the manipulation of matter on the atomic or molecular scale. The Center for Cancer Nanotechnology Excellence, the Nanoscale Science and Engineering Center, and the International Institute of Nanotechnology (under the direction of Chad Mirkin) and the

Institute for Bionanotechnology in Medicine (directed by Sam Stupp) have made Northwestern a world leader in nanotechnology research and development.

Our newest research center, the Argonne-Northwestern Solar Energy Research Center, or ANSER, brings the combined expertise of researchers at the Argonne National Laboratory and Northwestern together to focus on solar energy. ANSER—under the direction of Michael W. Wasielewski, chemistry—combines and expands the research interests of both institutions to take on the challenges of economically viable solar energy use. With the Center for Catalysis and Surface Science (directed by Peter Stair, chemistry), ANSER is the second Northwestern collaboration with Argonne to join in the essential search for sustainable energy options.

"Northwestern and Argonne offer a uniquely qualified critical mass of people working on solar energy solutions and we have excellent facilities to do the job."

Michael Wasielewski
Weinberg College of Arts & Sciences
Director, ANSER

Excellence is flourishing at Northwestern and is receiving the recognition that it so richly deserves. For example, in 2003, Robert A. Lamb, biochemistry, molecular biology and cell biology, was elected to the National Academy of Sciences. In 2007, he was elected a fellow of the American Academy of Arts and Sciences as well as president-elect of the International Union of Microbiology Societies.

Another colleague who has reached the highest level in his field is J. Larry Jameson, who was inducted into the Institute of Medicine in 2006. It says much about Northwestern that the vice president for medical affairs and dean of Feinberg is a member of that illustrious group. Feinberg's rapidly growing research program with its exceptional new faculty and facilities will excel under his direction.

Building a Stronger Infrastructure

During the past 15 years Northwestern has made a tremendous commitment to building and renovating the facilities necessary to becoming a first-rank research university. The results are dazzling even as the process continues.

Five years ago when I arrived at Northwestern I found a research program under intense scrutiny from federal agencies because of perceived lapses in research administration, management, and supporting services. I am pleased to say that our research infrastructure has been strengthened to the extent that our procedures and processes are in full compliance with federal, state, and local regulations. Key staff leaders with the requisite expertise and experience have been put in place to ensure that this infrastructure remains strong.

Two new units have helped us achieve that goal: The Office for Research Integrity (ORI) and the Office for Research Development (ORD). We will be saying good-bye to ORI associate vice president, Tim Fournier, as he leaves us to help bring the excellence of Northwestern education to Qatar. He has done much to identify the risks and educate our research community on the responsible conduct of research. ORD, headed by Holly Falk-Krzesinski, reaches across school, disciplinary, and institutional boundaries to foster alliances with industry, government, and other universities. ORD has strengthened Northwestern's capacity to undertake major research initiatives that garner national and international recognition. Falk-Krzesinski works with the new Office of Science, Technology, Engineering, and Math Education Partnerships (OSEP) in outreach efforts to the community. OSEP (headed by director Kemi Jonah and associate director Dean Grosshandler, both of the School of Education and Social Policy) connects elementary and high school students and teachers with the science, technology, engineering, and mathematics resources of Northwestern University.

Our administrative units have undergone substantial organizational structure and process changes over the last five years and are well prepared for the University-wide financial system initiatives that will be rolling out over the next year. All have highly professional personnel working to enhance and facilitate Northwestern research. Frank DiSanto, who brought leadership and long-term experience in research operation and system processes to our research program, has been instrumental in these preparations. Our research operations are much stronger as a result of his hard work.

I trust you've all noticed the modernization of research communications, an example of which you're holding in your hands or viewing on the web. In addition to the Office for Research web site and this annual report, these efforts include *CenterPiece*, which has grown from a newsletter into a research magazine that tells the powerful stories of that the research community at Northwestern. University research also enjoys a greater presence in University publications outside the Office for Research, sharing the good news of Northwestern's research achievements far and wide.

Hopes for the Future

On December 1, I am passing the baton to Jay Walsh, former senior associate dean at McCormick, an eminently well-qualified successor with whom I have enjoyed working. I leave with high hopes for the University's future. One example is the One Northwestern initiative, which I believe will lead to collaborative work in neurodegenerative disease with important clinical consequences. Another is that the programs to create sustainable energy will flourish to meet the needs of our society before it's too late for our planet. And still another is that by working globally to share our scientific and educational resources we will create alliances that rise above political barriers to solve societal problems. I believe that with its new facilities, great people, and focus on interdisciplinary areas that will make a real difference to human society, Northwestern is poised to lead the global research university community in the 21st century.

I end with confidence that Jay Walsh will continue in building a strong and sustainable research environment in which excellence can flourish. I wish him and all of you all the best for what lies ahead. I am honored by and grateful for the years I have spent with you. Thank you for all you have given me, and most of all, thank you for your hard and brilliant work that makes our University great.

Sincerely,

C. Bradley Moore

C. Bradley Moore
Vice President for Research
Professor of Chemistry

Hallmarks of Excellence

"I'm fascinated by the knowledge-based design of striking new substances to perform heretofore impossible functions that ultimately improve the quality of human life. To my students and me, scientific research is an exciting adventure."

Tobin Marks
Weinberg College of Arts & Sciences

Creating New Knowledge

The excellence of Northwestern University's research enterprise is built upon the excellence of Northwestern's faculty. As the title of this annual report—"Creating New Knowledge"—suggests, faculty members generate new knowledge; perform innovative research; attract, teach, and mentor exceptional students; and engage in activities that benefit and enrich society. While funding levels for sponsored projects provide one clear indicator of the vitality of the University's research enterprise, the distinction of Northwestern's faculty is also evidenced by membership in prestigious national academies and societies, awards from preeminent grant and fellowship programs, citations, and other recognition and honors.

This report focuses on both the broad hallmarks of research excellence—sponsored project awards, expenditures, and proposals—and on more individual hallmarks of faculty achievement during the past year. It also places Northwestern research within a benchmark group of universities. By putting our efforts in a context that considers peer institutions, we are better able to compare University benchmarks for research, which are based on the Consortium on Financing Higher Education (COFHE) groupings. COFHE institutions are private schools that attract a national undergraduate applicant pool and have characteristics in common that permit each school's inclusion in various cooperative studies.

Excellence in Schools and Programs

Northwestern's schools and graduate programs generally are ranked highly in "America's Best Graduate Schools," published in *U.S. News and World Report*. Table 1 on the next page highlights the Northwestern schools and programs that are ranked in the top 20.

Table 1 — Northwestern University Graduate and Professional School Program Rankings

SCHOOL/PROGRAM	1992	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Kellogg School of Management												
School of Management (Business Week)	1		2		2	1	1		1		3	
School of Management (US News)	4	6	6	2	5	3	5	4	5	4	4	5
Executive M.B.A.								1	1	1	1	1
Part-time MBA				3	3		2	3	3	3	3	3
Marketing	1		1	1	1	1	1	1	1	1	1	1
General Management	3		1	3	4	3	3	3	3	2	4	2
Nonprofit Organizations	3		4	4	3	2	2	4	5	5	6	4
Finance			8	7	8	7	9	7	7	7	10	9
Production/Operations Management				8	8	8	9	8	7	7	8	8
Entrepreneurship			10	10		9		11	13	7	12	11
Accounting			7	10	8	9	9	9	9	10	19	14
International Business						9		11	12	12	18	14
Supply Chain/Logistics								10	11	13	14	14
Information Systems								19	22	20	22	20
Quantitative Analysis				7	9	8	11					
School of Law												
School of Law (American Lawyer)			9									
School of Law (US News)	13	13	12	12	12	13	11	12	10	10	12	12
Tax Law										4	4	4
Trial Advocacy		13	3	2	3	3	4	4	3	6	7	5
Dispute Resolution		13		7	9		8	8	11	9	11	14
Clinical Training		13	9	10		8	9	9	5	9	9	10
Legal Writing										10	5	7
International Law		13						23	16	18	NR	12
Feinberg School of Medicine												
School of Medicine		25	21	21	22	20	22	21	20	20	20	21
Women's Health		25		8	10			12	17	11	15	8
AIDS		25						11	17	13	12	17
Pediatrics		25						17	16	15	12	16
Internal Medicine		25						21	23	25	20	20
Community Health						NR		2				
Health Services Administration			2			3		4				
Physical Therapy						9			10			
Clinical Psychology						19			11			
School of Communication												
Film (MFA)			9									
Drama (MFA)			10									
Speech and Language Pathology						4			3			
Audiology						2			4			
School of Eduction and Social Policy												
School of Education		13	15	18	20	10	10	9	11	6	10	7
Education Policy						19		16		15	18	19
Educational Psychology								22	16	16	19	NR
School of Music												
School of Music (US News)			6									
McCormick School of Engineering and Applied Science												
School of Engineering & Applied Science	19	13	13	15	19	18	20	19	20	21	21	21
Material Sciences	5	4	4	5	4	2	2	4	2	2	3	2
Industrial Engineering	14	15	10	10	9	8	7	7	7	4	7	6
Civil Engineering	12	11	12	10	12	12	10	11	9	8	10	10
Mechanical Engineering	17	18	16	15	17	16	16	16	13	10	10	12
Chemical Engineering	18	17	16	18	17	16	18	15	13	12	16	17
Biomedical Engineering	8	15	13	12	12		15	14	12	12	12	12
Environmental	20	20	24		14	19	14	14	11	15	20	19
Computer Engineering							18	18	21	28	21	25
Electrical Engineering	32	34	25	18				NR	26	28	29	
Applied Math							14				17	
Computer Science	26	NR		21			42				40	

Table 1 — Northwestern University Graduate and Professional School Program Rankings, Continued

SCHOOL/PROGRAM	1992	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Weinberg College of Arts & Sciences												
Chemistry				11		12					9	
Analytical												19
Inorganic												3
Physical												8
Theoretical												3
Mathematics				21		21					21	
Algebra/Number Theory/Alg. Geom.											16	
Topology											13	
Physics						28					29	
Biological Sciences						36					28	29
Economics	8		8		8					8		
Industrial Organization							2			3		
Econometrics										8		
Macroeconomics							9			8		
Microeconomics							7			9		
Public Finance							10			11		
Labor Economics										12		
Sociology	10		10		9					11		
Sociology of Culture							1			3		
Economic Sociology							6			6		
Historical Sociology							6			6		
Sex and Gender										13		
Social Stratification							NR			15		
Sociology of Population										23		
History			17		15					17		
African History										1		
African-American History							NR			12		
European History							NR			14		
Cultural History							NR			15		
U.S. Colonial History							NR			15		
Women's History							NR			18		
Psychology			18		17					22		
Social Psychology							NR			14		
Cognitive Psychology							NR			16		
English			20		18					19		
American Literature Before 1865										12		
African-American Literature							NR			17		
18th to 20th Century British Lit.							NR			18		
Political Science			20		20					21		
Geology												
Medill School of Journalism												
Journalism schools are not ranked by *US News & World Report*												

Footnotes:
1. Rankings are from *US News and World Report* unless otherwise noted.
2. NR denotes not ranked among top schools.
3. Empty cell deonotes no rankings of category in that year.
4. Subcategories/specialities are not ranked each year, though sometimes listed in current magazine with old rankings.

Members of National Academies and Societies

One of the highest honors for faculty is election to prestigious national academies and societies such as the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), the Institute of Medicine (IOM), and the American Academy of Arts and Sciences (AAAS).

One of the most coveted honors is election to the AAAS, an honor achieved by Robert A. Lamb, John Evans Professor of Molecular and Cellular Biology in the Weinberg College of Arts and Sciences, who was named a fellow of the American Academy of Arts and Sciences in 2007.

Lamb, who also is professor of microbiology and immunology at the Feinberg School of Medicine, is an internationally recognized authority on the influenza virus. He is investigating the molecular structure and the mechanism of replication of viruses because of their importance as disease-causing agents and to better understand how a virus is formed and the processes by which these viruses enter cells and assemble at the plasma membrane. Knowledge of virus structure will aid scientists in developing new vaccines.

Continued on p. 13 >

Table 2 — New National Academy Members, 2007

UNIVERSITY	NATIONAL ACADEMY OF SCIENCES		NATIONAL ACADEMY OF ENGINEERING		INSTITUTE OF MEDICINE		AMERICAN ACADEMY OF ARTS AND SCIENCES	
	2006	2007	2006	2007	2006	2007	2006	2007
Columbia	2	0	0	0	4	3	8	3
Cornell	0	2	2	2	0	0	4	5
Duke	1	1	0	0	1	1	1	1
Harvard	6	5	0	0	9	4	7	13
Johns Hopkins	0	1	2	1	3	6	2	2
MIT	3	5	2	5	2	1	3	12
Northwestern	**1**	**0**	**1**	**0**	**0**	**0**	**3**	**1**
Princeton	2	5	2	2	0	0	2	4
Rice	0	0	0	0	0	0	0	0
Stanford	1	5	2	4	0	3	8	8
Univ. of Chicago	2	0	0	0	0	0	3	9
Univ. of Pennsylvania	0	0	0	0	2	3	4	2
Univ. of Rochester	0	0	1	0	0	0	2	1
Washington Univ.	0	2	0	1	1	1	2	2
Yale	1	1	1	0	1	3	8	8

Sources: The National Academies: http://www8.nationalacademies.org/onpinews/byDate.aspx (February 9, May 1, and October 8, 2007; February 10, April 25, and October 9, 2006); American Academy of Arts & Sciences: www.amacad.org/news/alpha2007.aspx and www.amacad.org/news/alpha2006.aspx

President Bush presented laureates Achenbach and Marks with National Medals of Science and Technology during a White House awards ceremony in July 2007. Photographs by Ryan K. Morris, National Science and Technology Medals Foundation.

Achenbach and Marks Awarded National Medal of Science

Jan Achenbach, McCormick School of Engineering and Applied Science

Tobin Marks, Weinberg College of Arts and Sciences

Professors Jan Achenbach and Tobin Marks became Northwestern's first recipients of the nation's highest award for lifetime achievement in fields of scientific research last summer. Achenbach, civil and environmental engineering and engineering sciences and applied mathematics, and Marks, materials science and engineering, received the National Medal of Science from President George W. Bush at a White House ceremony in July 2007.

Bush presented the 2005 and 2006 National Medals of Science to 16 researchers, including Achenbach and Marks, and the 2005 and 2006 National Medals of Technology, the nation's highest honor for technological innovation, to seven individuals, three companies and one four-person team.

Achenbach, who received the 2003 National Medal of Technology two years ago, was honored for his seminal contributions to engineering research and education in the area of wave propagation in solids and for pioneering the field of quantitative nondestructive evaluation.

Marks was honored for his pioneering research in the areas of homogeneous and heterogeneous catalysis, organo-f-element chemistry, new electronic and photonic materials, and diverse areas of coordination and solid state chemistry.

Photograph of the National Medal of Science courtesy of National Science Foundation.

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Photo by Trevor Doherty

Saliva samples gathered by participants in their own homes are processed at Adam's laboratory.

A Measure of Stress

Emma K. Adam, School of Education and Social Policy and Thomas McDade, Weinberg College of Arts and Sciences

Is stress bad for your health? Emma Adam, education and social policy, and Thomas McDade, anthropology, received a $1.8 million grant from the National Institutes of Health to address this question using innovative biomarker methods. Adam and McDade are faculty fellows of the Institute for Policy Research and founding members of Cells to Society (C2S): The Center on Social Disparities and Health.

In their NIH-funded project, McDade and Adam join forces to examine whether stressors experienced during the adolescent and early adult years are predictive of stress-related biomarkers in a nationally representative sample of nearly 20,000 young adults. They hope to understand whether socioeconomic and racial/ethnic disparities in health may be explained in part by the impact of greater stressor exposure on these stress-related pathways. Examining the mechanisms by which stress harms health and identifying what types of stressors are most toxic and under which circumstances, McDade and Adam hope to inform interventions aimed at reducing stress-related health disparities.

These innovative biomarker methods are a central part of McDade's research into how social and cultural environments affect human development, biology, and health. In particular, he has focused on dried blood spot samples—drops of whole blood collected on filter paper

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following a simple prick of the finger—as a "field-friendly" alternative to venipuncture. The relative ease of collection, transport, and storage of dried blood spot samples makes it possible to investigate the determinants of physiological function in larger, more diverse samples than typically applied in clinical research settings.

Adam focuses on another minimally invasive biomarker—saliva. Small samples of saliva can be gathered easily and non-invasively from subjects of all ages at home, work or school. Samples can later be analyzed for a variety of biomarkers, including Adam's primary marker of interest, the stress-sensitive hormone cortisol. She has gathered and analyzed tens of thousands of saliva samples for cortisol levels, with the primary purpose of identifying how everyday social and emotional experiences relate to cortisol levels and patterns throughout the day, and the implications of differences in cortisol levels for emotional and physical health outcomes.

C2S was developed to integrate perspectives from the social/behavioral and life/biomedical sciences for a more comprehensive understanding of health in relation to humanity's complex social, economic, and cultural environments. Adam and McDade (along with Chris Kuzawa, anthropology) direct the annual C2S Summer Biomarker Institute, supported by a $1 million NIH planning grant awarded to C2S in 2006. Each summer, participants come from all over the world to learn about minimally invasive methods for assessing biomarkers of physiological function and health in community-based research settings.

New Center to Map Infectious Disease Proteins

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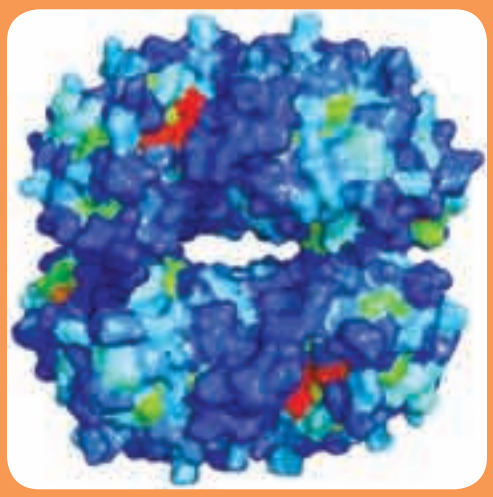
Wayne F. Anderson, Feinberg School of Medicine

As the world population grows and threats of climate change loom, the potential for widespread infectious diseases increases. Wayne Anderson, molecular pharmacology and biological chemistry and co-director of Northwestern's Synchrotron Research Center, is leading the new Center for Structural Genomics of Infectious Diseases (CSGID) in an effort to determine the structures of proteins that are potential targets for drugs to combat these infectious diseases.

CSGID is one of two national centers established by the National Institute of Health's National Institute of Allergy and Infectious Diseases (NIAID) to apply structural biology technologies to characterize the three-dimensional atomic structure of proteins from organisms causing emerging and re-emerging infectious diseases. The center will be run by a consortium that includes Northwestern, Argonne National Laboratory, University of Toronto, Washington University in St. Louis, J. Craig Venter Institute, University of Virginia, University College London, and University of Texas Southwestern Medical Center.

CSGID researchers expect to determine more than 375 structures during the five-year period of the $31 million contract with NIAID, emphasizing those of biomedical relevance and potential therapeutic benefits. Target proteins will include drug targets, essential enzymes, virulence factors, and vaccine candidates. One focus of CSGID will be determining the structures of complexes of the target proteins with small molecule ligands such as natural substrates, cofactors, and drug candidates. The resulting protein expression systems, purified proteins, ligand screens, and protein structures will provide valuable data and reagents that will benefit future research and drug discovery. The research results will be posted on a scientific web site for scientists to use immediately in their work on new drugs.



The two figures show different types of depictions of the same protein from *Bacillus anthracis*, the bacterium that causes anthrax. The top image is a ribbon showing its internal architecture, how the protein chain folds up. The bottom image shows the surface of the same protein colored such that the essential amino acids in the active site of the enzyme are red.

Table 3 — National Academy of Sciences Membership with Current Affiliation

UNIVERSITY	MEMBERS 2006	MEMBERS 2007
Harvard	165	165
Stanford	125	130
MIT	101	103
Princeton	71	73
Yale	60	61
Columbia	38	44
University of Chicago	38	41
Cornell	37	39
University of Pennsylvania	34	33
Duke	19	20
Johns Hopkins	18	19
Northwestern	**18**	**18**
Washington University	14	16
University of Rochester	7	8
Rice	2	3

Source: National Academy of Sciences of the United States of America Membership Directory/July 2006 and via Member Directory search, September 2007 on www.nasonline.org/

Table 4 — National Academy of Engineering Membership with Current Affiliation

UNIVERSITY	MEMBERS 2006	MEMBERS 2007
MIT	107	109
Stanford	86	87
Cornell	24	23
Princeton	19	21
Columbia	20	18
Northwestern	**18**	**18**
Harvard	15	15
Johns Hopkins	11	12
Rice	13	10
University of Pennsylvania	9	9
Yale	6	6
Univ. of Rochester	5	5
Washington University	4	4
Duke	3	3
University of Chicago	1	1

Source: www.nae.edu/nae/naepub.nsf/Home+Page?OpenView; July 2006 and September 2007

Table 5 — Institute of Medicine Membership with Current Affiliation

UNIVERSITY	MEMBERS 2006	MEMBERS 2007
Harvard	143	144
Stanford	49	50
Johns Hopkins	48	47
Columbia	44	45
University of Pennsylvania	42	41
Yale	39	37
Duke	33	32
MIT	28	27
Washington University	20	23
University of Rochester	14	13
University of Chicago	10	10
Cornell	8	11
Princeton	8	9
Northwestern	**3**	**3**
Rice	1	1

Source: Institute of Medicine Public Directory, October 2006 and October 2007

CAREER Awards from the National Science Foundation

The Faculty Early Career Development (CAREER) Program is the National Science Foundation's most prestigious award program for new faculty members. The CAREER Award recognizes and supports the early career-development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century. Six Northwestern faculty members were recipients of CAREER Awards in 2007:

Fabian E. Bustamante, assistant professor of electrical engineering and computer science (See p. 15.)

Dongning Guo, assistant professor of electrical engineering and computer science (See p. 15.)

Russell E. Joseph, assistant professor of electrical engineering and computer science (See p. 15.)

Wojciech Olszewski, associate professor of economics

Continued on p. 14 >

Bryan A. Pardo, assistant professor of electrical engineering and computer science (See p. 15.)

Suzan van der Lee, assistant professor of earth and planetary sciences

With a total of 29 NSF CAREER Awards, Northwestern is tied for fifth with Columbia University among its peer universities.

Citations

Among the nation's most important researchers are those faculty members whose influence is demonstrated by the citations to their work in the literature of their fields. In this way, their colleagues acknowledge their intellectual debt to these individuals. Researchers who have made fundamental contributions to the advancement of science and technology in recent decades are recognized in this list.

In 2007, 40 Northwestern faculty members appeared on the Institute for Scientific Information list of highly cited researchers. This list is made up of less than one-half of one percent of the more than 5 million researchers indexed in the ISF database. The following Northwestern faculty are among the most-cited researchers worldwide in their respective categories:

James C. Anderson, Economics/Business

Alvin Bayliss, Mathematics

Zdenek P. Bazant, Engineering

Ted Belytschko, Engineering

Robert Ogden Bonow, Clinical Medicine

Lawrence J. Christiano, Economics/Business

Stephen H. Davis, Engineering

Greg J. Duncan, Social Sciences, General

Katherine T. Faber, Materials Science

Arthur J. Freeman, Physics

Robert J. Gordon, Economics/Business

Continued on p. 19 >

Table 6 — NSF CAREER Awards

UNIVERSITY	2002-2007	NEW AWARDS IN 2007
Cornell	40	12
Stanford	38	9
MIT	42	9
Columbia	29	7
Northwestern	**29**	**6**
Rice	17	5
University of Pennsylvania	19	3
Johns Hopkins	20	3
Yale	25	3
Duke	27	3
Princeton	27	3
University of Chicago	15	2
Washington University	16	2
University of Rochester	11	1
Harvard	14	1

Source: www.nsf.gov/crssprgm/career/awardsearch.jsp; October 19, 2007

Table 7 — Highly Cited Researchers

UNIVERSITY	2007	INCREASE IN NUMBER SINCE 2006
Harvard	183	14
Stanford	136	3
MIT	81	8
Princeton	69	7
Yale	61	1
University of Pennsylvania	64	9
Cornell	54	2
Columbia	50	5
University of Chicago	48	5
Duke	40	1
Northwestern	**40**	**6**
Johns Hopkins	34	2
Washington University	28	1
University of Rochester	13	0
Rice	9	0

Source: Institute for Scientific Information Highly Cited Researchers, http://isihighlycited.com, October 2006 and October 2007

The Beginning of an Excellent CAREER

McCormick faculty receive four prestigious National Science Foundation awards

Four assistant professors in the McCormick School's Department of Electrical Engineering and Computer Science (EECS)—Fabian Bustamante, Dongning Guo, Russell Joseph, and Bryan Pardo—received Faculty Early Career Development (CAREER) awards from the National Science Foundation (NSF) in 2007.

The CAREER program offers the NSF's most prestigious awards for new faculty members. It recognizes and supports the early career-development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century. CAREER awardees are selected on the basis of creative career-development plans that effectively integrate research and education within the context of the mission of their institution. The minimum CAREER award is $400,000 over a five-year period.

Five McCormick faculty members also received CAREER Awards in 2006: Hooman Mohseni and Seda Memik, both assistant professors of EECS; Guillermo Ameer, assistant professor of biomedical engineering; Bartosz Grzybowski, assistant professor of chemical engineering; and Pablo Durango Cohen, assistant professor of civil and environmental engineering.

For the EECS department, the high concentration of recent CAREER Award winners is a strong indicator of future success. "This level of achievement for young faculty is indicative of the exciting progress that the department has made over the past two years," says Dean Julio M. Ottino. "The CAREER Award recognizes outstanding teaching and research, and is an important recognition for junior faculty."

"The CAREER Award recognizes outstanding teaching and research, and is an important recognition for junior faculty."

Dean Julio Ottino
McCormick School of Engineering and Applied Sciences

Fabian Bustamante

Fabian Bustamante researches the design, deployment, and evaluation of large-scale distributed systems in both wide-area and mobile networks. His primary focus is globally distributed services designed following a cooperative, self-organizing model. Examples of such systems include peer-to-peer data storage, group communication infrastructures, and multiplayer games. Cooperative data storage services, for example, aggregate the often underutilized disk space and network bandwidth of existing desktop computers to provide a self-scaling, universally accessible storage system.

"Most large-scale systems—such as sets of hundreds, thousands, or even a million interconnected computers—are designed to regularly and independently measure their environment for adaptation," says Bustamante. "As these systems grow in popularity, redundant

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measurements will result in an unsustainable degree of monitoring and restrict the variety, number, and span of these services. I believe that any solution to systems problems in this context must be carefully crafted as not to impose unbearable demands on the environment or the systems administrators at risk of curtailing further growth."

Bustamante will use his CAREER award to define and explore a new model, called "3R," for the design and implementation of distributed systems. 3R focuses on reducing aggregated control and administrative overhead by strategically reusing and recycling environmental information gathered by ubiquitous services such as content distribution networks and some peer-to-peer systems.

Dongning Guo

Dongning Guo's work concerns the fundamental capacity of communication systems and the design of practical systems for achieving that capacity. Guo's CAREER award will allow him to explore the relationships between information theory and estimation theory and their application to wireless networks.

"Our work is unique in that it bridges the engineering and the fundamental science of information transmission," Guo says. "We hope to unveil the boundary between what is physically possible and what is physically impossible assuming the best design of a communications network."

"The current state-of-the-art for ad-hoc networks—networks without preexisting infrastructure—is rudimentary, providing a data rate that is orders of magnitude worse than networks with infrastructure," Guo says. "It's important to improve these networks because they are critical for the military and for other applications, such as disaster relief."

One major project in Guo's research group is a joint effort with eight other research institutions aimed at an overall theoretical foundation for mobile ad-hoc networks. This project, funded by the Defense Advanced Research Project Agency, will help industry develop technologies that allow wireless terminals—such as laptops or phones—to communicate and self-organize into efficient Internet-like networks.

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Russell Joseph

Russell Joseph's research focuses on computer architecture and power-aware computer systems, including techniques for monitoring, characterizing, and optimizing performance and power consumption. Making the best use of components such as transistors, logic gates, and memory elements, his group works to develop next-generation processors that will allow for improved computing performance without overheating, wasting energy resources, or failing during critical computations.

Joseph will use his CAREER award to develop microarchitectural and system software models as well as methodology and enhancements

to improve the power, performance, and reliability of multicore microprocessors. He aims to identify ways to overcome two important obstacles to future microprocessor implementation: manufacturing defects and variations that prevent silicon from being produced as intended; and in-field degradation and failure, which causes parts of the processor to stop working shortly after production.

Joseph calls this a "new paradigm" of probabilistic architectures, which proposes hardware and software support that enable the design and management of these high-level microprocessors.

"We are investigating techniques that allow us to overcome these challenges by modeling and designing resilient hardware and software that monitors, makes a diagnosis, and adapts the processor to recover from variation, degradation, and potential failure," he says. "This is a rather ambitious goal, and this award allows us to examine this topic in some detail over a five year period."

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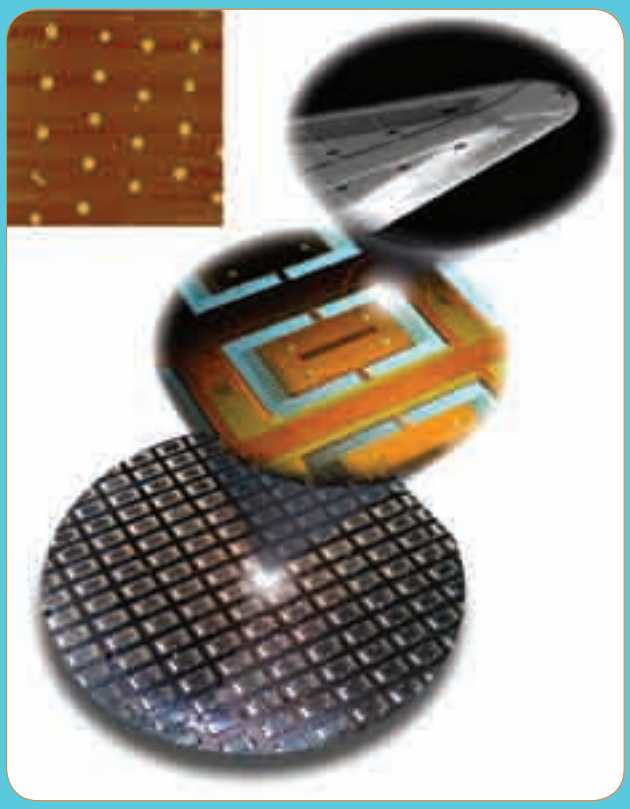
Bryan Pardo

As digital music databases continue to grow exponentially, finding ways to automatically index, label, and access multimedia content in meaningful ways is of paramount importance. For instance, online consumers may struggle to identify a song heard on the radio if they don't know the name of the artist or song. Finding other methods of identifying the music —perhaps by melody or timing—could improve the way consumers, performers, and academics utilize the growing archives of digital music.

Bryan Pardo develops new ways to search for and identify digital content by applying machine learning, probabilistic natural language processing, and database search techniques to auditory user interfaces for human-computer interaction. He takes a broad view of natural language, including timbre and prosody (timing, pitch contour, loudness), with an emphasis on music and speech prosody, and hopes to—per the title of his award proposal—make "Music Documents Accessible in Musical Terms." Pardo will use his CAREER award to develop source separation and score alignment, two key technologies required to automatically find, label, and manipulate important musical structures in audio recordings of music.

"For scholars, musicians, and even casual listeners, the music document is only the beginning, a tool to initiate the task at hand. Musicians may be interested in remixing a musical recording, scholars may wish to analyze the harmonies in a piece, and others may want to remove the sound of an unwanted cell phone ring from a recording of their daughter's flute recital." Pardo says. "Systems able to reliably access audio features, annotate the audio with new information, and integrate the annotated audio with lyrics and musical scores would represent a fundamental improvement in our ability to access and manipulate music documents, allowing a number of new musical applications and interactions for the expert and novice alike."

—By Kyle Delaney, McCormick, used with permission



The image above shows a 4-inch wafer containing microfabricated nanofountain probe chips. A progression of images at various magnifications is shown. The inset on the left shows a 2-D array of patterned gold nanoparticles (B. Wu, et al., *Langmuir*, 23, 2007).

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Nanofountain Probes Pattern Infinitesimal Materials

Horacio D. Espinosa, McCormick School of Engineering and Applied Science

Horacio D. Espinosa, mechanical engineering, and his group have pioneered a method for the fabrication of small scale systems called Nanofountain Probes (NFPs). The NFP is a cantilevered probe chip with integrated microchannels that can be mounted on commercial atomic force microscopy (AFM) equipment. Reservoirs on the chip hold liquid inks such as nanoparticle solutions, that are delivered through enclosed channels to ring-shaped apertured tips. Fluid is a very effective medium for the direct delivery of molecules, which self-assemble on substrates with very specific nanoscale architectures.

Researchers using microfabrication processes created a one-dimensional array of 12 probes connected to two reservoirs in 4-inch silicon wafers. This system surpasses other tip-based nanofabrication approaches because it provides continuous delivery of molecules contained in a fluid buffer. Researchers are able to control dimensions of patterned molecules because of the tip-shell configuration of the probe and the control of multiple process variables, such as electric fields. The system is scalable to two-dimensional arrays to achieve greater nanofabrication output.

NFPs are extremely versatile and have been successfully used in patterning a

number of organic and inorganic materials including thiols, gold nanoparticles, DNA, catalysts nanoparticles followed by direct growth of single-walled carbon nanotubes (SWCNTs), sol-gels, and, more recently, proteins through application of electric fields.

Based on its successful use with a variety of materials, Espinosa expects NFP technology to have a number of applications in nano- and biotechnology including fabricating semiconducting nanodevices, e.g., transistors and sensors based on semiconducting nanowires. Beyond electronics, the NFP is being used in the manufacture of DNA and protein chips, a technology of great interest to the life sciences industry, especially for its ability to identify biomarkers associated with specific diseases. NFPs also are being used to identify optimal chemotherapeutic drug doses by investigating drug-cell interactions through direct patterning of biocompatible drug carriers. Another promising field of application is the use of NFP technology for minimally invasively direct delivery of DNA, RNA, as well as functionalized nanoparticles inside cells followed by real-time monitoring of cell activity.

This research is supported by the National Science Foundation.

Citations, continued from p. 14

Ranjay Gulati, Economics/Business

John Hagan, Social Sciences, General

Michael L. Honig, Computer Science

James A. Ibers, Chemistry

Leon M. Keer, Engineering

Robert A. Lamb, Microbiology

Wing Kam Liu, Engineering

Tobin J. Marks, Chemistry

Thomas O. Mason, Materials Science

Bernard J. Matkowsky, Mathematics

Marsel M. Mesulam, Neuroscience

Richard J. Miller, Neuroscience, Pharmacology

Jorge Nocedal, Mathematics

Robert H. Porter, Economics/Business

Mark A. Ratner, Chemistry

Sergio Rebelo, Economics/Business

Martin H. Redish, Social Sciences, General

Michael Schmitt, Physics

Continued on next page >

Citations, continued from p. 19

Robert Schleimer, Immunology

Patricia G. Spear, Microbiology

Jeremiah Stamler, Clinical Medicine

Seth Stein, Geosciences

Allen Taflove, Computer Science

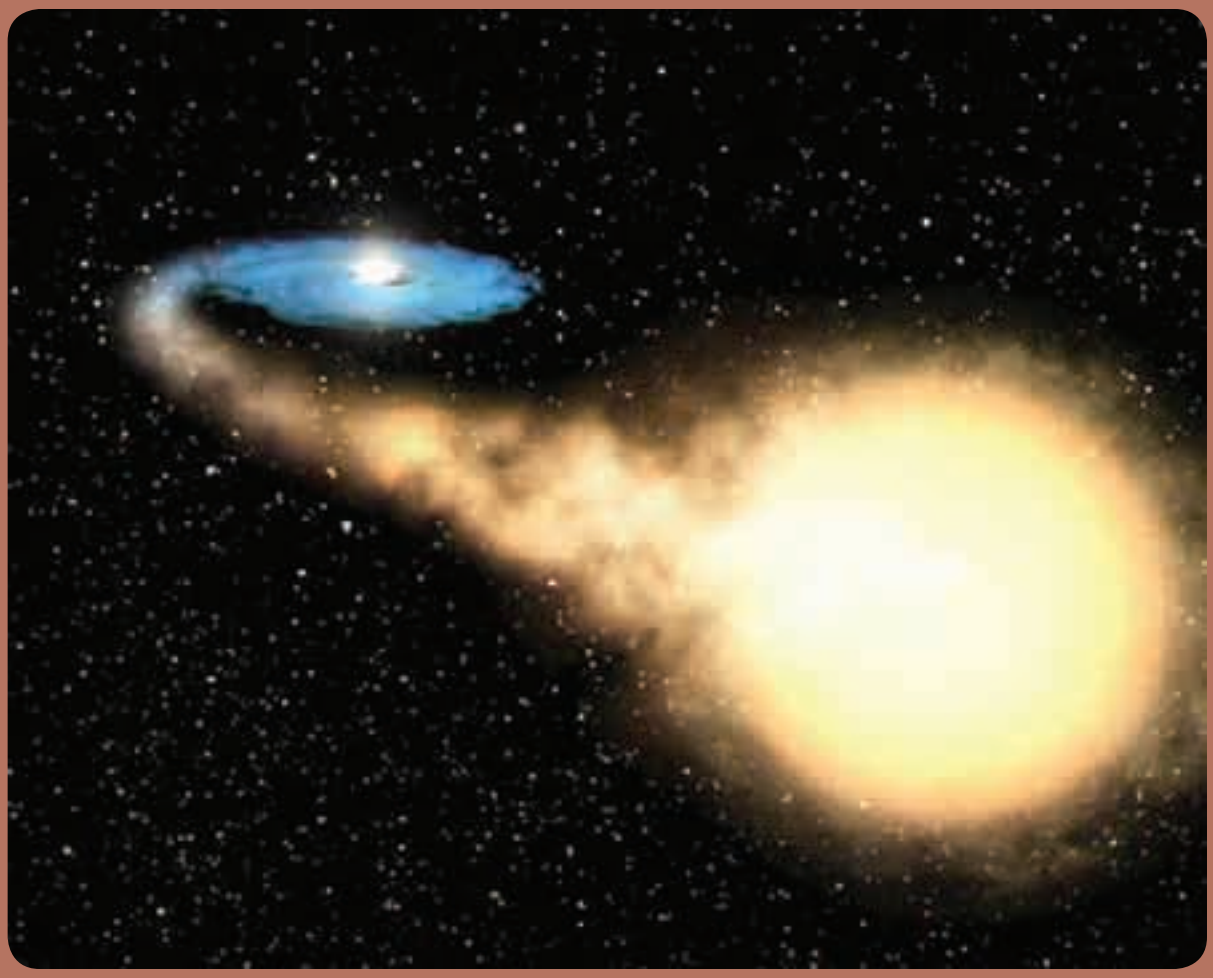
Martin A. Tanner, Mathematics

Peter W. Voorhees, Materials Science

Julia R. Weertman, Materials Science

Michael D. Whinston, Economics/Business

Edward J. Zajac, Economics, Business



Artist's impression of an X-ray binary. Mass is pulled from a star (yellow) in a binary system and eventually accreted onto the compact object through an accretion disk (blue) formed around it. Image credit: NASA, ESA, and F. Mirabel.

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Where Do Dead Stars Come From?

Vicky Kalogera, Weinberg College of Arts and Sciences

Where do white dwarfs, neutron stars, and black holes originate? These astral entities, known as compact objects, are the endpoints of ordinary stars when they run out of nuclear fuel in their cores. Once a stellar core is dead, gravity can either be balanced by pressure forces of high-density matter (and thus form a white dwarf or a neutron star), or win altogether and lead to complete gravitational collapse and the formation of a black hole.

These extreme physical states are believed to lie at the heart of some of the most energetic phenomena in the universe such as gamma-ray bursts and X-ray binary systems. Compact objects are also expected to be detectable sources of gravitational waves.

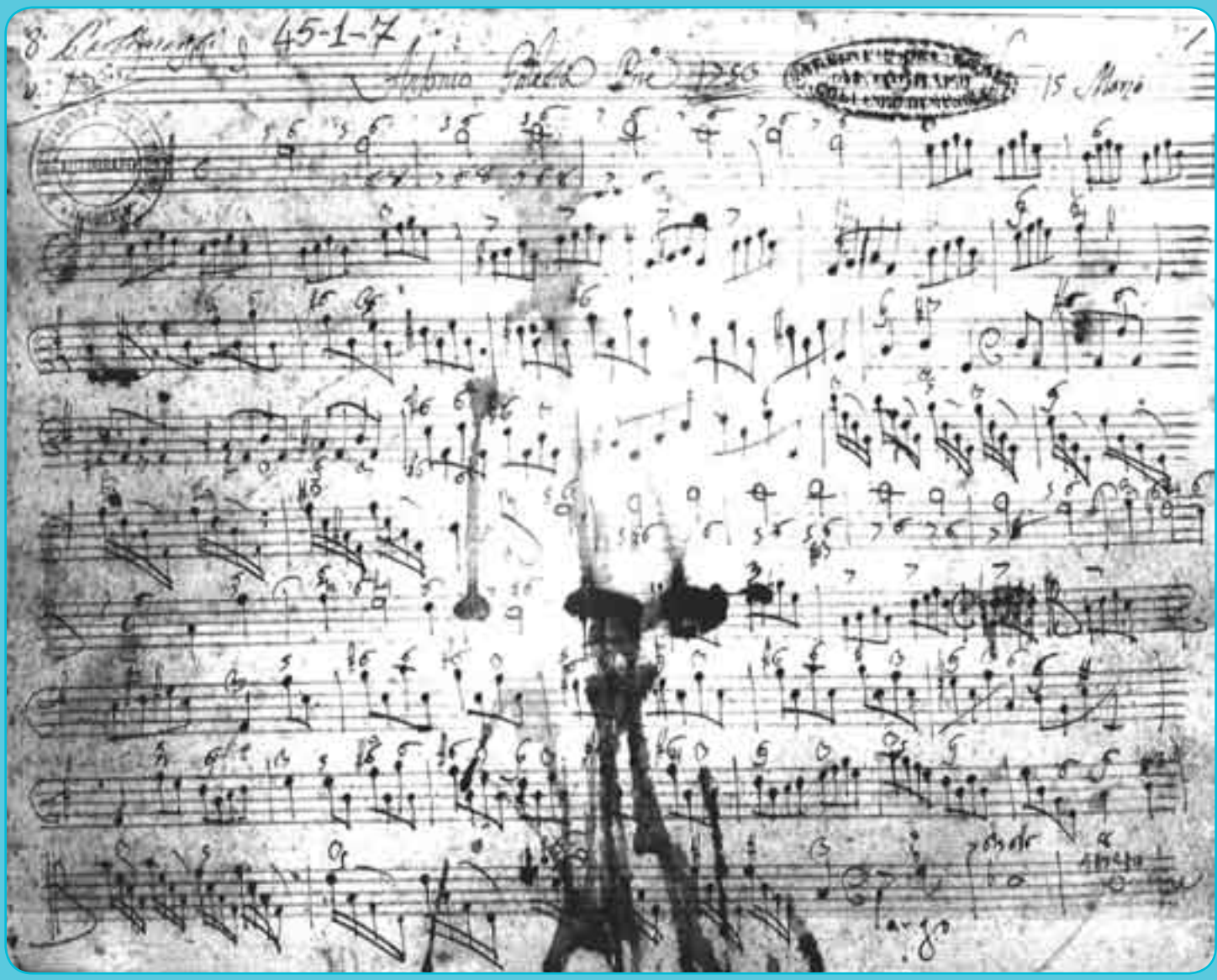
Vicky Kalogera, physics and astronomy, and her research group thoroughly examine this question of origin. Over years a "standard" picture has crystallized: neutron stars and black holes are thought to form from stars more massive than about 10 times the mass of the sun in supernova explosions powered by the collapse of the inner stellar core. As part of the same standard picture, it has been widely accepted that immediate progenitors must satisfy a lower mass limit of two times the solar mass and that explosions forming neutron stars are asymmetric leading to recoil kicks of 200-300 kilometers per second (km/s), whereas black hole formation is less dramatic with either no or very small (of about 20km/s) kicks.

Kalogera, in close collaboration with postdoctoral associate Bart Willems and students, has led recent studies that challenge the standard picture. Specifically, they have developed a methodology for following backwards in time the evolution of binary systems with neutron stars or black holes; this allows them to derive quantitative constraints on their progenitors.

The results have been surprising: they have shown that in a specific galactic system known as the double pulsar, the second neutron star has formed from an unusually low-mass progenitor of about 1.5 times the solar mass with a recoil kick lower than about 100km/s. A study similar in concept of an X-ray binary harboring a black hole has provided the first evidence that some black holes form with significant recoil kicks, in excess of 100km/s.

These results (published in *The Astrophysical Journal and Physical Review D*) clearly challenge our standard picture concerning the formation of neutron stars and black holes, and they provide evidence for the actual diversity of compact object progenitors and formation processes.

This research is supported by the David and Lucile Packard Foundation and the National Science Foundation Astronomy Division through a CAREER grant.



Scan of a manuscript page of the type Robert Gjerdingen studies. It is a boy's lesson book dated 15 March, 1753 with ink spilled on it—the equivalent of 18th-century pizza stains.

Partimenti: Tools in Developing Musical Memory

Robert O. Gjerdingen, School of Music

Robert Gjerdingen, music studies, recently published *Music in the Galant Style* (Oxford, 2007), in which he explores the "Italian School" of music, bringing to light one of the secrets of Neapolitan success: the instructional bass or *partimento*. Given just the bass part to an imaginary ensemble of voices or instrumentalists, a young boy in the conservatory would sit at a keyboard and play all the parts as if they were written out before him. To accomplish

this magic, these young musicians needed to train their memories and imaginations. They practiced a non-verbal form of mental discipline that, when mastered, allowed them to compose sonatas or symphonies with the same facility that might characterize a master jazz musician today.

European court musicians were trained in *partimenti*, or instructional basses, from the late 1600s until the early 1800s. *Partimenti* had their greatest influence first in Italian conservatories, especially at Naples, and then later at the Paris Conservatory, where the principles of the "Italian school" continued to be taught far into the twentieth century. Because learning the Italian style of music was a priority for almost any eighteenth-century musician, many well-known non-Italian composers, including Bach, Handel, Haydn, and Mozart, also studied or taught *partimenti*.

The oldest Italian conservatories were not established to conserve music. They were charitable religious institutions where orphans and foundlings would be taught trades. In a society where family connections and social rank were all-important, an orphan needed a marketable skill in order to make his way in the world. It was not enough to learn "about" music. The child needed to become fluent in the courtly style so that he could eventually perform at church, in an aristocratic chamber, or at the opera theater. Thus training in *partimenti* was practical, not theoretical.

By the eighteenth century, the best conservatories found that they could supplement their income by hiring out their well-trained young musicians. This income made possible the recruitment of ever more illustrious teachers, with the result that the Italian conservatories became magnets for talented students and teachers from all over Europe. The conservatories began accepting paying students, and slowly transformed into institutions much like the music conservatories of today.

Gjerdingen edits the web-based series *Monuments of Partimenti*, which is funded by a grant from the National Endowment for the Humanities, produced at Northwestern's School of Music, and hosted by Northwestern University. The series provides free access to the *partimento* repertory and to the sound files for *Music in the Galant Style* in hopes of encouraging research into the music-cognitive world of eighteenth- and nineteenth-century musicians. All material in the series is in the public domain and may be freely copied and redistributed. The series may be found at http://faculty-web.at.northwestern.edu/music/gjerdingen/partimenti/.

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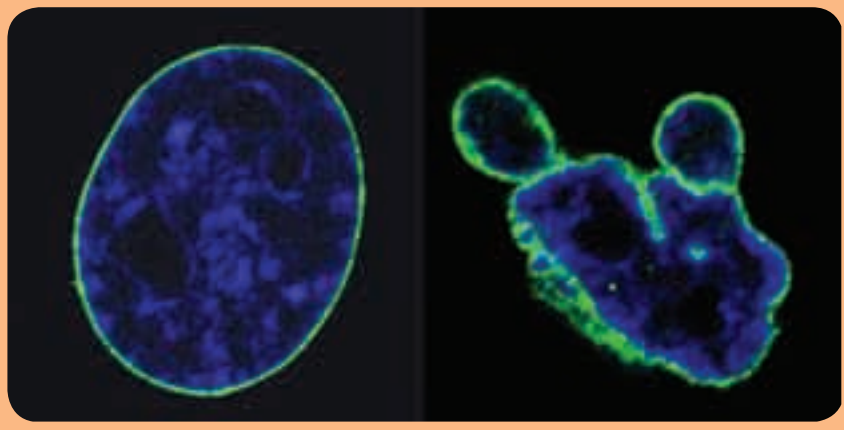
Lamin Mutations: Key to Many Human Diseases

Robert Goldman, Feinberg School of Medicine

Hutchinson Gilford Progeria Syndrome is a rare premature aging disease, often used as a model for understanding normal human aging. Victims have the appearance of the elderly, even at 4-5 years, and die of heart attacks and strokes by an average age of 13. The cause of Progeria remained unknown until 2003, when Francis Collins, head of the National Human Genome Institute, and colleagues discovered that the mutation causing Progeria was in the human nuclear lamin A gene (LMNA). At the time, the Feinberg School of Medicine laboratory of Robert Goldman, cell and molecular biology, was one of the few labs in the world with a serious interest in the nuclear lamin proteins. Because of his ongoing lamin research program, Collins contacted Goldman to initiate a collaborative study that has helped to determine the cellular and molecular mechanisms responsible for Progeria.

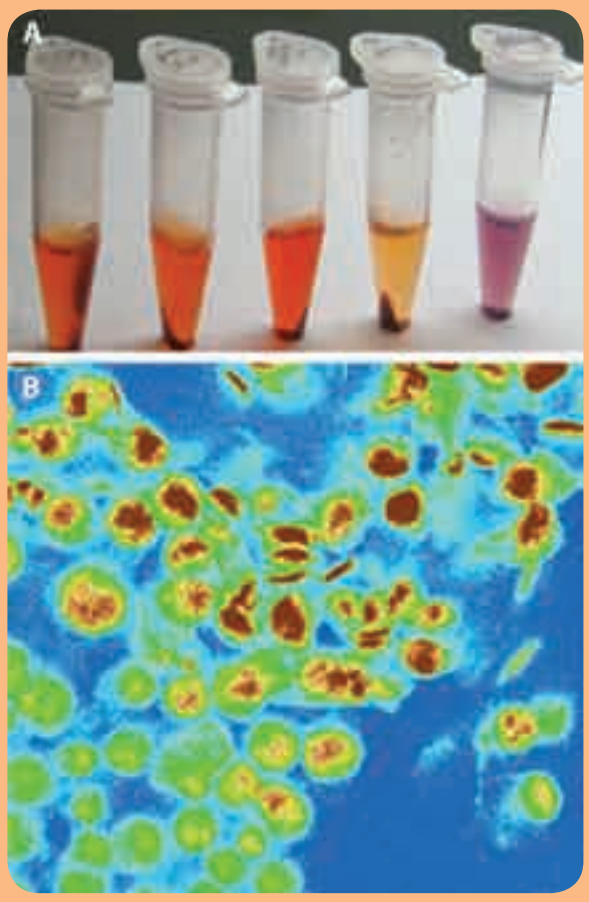
The Goldman group, which includes research associate Anne Goldman and collaborator Steve Adam, cell and molecular biology, has been studying the nuclear lamins for more than 25 years in a project funded by the National Cancer Institute, the National Institute on Aging, and a Senior Scholar award from the Ellison Medical Research Foundation. These researchers have determined that the lamins are key elements of the molecular architecture of the nucleus with essential roles in regulating its size, shape and mechanical properties. They have also determined that lamins are required for normal DNA replication, gene transcription, and the assembly and disassembly of the nucleus during cell division.

The lamin story does not end with Progeria, as the gene is now known to be one of the most extensively mutated in the human genome, with approximately 300 mutations reported to date. Uniquely for a single gene, these lamin A mutations cause a remarkable number of different diseases including several forms of muscular dystrophy, cardiomyopathies, neuromuscular junction diseases, skin and bone diseases, and numerous others. Goldman now believes that lamins also play important roles in many of the more prevalent human diseases including cardiovascular disease and cancer.



Description of images: Fluorescence images showing a normal nucleus (on left) and a nucleus in a Progeria Patient's cell (on right). Blue is chromatin and green is nuclear lamin. Note the extremely abnormal shape of the Progeria nucleus.

Photo by Kelly Ann Janura



The image shows that the diamonds, suspended in water for ease of application (A), were capable of rapidly crossing cell membranes to further reduce non-specific cellular exposure and enhance therapeutic efficacy (B). These integrated nanodiamond systems were also capable of empowering potent chemotherapy across multiple cell lines that were tested, including human colon cancer cells.

Nanodiamonds for Efficient Cancer Drug Delivery

Dean Ho, McCormick School of Engineering and Applied Science

Nanodiamonds, a revolutionary class of nanomaterials, are two nanometers in diameter in single-particle form, and can be manipulated to form clusters 50 to 100 nanometers wide. Their size and structure make nanodiamonds ideal for drug delivery because they are able to shield and slowly release drugs trapped within clusters of nanodiamond aggregates.

Dean Ho, biomedical engineering, and researchers in his lab recently used nanodiamonds to deliver cancer drugs. They fabricated clusters of nanodiamonds capable of trapping and releasing a potent chemotherapeutic slowly through controlled elution or extraction mechanisms. Their research showed that nanodiamonds were capable of trapping nearly five times the amount of drug compared to conventional drug delivery methods, a difference that will make chemotherapy significantly more efficient.

Cancer drugs kill both cancerous and healthy cells, and patients often suffer from complications or even death from the too rapid or uncontrollable release of these drugs. The engineered trapping and slow-release function of the nanodiamonds will help improve treatment by controlling release of the drug into the body.

By harnessing the innately ordered shape of the nanodiamonds, Ho and his group demonstrated that nanodiamond clusters shield the drug while also releasing it gradually to the cells. Nanodiamonds do not elicit an inflammatory response from cells as shown by the absence of increased inflammatory gene expression after the drug is released and the empty nanodiamond clusters are still present. This finding was particularly significant in that several other nanomaterials have been shown to promote the spread of tumors and even inhibit the efficacy of the cancer drug being delivered. This work with nanodiamond clusters for drug delivery represents a significant advancement over several conventional methods of cancer drug therapy. Ho believes that nanodiamonds could find rapid clinical applications due to their ability to improve treatment efficacy while reducing complications.

This work was funded by a V Foundation for Cancer Research V Scholar Award and a grant from the National Institutes of Health (National Institute of Allergy and Infectious Disease).

Northwestern Leads National Hispanic Study

Martha L. Daviglus, Feinberg School of Medicine

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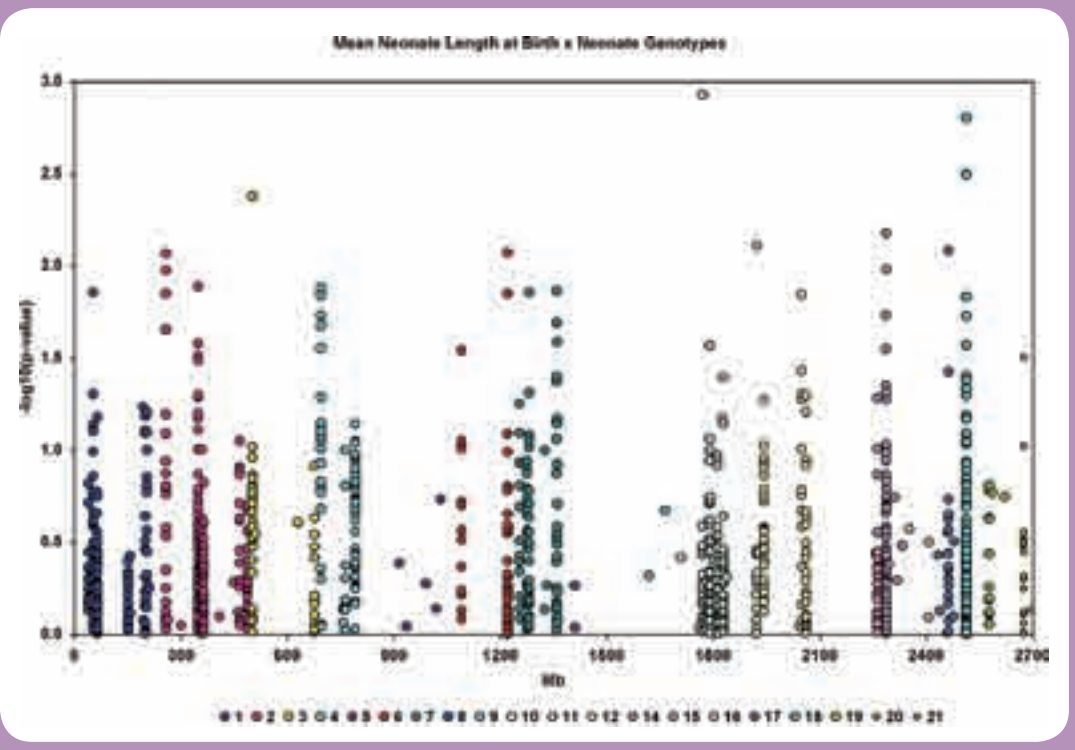
Chicago has the third largest Hispanic population in the country. Thus it is fitting that it has been selected as one of four research sites for the nation's largest study of health and disease in Hispanic/Latino populations, led by Martha Daviglus, preventive medicine.

Northwestern received $11.1 million from the National Institutes of Health (NIH) to conduct a six-and-a-half-year study in Chicago. A multidisciplinary team of health experts from Northwestern and the University of Illinois at Chicago will work together on the project, recruiting approximately 4,000 Hispanics of various nationalities age 18 to 74 years, 50 percent of whom will be women.

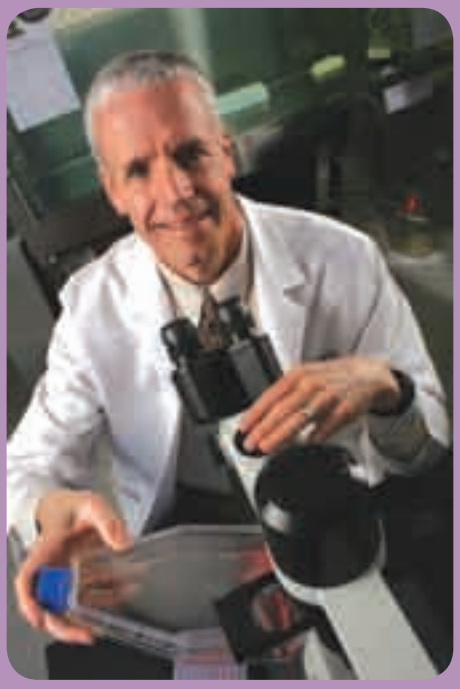
"We know that Latinos, who are becoming the largest minority group in the country, have a higher prevalence of obesity, diabetes, and other risk factors," says Daviglus, who is of Hispanic descent. "We hope to apply what we learn from this study to improve the health of Latinos and other underserved populations."

Participants will be followed for up to four years and will receive screenings and medical exams focused on identifying the prevalence of cardiovascular disease, asthma, diabetes, stroke, and other conditions. The study takes into account the role of diet, physical activity, and other lifestyle factors along with culture and socioeconomic status.

The Hispanic population is expected to triple in size by 2050, according to NIH director Elias A. Zerhouni. He adds that the knowledge gained from this study of Hispanics will also enhance understanding of health issues in other ethnic groups.



This map of genetic variation in 75 genes located on different chromosomes shows evidence for possible association of some of the genetic variants with size at birth in the offspring of HAPO mothers.



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Genome-wide Analysis Mapping to Identify Disease Risks

William L. Lowe, Jr.,
Feinberg School of Medicine

While much progress has been made in identifying the genes responsible for monogenic diseases (diseases like cystic fibrosis which occur due to mutations in a single gene), until recently, progress has been limited in identifying the genetic underpinnings of common diseases like diabetes, hypertension, coronary artery disease and cancer. These diseases are complex genetic diseases—diseases in which variation in multiple genes in conjunction with environmental factors determine disease risk.

A new technology, genome-wide association mapping, which takes advantage of the sequencing and mapping of the human genome, now allows exploration of genetic variation across the entire human genome. This technology has recently been used to identify genes in which variations in DNA sequence are associated with a small but measurable increase in the risk for common diseases like types 1 and 2 diabetes, breast and prostate cancer, and Crohn's Disease, to name a few.

William Lowe, medicine, and colleagues from endocrinology and preventive medicine will be performing genome-wide association studies using a bank of DNA and phenotype information collected from nearly 18,000 mothers and their babies who were enrolled in a study conducted by Boyd Metzger, endocrinology, the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Study. The HAPO Study is a multi-center, international study in which the impact of glucose levels in the mother on growth and outcome of the fetus was examined in 25,000 pregnant women from multiple racial groups.

By using genome-wide association mapping to interrogate over 900,000 DNA sequence variations in 3,500 mothers and their babies, the research team will seek to identify genetic variation that impacts fetal growth and glucose levels in the mother and to define the role of interaction between genetic variation and the intrauterine environment in the regulation of fetal growth. As low and high birth weight are not only major causes of neonatal morbidity and mortality but also have been associated with increased risk of metabolic diseases in adults, identification of genes that regulate fetal growth and maternal metabolism will provide new information about the pathways that regulate these processes as well as important insight into susceptibility genes for chronic diseases like type 2 diabetes.

This research is supported by a National Institutes of Health grant which is part of the NIH Gene-Environment Interaction Initiative and an NIH-funded grant on the relationship between genetic factors that regulate fetal size and susceptibility to adult metabolic diseases.

Figure (opposite page): A) Side view into a diamond-anvil cell for ultra-high pressure experiments on Earth and technological materials. The anvils, each about 2.5 mm in height, are precisely cut and aligned to support static pressures at their tips in excess of 100 gigapascals (one million bars). Samples are compressed hydrostatically within a tiny sample chamber (B) containing a helium pressure medium. The diamonds, transparent to visible, infrared, and X-radiation, allow researchers at Northwestern to probe the structures and physical properties of materials formed under extreme conditions at the Advanced Photon Source, Argonne National Laboratory. B) View through the top diamond of a hydrous high-pressure phase of olivine, called ringwoodite (blue crystal) at 300-thousand bars. Laser heating the sample to 2,000 degrees Kelvin (conditions at about 900 km depth) transforms the material to silicate perovskite (orange spots). These studies address the effects of water on mineral reactions at high pressure, which may incorporate vast quantities of dissolved H_2O in the Earth's deep interior.

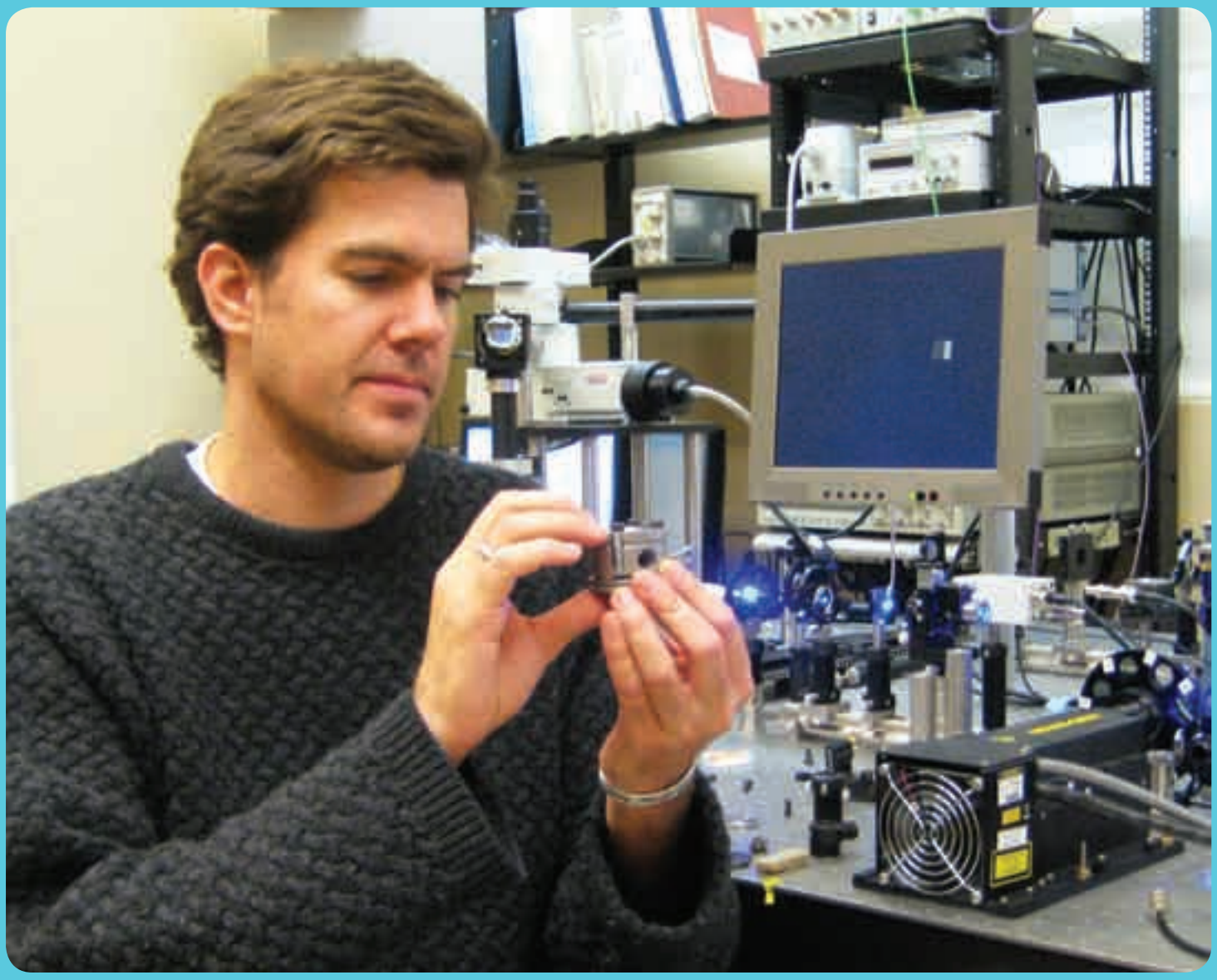
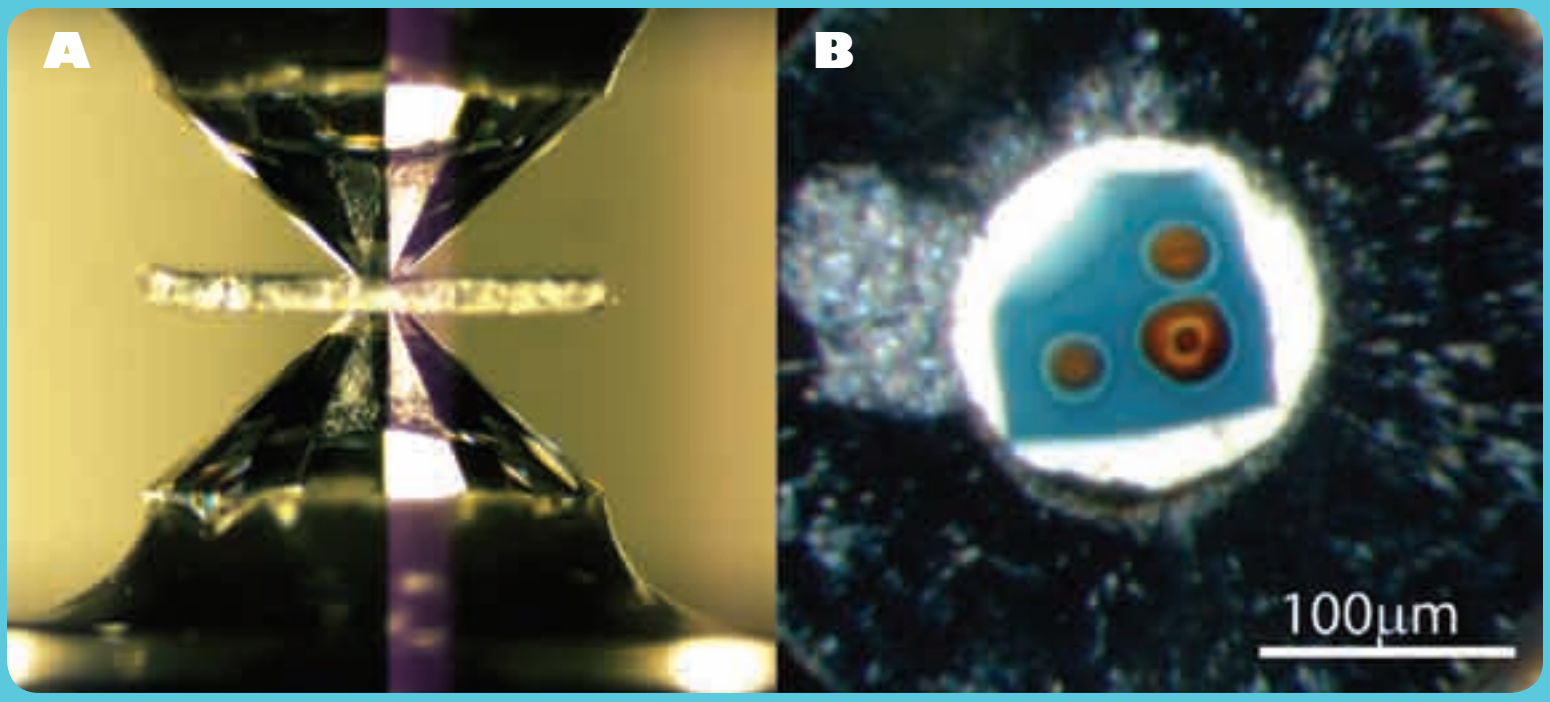


Photo by Christopher M. Holl



Earth's Deep Water Cycle

Steven Dollard Jacobsen, Weinberg College of Arts and Sciences

Earth is unique among the terrestrial planets in having liquid water on its surface. Water supports life and influences geologic processes such as plate tectonics, but little is known about the origin or extent of water on Earth. Research by Steven Jacobsen, earth and planetary sciences, suggests that water in the oceans may be just the tip of the iceberg.

Jacobsen simulates conditions deep in the Earth inside presses made of gem-diamonds, where he combines water with the Earth's mantle materials at high pressures and temperatures. At conditions corresponding to a depth of 400-600 km (250-370 miles), some minerals remarkably absorb as much as one weight percent of H_2O, amounting to the equivalent of five to ten oceans of H_2O in mass.

The water gets incorporated into such high-pressure mineral structures as hydroxyl, which Jacobsen characterizes using synchrotron-based infrared absorption and X-ray diffraction studies. Once the minerals are pressurized to about 300-thousand bars (30 gigapascals), samples are laser heated to mantle temperature conditions. In-situ studies of hydroxyl incorporation and material properties indicate that hydrated mantle silicates differ from anhydrous ones, exhibiting lower density, higher compressibility, and slower elastic-wave speeds.

If deep reservoirs of water exist in the mantle, could they be detected seismically? To address this question, Jacobsen has developed an ultrasonic probe that mimics the seismic waves traveling through the mantle after large earthquakes. By monitoring how hydration affects the speed of elastic strain waves, he is providing seismologists with the information needed to interpret tomographic images of the mantle where water may be present. One such seismologist is department colleague Suzan van der Lee, earth and planetary sciences. Together, Jacobsen and van der Lee released a book entitled *Earth's Deep Water Cycle*, published by the American Geophysical Union.

Results from Jacobsen's lab are now being used to distinguish variations in temperature from compositional changes, such as hydration, in seismic velocity maps of the mantle. Much of Jacobsen's work is carried out at the Advanced Photon Source of Argonne National Laboratory and is supported by the National Science Foundation.

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Benjamin F. Jones

Modern Genius Found in Teams, Not Individuals

Benjamin F. Jones, Brian Uzzi, Kellogg School of Management
Stefan Wuchty, NICO

An acclaimed tradition in the history of science highlights the role of individual genius in scientific discovery. This tradition can be seen in the tendency to equate great ideas with particular names, such as the Heisenberg uncertainty principle, Euclidean geometry, Nash equilibrium, and Kantian ethics.

Yet, especially in recent times, collaborations between scholars are more frequent in many fields. In "The Increasing Dominance of Teams in the Production of Knowledge," Stefan Wuchty, NICO, and Ben Jones and Brian Uzzi of Kellogg present a systematic analysis of teamwork across all fields of science, engineering, social sciences, arts and humanities, and patenting. The authors searched 19.9 million papers published over the most recent five decades and more than 2.1 million patents over a similar time frame (see *Science* 316:1037-1039, 2007 and "Why Do Team Authored Papers Get Cited More," *Science* (Letters) 317:1496-1497, 2007).

The team's findings show that science has been changing fundamentally, and in a remarkably universal way. First, research is increasingly done in teams across virtually all fields. In the sciences, average team size has grown steadily each year and nearly doubled from 1.9 to 3.5 authors per paper over 45 years. Nearly 100 percent of 171 different fields of science and engineering, 54 fields of social sciences, and 36 patenting fields show an increased propensity for co-authorship over time—even 90 percent of arts and humanities fields show this rise in teamwork.

The relative research impact of team-authored papers also is growing. Teams typically produce more highly cited research than individuals do and this advantage

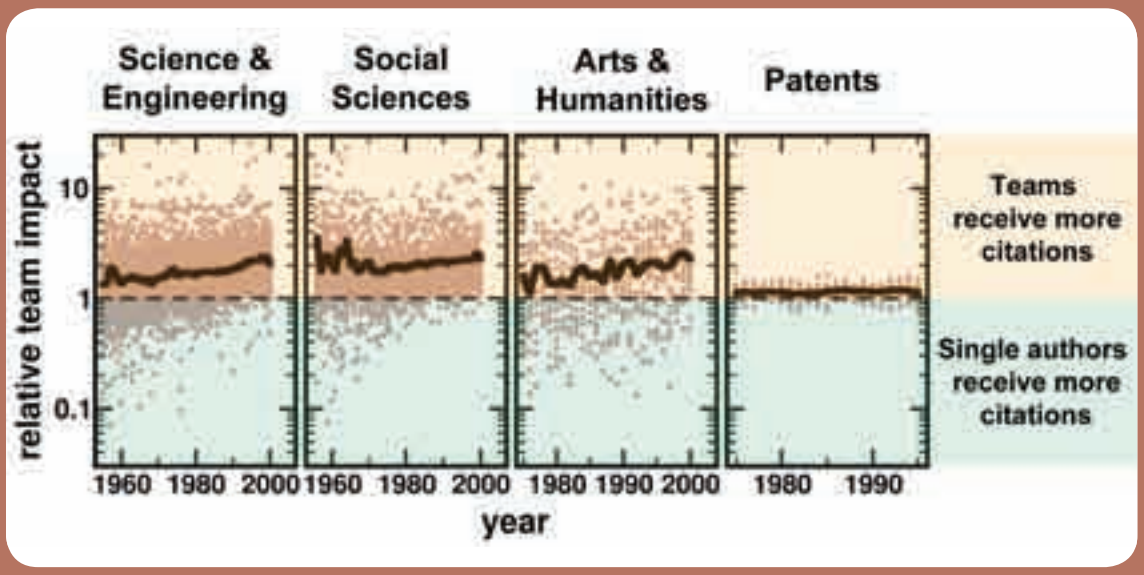
Photo by Robb Hill

Brian Uzzi

Stefan Wuchty

is increasing. Perhaps most importantly, teams now produce the exceptionally high impact research, even in fields where that distinction was once the domain of solo authors.

While analysis of root causes of these trends will be left to ongoing work, the findings substantiate that the contest between collaboration and individuality appears to increasingly favor teamwork. This change is likely to reshape research with implications for how we train scholars, reward individuals, integrate newcomers, organize research, allocate funding, and boost scientific and technical progress.



The core findings showing the systematic relationship between teamwork and the quality of scientific research is summarized in our measure of relative team impact (RTI), which computes the mean number of citations received by team-authored work divided by the mean number of citations received by solo-authored work. RTI greater than 1 indicates that teams produce more highly cited papers than solo authors and vice versa for RTI less than 1. Each dot in the graph is the RTI for a particular field in a particular year. The black line is the average across the underlying fields. While teams underperformed solo authors in many fields in the 1960s, teams now outperform solo authors in virtually all fields.

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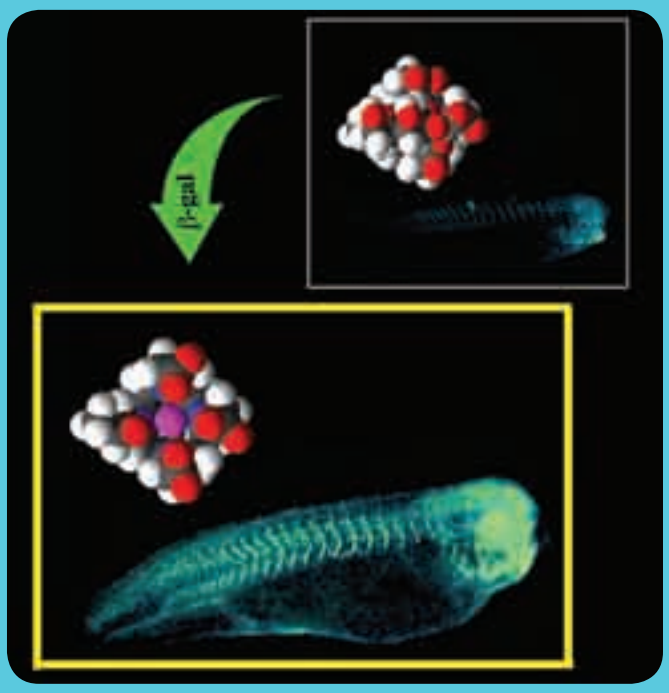

Turning on! New molecular probes that detect gene expression in living animals by MR Imaging can make the detection of diseases earlier and more accurate.

Seeing is Believing: Molecular Imaging of *in vivo* Gene Expression

Thomas J. Meade, Weinberg College of Arts and Sciences, Feinberg School of Medicine

Not long ago, the only tools available to probe cellular and physiological processes at any level were the five senses. The morphology or structure of the specimen determined the investigation of mechanisms of biological and clinical diagnostic questions. Times have changed.

The quest to understand fundamental biological questions drives technological advances in molecular imaging, a fast-paced and emerging area of research. Magnetic resonance imaging (MRI), a powerful tool in clinical and biological settings, is non-invasive and yields a true volume rendering of the subject with cellular resolution (10 microns).

To permit the direct observation of ongoing developmental events in living embryos, the descendants of individual precursors in an intact embryo are labeled by stable, nontoxic, membrane impermeable MRI lineage tracers. Since a complete time-series of high-resolution three-dimensional MR images can be analyzed forward or backward in time, one can fully reconstruct the cell divisions and cell movements responsible for any particular descendant(s). Unlike previous methods, where labeled cells are identified at the termination of the experiment, this technique allows the entire kinship relationships of a clone to be determined in whole animals.

Thomas J. Meade, chemistry, biochemistry and molecular and cell biology, neurobiology and physiology, radiology, and his laboratory pioneered the development of molecular imaging MR probes that are biochemically activated *in vivo*, using an acquired 3D-MR image to report this information. The modulation is triggered by two types of biological events: enzymatic processing of the contrast agent and the reversible binding of an intracelluar messenger. These agents represent the first examples of direct, three-dimensional visualization of gene expression and intracellular second messenger activation in the form of a 3D-MR image.

If early and accurate detection is the formula for solving public health problems, then the new diagnostic techniques of tomorrow must be developed in the chemistry labs of today.

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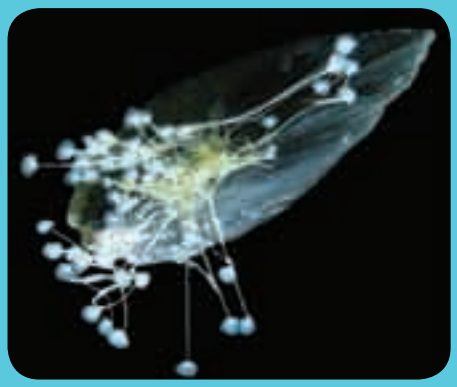
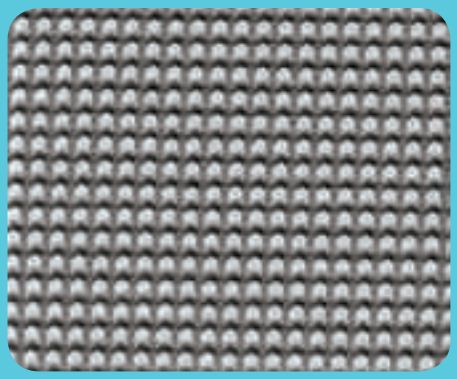


A mussel uses specialized proteins to adhere to wet surfaces.



Array of nanopillars.

Sticking To It

Phillip B. Messersmith, McCormick School of Engineering and Applied Science

Many biological organisms rely on adhesion to facilitate essential activities such as locomotion, protection, and gathering of food. Two quite different biological adhesive strategies, those found in mussels and geckos, inspire the research of Phillip Messersmith's group. "Mussels are promiscuous foulers of rocks, ship hulls, and wood, which they accomplish by gluing themselves permanently onto wet surfaces using specialized proteins," says Messersmith, biomedical engineering and materials science. "Geckos, on the other hand, temporarily attach to dry surfaces during locomotion using minute hair-like structures on their foot pads."

Messersmith and his research group apply the tools of nanotechnology and polymer chemistry to better understand these biological adhesives and to develop new biomimetic materials that capture the unique properties of their natural counterparts. The outcomes of this research include liquid surgical adhesives for tissue repair, temporary wet adhesives, and nonaccumulating medical device coatings for prevention of bacterial infections.

Inspired by the disparate strategies of the gecko and the mussel, Messersmith and his research group described a new adhesive material composed of a tape-like array of nanopillars (see picture) coated by a synthetic polymer (Lee, et al., *Nature* 448: 338-342, 2007). The nanopillar array mimics the gecko foot-hairs to provide reversible adhesion, whereas the polymer coating provides wet adhesion due to a composition similar to mussel adhesive proteins. The resulting material was adhesive in both wet and dry conditions and could be detached and reattached more than 1,000 times without significant loss of adhesion strength.

The group has also recently described a unique mussel-inspired method of applying functional coatings to material surfaces (Lee, et al., *Science* 318: 426-430, 2007). The coatings employ chemical building blocks found in mussel adhesive proteins, can be applied to virtually any material, and support the formation of a variety of organic and inorganic coatings.

This research is supported by the National Institutes of Health, the National Aeronautics and Space Administration, and industry.

Nanoscale Electrostatics Can Create Complex Structures

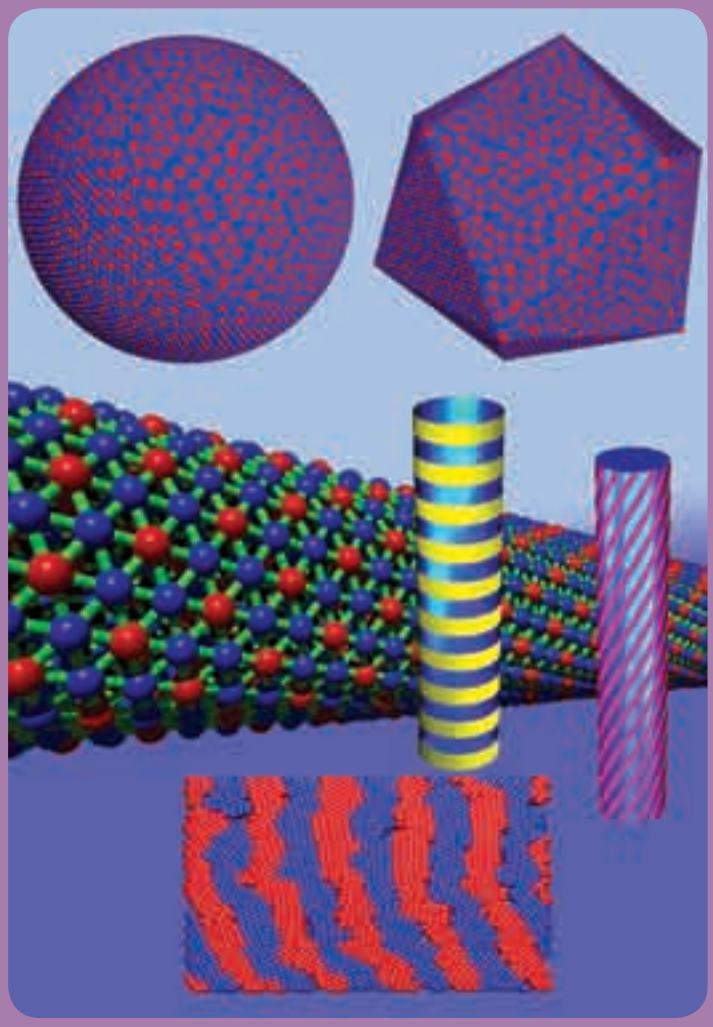
Monica Olvera de la Cruz, McCormick School of Engineering and Applied Science

Electrostatics plays a central role in biology. Nucleic acids are strongly charged and proteins are composed of units with tunable degrees of charge. These charges make the association of biomolecules into functional units strongly dependent on local ionic concentrations. Biological systems could not modify their highly specific conformations to generate work if the local environment could not control structural changes. Most proteins and nucleic acids co-assembled into highly functional units have surface charge heterogeneities. The cohesive energy that holds the oppositely charged biomolecules together leads to charged patterns or ionic nanoassemblies. Monica Olvera de la Cruz, materials science and engineering, and her research group have designed useful biomolecular co-assemblies with prescribed charged heterogeneities that assemble at physiological conditions. When interacting, charge polarizability breaks the symmetry, a crucial concept for biological function. These entities organize into specifically designed functional complex structures.

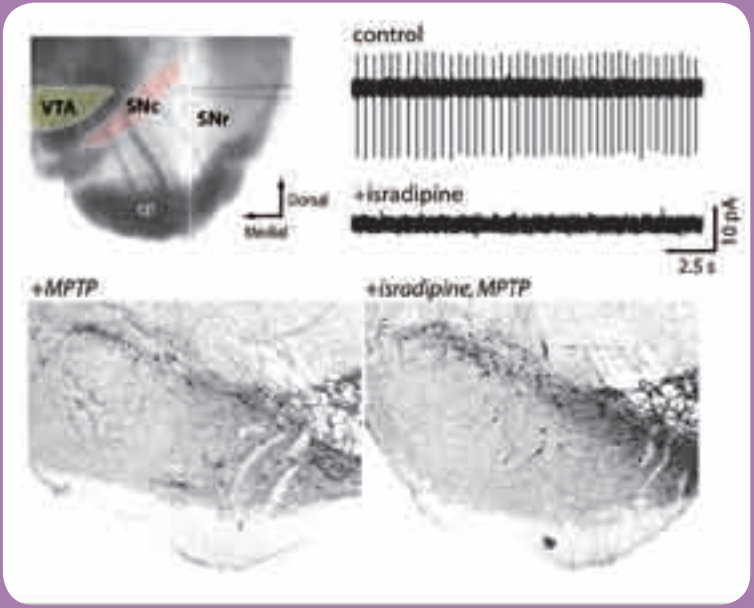
An important part of understanding patterns at the molecular level is through the study of their symmetry or, conversely, the symmetries which they "break" or don't obey. Molecules and atoms within the body are subjected to the same fundamental forces that physicists have discovered over the past 250 years. Not only do these forces govern all the molecules within the body, but they cause the molecules to interact with each other in a very predictable manner. The Olvera de la Cruz group has found that with theoretical arguments and numerical simulations they can show how symmetric electrostatic interactions alone can break symmetries. The formation of helical charged patterns is an example of an electrostatic origin of chirality (or breaking of mirror symmetry) in assemblies of charged molecules.

Such a fundamental mechanism has many consequences for molecular biology. Nucleic acids and most proteins are charged and self-assemble into asymmetric functional units. Biomolecules, which have evolved to become chiral, form many helical structures in biological environments.

An understanding of chirality can lead to methods to control structures such as viruses. Controlling features of self-organized nanoscale architectures, especially those of viral size and shape, has eluded chemists and engineers for decades. The new findings offer a possible explanation of the origin of chirality in biomolecular assemblies.



Bio-mimetic materials of co-assembled molecules are designed by theory and modeling to present surface nano-patterns of alternating charges with different symmetries for specific functions in spherical (top left), icosahedra (top-right) cylindrical (middle) and planar (bottom) geometries.



Top left: A brain slice showing the *substantia nigra pars compacta* (SNc) where vulnerable dopaminergic neurons are found. Areas adjacent to it are the *substantia nigra pars reticulata* (SNr) and the *ventral tegmental area* (VTA). Top right: A recording of the pacemaking activity of a SNc dopaminergic neuron before and after application of isradipine, showing the importance of L-type channels in this activity. Bottom: Sections from the same region of the brain from mice treated with the dopamine cell toxin MPTP in control (left) and isradipine-treated mice (right). The sections are stained for tyrosine hydroxylase, a marker of viable dopamine neurons; note how many healthy cells there are in the isradipine-treated mouse.

New Hope for Sufferers of Parkinson 's Disease

D. James Surmeier, Feinberg School of Medicine

Parkinson's disease (PD) is the second most common neurodegenerative disease in the world. PD robs sufferers of fluid movement, making tasks as simple as picking up a glass of water or walking across the room difficult and slow. PD has no cure, nor is there a proven strategy for slowing its progression. Work at Northwestern's Feinberg School of Medicine, however, is giving those who suffer from PD new hope.

Although there are signs of pathology in many brain regions, the core motor symptoms of PD are attributable to the selective degeneration of dopaminergic neurons in a small area in the midbrain called the *substantia nigra pars compacta*. A research team headed by D. James Surmeier, physiology chair and director of the NIH-funded Morris K. Udall Parkinson's Disease Research Center of Excellence at Northwestern, found that these vulnerable neurons rely upon calcium channels to maintain their autonomous activity and this reliance increases with age. This reliance poses a sustained metabolic stress on mitochondria in these cells, potentially accelerating their aging and death. The calcium channels underlying autonomous activity in dopaminergic neurons are closely related to the L-type channels found in the heart and smooth muscle. Surmeier's team found that systemic administration of isradipine, a dihydropyridine blocker of L-type channels, forces dopaminergic neurons in rodents to revert to juvenile, calcium-independent mechanisms to generate autonomous activity, lowering their metabolic stress level. More importantly, this "rejuvenation" conferred protection against toxins that produce experimental parkinsonism, pointing to a potential neuroprotective strategy for PD with a drug class that has been used safely by humans for decades.

These discoveries, featured in *Nature* this past summer, are being translated into clinical practice through a collaborative effort among Surmeier, John Kessler, physiology, and Tanya Simuni, neurology, with the support of the FSM Translational Research Fund, Northwestern Medical Faculty Foundation, and Northwestern Memorial Hospital. Their hope—and that of the PD patients—is that a large scale, neuroprotection clinical trial will get underway in 2008.

35 ■

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Analyzing New Forms of Visual Representation

Krista A. Thompson, Weinberg College of Arts and Sciences

How have visual means of production—from print media to music videos—fundamentally changed how black youth across nations come to understand each other and express their connection to other groups in the African diaspora? How have the media and other authorities misrecognized and even vilified these resultant visual practices because they cannot understand or translate this contemporary visual language? In her new book project, *The Visual Economy of Light in African Diasporic Practice*, Krista Thompson, art history, uses these questions to animate the study of current visual practices among black urban youth in the northern Caribbean and southern United States. Specifically, she illuminates how black youth in Nassau, Atlanta, and Kingston, Jamaica engage in performances of visibility, practices that are about being seen and, more specifically, being seen in the process of being represented.

Light or its simulation is intrinsic to these expressions, whether in public dance dancehalls in Kingston, theatrical prom entrances in Nassau, or makeshift roadside photography studios in Atlanta. Thompson explores how the meaning of representation has been reconfigured in these practices in which the visual mechanics of being seen —light, cameras, and backdrops—have become their own form of representation.

Thompson maps the visual cultural networks of circulation between the Caribbean and southern United States, paying attention to forms of black ephemera, including popular magazines, CD covers, music videos, and other sources that circulate between these black urban communities. Her interviews of young people in each society, asking them to identify the forms they find most influential, offer further evidence about which forms and signifying practices capture the diasporic imagination.

Currently many art critics and historians assume there are no black urban visual traditions on which the artists draw. To counter this, Thompson examines how the logic of representation evident in black youth practices informs the artistic production of leading contemporary artists, including realist figurative painter Kehinde Wiley, photographer and videographer Luis Gispert, and multimedia artists Charles Nelson and Kori Newkirk.

2007 Faculty Recognition and Honors

Each year President Henry S. Bienen hosts a faculty recognition dinner honoring members of the Northwestern faculty who have brought distinction to the University. Northwestern's Office of Administration and Planning, in conjunction with the school deans, compiles a comprehensive list of faculty awards and honors. The Faculty Honors Committee then selects those faculty members awarded the most prestigious awards for University recognition. The following faculty members were honored at the 2007 faculty recognition dinner for bringing distinction to Northwestern by their important recognition from societies and agencies outside the University in 2006–07:

Jan D. Achenbach, 2005 National Medal of Science, Executive Office of the President of the United States and the National Science Foundation

Ken Alder, Distinguished Fellow, Dibner Institute

Ronald J. Allen, Yangtze River Scholar, Ministry of Education of the People's Republic of China

Guillermo A. Ameer, Established Investigator Award, American Heart Association

Zdenek P. Bazant, Honorary Doctorate, Vienna University of Technology (Austria); Honorary Member, American Society of Civil Engineers

Ted B. Belytschko, Honorary Doctorate, National Institute of Applied Science of Lyon (France)

Robert O. Bonow, Gold Heart Award, American Heart Association

Fabian E. Bustamante, Early Career Development Award, National Science Foundation

Hui Cao, Fellow, American Physical Society; Fellow, Optical Society of America

P. Lindsay Chase-Lansdale, Fellow, Association for Psychological Science

Yan Chen, Young Investigator Award, Air Force Office of Sponsored Research

Dennis Chong, Corecipient, Best Paper Prize, American Political Science Association Political Psychology Section; Franklin L. Burdette Pi Sigma Alpha Award, American Political Science Association

Rives B. Collins, Creative Drama Award, American Alliance for Theatre and Education

D. Mark Courtney, Young Investigator Award, Society for Academic Emergency Medicine

Peter Dallos, Distinguished Scholar, Woods Hole Marine Biology Laboratory

Isaac M. Daniel, Honorary Member, Society for Experimental Mechanics

Gueorgui M. Derluguian, Norbert Elias Prize, Norbert Elias Foundation

Penelope L. Deutscher, Alexander von Humboldt Research Fellowship, Alexander von Humboldt Foundation

Daniel A. Diermeier, Corecipient, Best Paper Award, International Association for Conflict Management; Faculty Pioneer Award in Academic Impact, Aspen Institute

Faculty Recognitions continued on next page >

N. Druckman, Corecipient, Best Paper Prize, American Political Science Association, Political Psychology Section; Corecipient, Franklin L. Burdette/Pi Sigma Alpha Award, American Political Science Association; Jewell-Lowenberg Award, Legislative Studies Quarterly

David C. Dunand, Fellow, ASM International

Greg J. Duncan, Elected President, Population Association of America; Elected President, Society for Research in Child Development

Stuart Dybek, MacArthur Fellow, John D. and Catherine T. MacArthur Foundation; Rea Award for the Short Story, Dungannon Foundation

Kyla S. Ebels-Duggan, George Plimpton Adams Prize, Harvard University Department of Philosophy

Lee Epstein, McGraw-Hill Award for Best Journal Article on Law and Courts, American Political Science Association

Wendy N. Espeland, Fellow, Radcliffe Institute for Advanced Study, Harvard University

Brodwyn M. Fischer, Fellowship, American Council of Learned Societies

Kenneth D. Forbus, Fellow, Association for Computing Machinery

Sarah E. Fraser, Frederick Burkhardt Fellowship, American Council of Learned Societies; Fellowship, Getty Research Institute

Adam Galinsky, chosen for *The New York Times Magazine Year in Ideas* issue,

Franz M. Geiger, Research Fellowship, Alfred P. Sloan Foundation

Loren Ghiglione, Roy F. Aarons Award, Association for Education in Journalism and Mass Communication

Cindy Gold, Joseph Jefferson Award for Best Actress in a Principal Role in a Musical, Jefferson Awards Committee

Nina Gourianova, Fellowship, National Humanities Center

Bartosz A. Grzybowksi, Camille Dreyfus Teacher-Scholar Award, Camille and Henry Dreyfus Foundation; Research Fellowship, Alfred P. Sloan Foundation

Dongning Guo, Early Career Development Award, National Science Foundation

Kasturi Haldar, Fellow, American Academy of Microbiology

Bard N. Harstad, Arnbergska Priset, Royal Swedish Academy of Sciences

Larry V. Hedges, Ingram Olkin Award, Society for Research Synthesis Methods

Carol A. Heimer, Law and Public Affairs Fellow, Princeton University Program in Law and Public Affairs

Igal E. Hendel, Corecipient, COMPASS Prize for the Best Paper in an Academic Journal Competition Policy Associates

Brian M. Hoffman, Zavoisky Award, Zavoisky Physical-Technical Institute of the Russian Academy of Sciences

Katherine E. Hoffman, Charles A. Ryskamp Research Fellowship, American Council of Learned Societies

Michael L. Honig, Research Award for Senior U.S. Scientists, Alexander von Humboldt Foundation

Joseph T. Hupp, David C. Grahame Award, Electrochemical Society

Steven D. Jacobsen, Distinguished Lecturer, Mineralogical Society of America

Russell E. Joseph, Early Career Development Award, National Science Foundation

Vicky Kalogera, Maria Goeppert Mayer Award, American Physical Society

William L. Kath, Fellow, Optical Society of America

Chuck Kleinhans, Teaching Award, Society for Cinema and Media Studies

Philip Kotler, Honorary Doctorate, Nyenrode Business University, the Netherlands; Prize for Leadership on Business and Economic Thinking, Telecom Italia; Professional Achievement Award, University of Chicago

Jennifer Lackey, Charles A. Ryskamp Research Fellowship, American Council of Learned Societies

Robert A. Lamb, Fellow, American Academy of Arts and Sciences; Vice President, President-Elect, International Union of Microbiology Societies

Lincoln J. Lauhon, Research Fellowship, Alfred P. Sloan Foundation

Judy C. Ledgerwood, Individual Artist's Award, Driehaus Foundation

Carol D. Lee, Distinguished Service Award, National Council of Teachers of English; Member, National Academy of Education

Jennifer S. Light, New Directions Fellow, Mellon Foundation

Robert A. Linsenmeier, Theo C. Pilkington Outstanding Educator Award, American Society for Engineering Education, Bioengineering Division

Wing K. Liu, John von Neumann Medal, U.S. Association for Computational Mechanics; Robert Henry Thurston Lecture Award, Society of Automotive Engineers International

Kevin M. Lynch, Ralph R. Teetor Educational Award, Society of Automotive Engineers International

Nancy K. MacLean, James Willard Hurst Prize, Law and Society Association; Outstanding Book Award, Gustavus Myers Center

Yuri I. Manin, Elected Member, Orden pour le mérite fur Wissenchaften und Künste (German honor society)

Joseph Margulies, Jeanne and Joseph Sullivan Award, Heartland Alliance; Silver Gavel Award, American Bar Association

John F. Marko, Fellow, American Physical Society

"We hope to unveil the boundary between what is physically possible and what is physically impossible assuming the best design of a communications network."

Dongning Guo
CAREER award recipient
McCormick School of Engineering and Applied Science

Faculty Recognitions continued on next page >

Tobin J. Marks, National Medal of Science, Executive Office of the President of the United States and the National Science Foundation; Award for Distinguished Service in the Advancement of Inorganic Chemistry, American Chemical Society

Kate Masur, Fellow, National Endowment for the Humanities

Daniel P. McAdams, Best Book Published in 2006, Professional and Scholarly Publishing Division of the Association of American Publishers

John McCarron, Journalism Award, Lambda Alpha International

Thomas J. Meade, Allen & Constance Ford Award, Case Western Reserve University

Victoria H. Medvec, Corecipient, Best Empirical Paper Award, International Association for Conflict Management

Stephen D. Miller, Fellow, American Academy of Microbiology

Susan Mineka, Distinguished Scientist Award, Society for a Science of Clinical Psychology

Hooman Mohseni, Young Faculty Award, Defense Advanced Research Projects Agency

Joel Mokyr, Elected President, Midwestern Economics Association

Darby J. Morhardt, Award for Excellence in Social Work Practice, SeniorBridge

Dale T. Mortensen, Jacob Mincer Award, Society of Labor Economists

Helmut H. Muller-Sievers, Fellowship, Getty Research Institute

J. Keith Murnighan, Distinguished Educator, Career Achievement Award, Academy of Management

David Nadler, Research Fellowship, Alfred P. Sloan Foundation

Aviv Nevo, Corecipient, COMPASS Prize for the Best Paper in an Academic Journal, Competition Policy Associates

Justin M. Notestein, New Faculty Award, Camille and Henry Dreyfus Foundation

Teri W. Odom, New Faculty Award, Rohm and Haas Technology Community Organization

Emile A. Okal, Fellow, American Geophysical Union

Wojciech Olszewski, Early Career Development Award, National Science Foundation

Julio M. Ottino, Reilly Lectureship, University of Notre Dame

Benjamin I. Page, Kammerer Prize for Best Book in American Politics, American Political Science Association

Thrasos Pappas, Fellow, International Society for Optical Engineering

Bryan A. Pardo, Early Career Development Award, National Science Foundation

Yari M. Perez Marin, Woodrow Wilson Fellowship, Woodrow Wilson National Fellowship Foundation

Maurice Possley, Thurgood Marshall Award, Death Penalty Information Center

Monica Prasad, Barrington Moore Award, American Sociological Association; Distinguished Contribution to Scholarship Award, American Sociological Association Political Sociology Section

David Protess, named in 20 "Most Important Journalists since WWI," *Encyclopedia of American Journalism*

Stella Radulescu, Grand prix de Poésie (First Grand Poetry Prize), Société des poètes et artistes de France; Grand Prize for Free Verse Poetry, 2006 International French Language Poetry Competition

Michael J. Rakowitz, Jury Award at the Sharjah Biennial

Frederic A. Rasio, Fellow, American Physical Society

Mark A. Ratner, CNR Rao Award, Indian Chemical Society

Sergio T. Rebelo, Fellow, Econometric Society; Order of Santiago de Espada, President of Portugal

Stephen P. Reinke, Bell Canada Award for Video Art, The Canada Council for the Arts

Sandra L. Richards, Outstanding Teacher of Theatre in Higher Education, Association for Theatre in Higher Education

Jennifer A. Richeson, Award for Outstanding Contributions to Psychology, Illinois Psychological Association

Reuel R. Rogers, Corecipient, Best Book in Urban Politics, American Political Science Association

Alan V. Sahakian, Fellow, Institute of Electrical and Electronics Engineers

George C. Schatz, Bourke Lectureship and Medal, Royal Society of Chemistry

Karl A. Scheidt, Excellence in Chemistry Award, AstraZeneca; Research Fellowship, Alfred P. Sloan Foundation

Neena B. Schwartz, Pioneer in Reproduction Lectureship Award, Frontiers in Reproduction Research Program in Woods Hole

Marshall S. Shapo, Robert B. McKay Law Professor Award, American Bar Association, Tort Trial and Insurance Practice Section

Joshua H. Singer, Research Fellowship, Alfred P. Sloan Foundation

Nelson P. Spruston, Distinguished Investigator, National Alliance for Research on Schizophrenia and Depression

Kristen A.Stilt, Carnegie Scholar, Carnegie Corporation

Arthur L. Stinchcombe, Corecipient, Paul F. Lazarsfeld Award, American Sociological Association Methodology Section

Charles Taylor, Templeton Prize for Progress Toward Research or Discoveries about Spiritual Realities, Templeton Foundation

Kathleen Thelen, elected President, Organized Section on Politics and History, American Political Science Association

Lars Toender, Leo Struss Award, American Political Science Association

Olke C. Uhlenbeck, Lifetime Achievement Award, RNA Society

David H. Uttal, Fellow, Association for Psychological Science

Brian Uzzi, W. Richard Scott Best Paper Prize, American Sociological Association

Suzan van der Lee, Early Career Development Award, National Science Foundation

Rudolph T. (Butch) Ware, Woodrow Wilson Fellowship, Woodrow Wilson National Fellowship Foundation

Sandra R. Waxman, Fellowship, James McKeen Cattell Fund; Fellowship, John Simon Guggenheim Memorial Foundation

Diane B. Wayne, National Award for Scholarship in Medical Education, Society of General Internal Medicine

Alexander G. Weheliye, William Sanders Scarborough Prize, Modern Language Association

Irwin A. Weil, Honorary Doctorate, Russian State University

Garry Wills, Lifetime Achievement Award, The English-Speaking Union of the United States Ambassador Book Awards

Catherine S. Woolley, C.J. Herrick Award, American Association of Anatomists ■

Scotland Haunts Zimmerman's *Lucia di Lammermoor*

Mary Zimmerman and Daniel S. Ostling, School of Communication

Mary Zimmerman's exploration of Walter Scott's shocking 1819 novel *The Bride of Lammermoor* led her down winding roads in Scotland, where her imagination was fed by the country's untamed vistas and abandoned castles. The journey inspired her ghost story-like vision for the new production of Donizetti's *Lucia di Lammermoor*, which opened the Metropolitan Opera's season last September.

Zimmerman, performance studies, recalls her visit last year with set designer Daniel Ostling, theatre, to the west coast of the country from which her mother's family came. "We stopped the car in wild places and felt the ground. We really examined the architecture and took thousands of photographs," she remembers. Culzean Castle, into which the pair crept despite its being closed to visitors, "became the core of our design: the strange shade of green of the outsized rooms, the bare branches above our heads, the alleyways. . . . It felt like a place haunted by madness, the setting for a ghostly Victorian tale."

Lucia features images from their Scottish sojourn. Unifying elements that recur from scene to scene include a dark, polished wood floor and portals that are often adorned with lace. "It's a set that reveals itself by a series of portals," says Zimmerman, who did not want to interrupt the dramatic flow with unnecessary scene changes. "It's an intense, dense, brief opera with a very simple plot. I wanted the momentum to just keep accelerating, to not lose the forward thrust of the story."

Zimmerman says that she tried to create a Gothic Romance—"romance with a capital R"—for *Lucia*. "It's a sort of ghost story, a world unto itself. All works of art pretend to be about a certain period, but in fact they're figments of our imagination and more closely resemble dreams than anything in the real world."

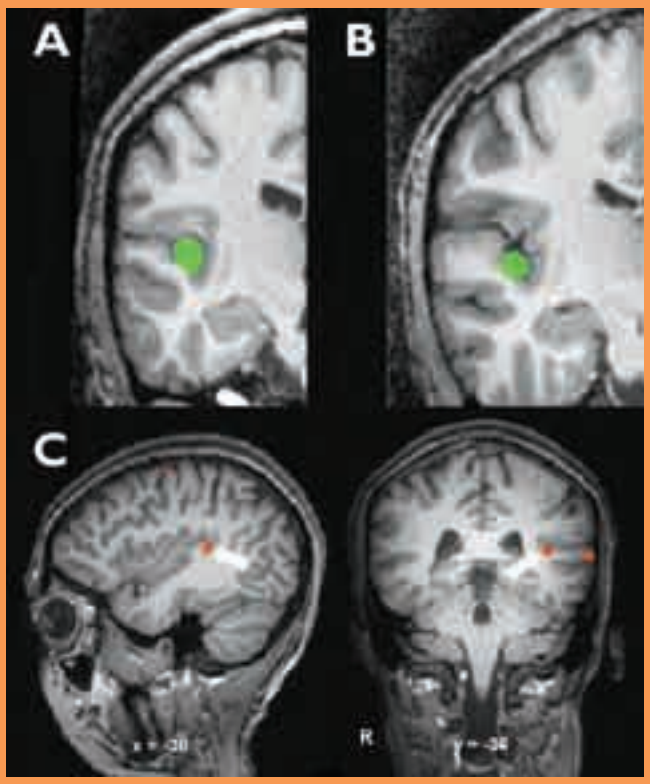
—Adapted from an article by Elena Park in the Metropolitan Opera's 2007-2008 *Season Book*. Photos by Daniel Ostling, except where noted.

A scene from Donizetti's *Lucia di Lammermoor*. Photo © 2007 Ken Howard/Metropolitan Opera, all rights reserved.

A scene from Donizetti's *Lucia di Lammermoor* with Natalie Dessay in the title role. Photo © 2007 Ken Howard/Metropolitan Opera, all rights reserved.

Andrew Campbell

Learning a Second Language: Is It All In the Head?



Green label shows left HG from (A) a representative successful learner and (B) a representative less successful learner. See the difference in size. Panel (C) shows increased activation (in orange) bordering HG after training in the successful relative to the less successful learners.

Patrick C.M. Wong, School of Communication

Research led by Patrick C.M. Wong, communication sciences and disorders, specifically links brain anatomy to the ability to learn a second language in adulthood. Wong and his team were able to predict to a certain extent—even before exposing participants to an invented language—who would be more successful in learning 18 words in a "pseudo" language based on the size of Heschl's Gyrus (HG), a brain structure that typically accounts for no more than 0.2 percent of entire brain volume. Specifically, they measured the size of participants' HG on MRI brain scans, including volume of gray and white matter, and found that the size of left but not right HG made the difference.

The participants were American English-speakers aged 18 to 26 who previously were involved in two related studies published by Wong and his research team. The three studies have identified behavioral, neurophysiologic and, currently, neuroanatomic factors that when combined better indicate second-language learning success than each single factor alone.

While this study demonstrates a link between biology and linguistics it does not argue that biology is destiny when it comes to learning a second language. In fact, Wong and his research team are already testing different learning strategies for participants whom they think will be less successful to see if altering the training paradigm results in improvement.

Wong's research is supported by grants from the National Institutes of Health. These findings were recently published in *Cerebral Cortex* (July 2007) and attracted the attention of significant international media including *The New York Times*, *The London Times*, *The Wall Street Journal*, and *The International Herald Tribune*. The collaborators of this study include School of Communication's Catherine Warrier, communication sciences and disorders, SoC undergraduate Anil Roy, and Robert Zatorre and Virginia Penhune at the Montreal Neurological Institute.

Research Statistics

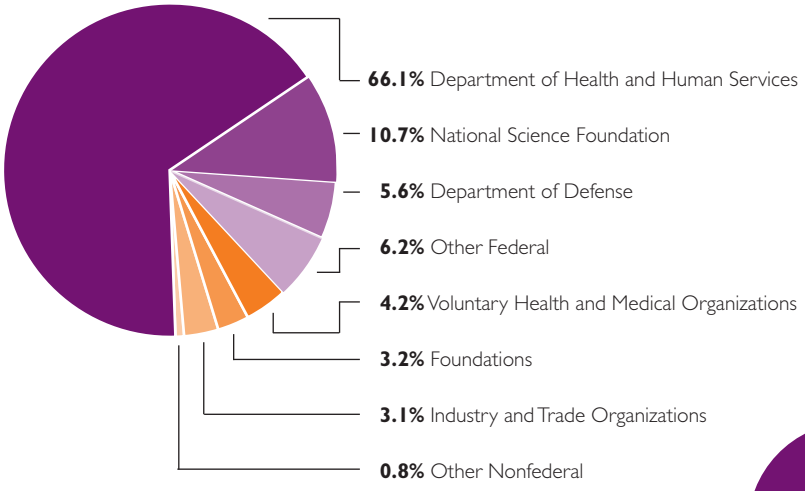
Fiscal Year 2007

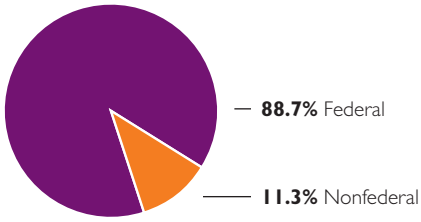
Sponsored Research Proposals

Proposal volume increased substantially in fiscal year 2007 to $1.72 billion, up from $1.48 billion in fiscal year 2006. This 16.0 percent increase is impressive, and it is worthwhile noting the five-year increase of 41.7 percent from $1.21 billion in fiscal year 2003. Most of the research-intensive schools and units experienced double-digit increases, led by the University Research Centers with a 58.7 percent increase to $136.6 million and the McCormick School of Engineering and Applied Science with a 54.5 percent to $276.3 million. The Feinberg School of Medicine realized the largest gain in dollars proposed, breaking through the $1 billion mark. Feinberg proposal activity increased by $105 million to $1,026.7 billion, an increase of 11.4 percent. The Weinberg College of Arts and Sciences had a 14.4 percent increase to $201.8 million.

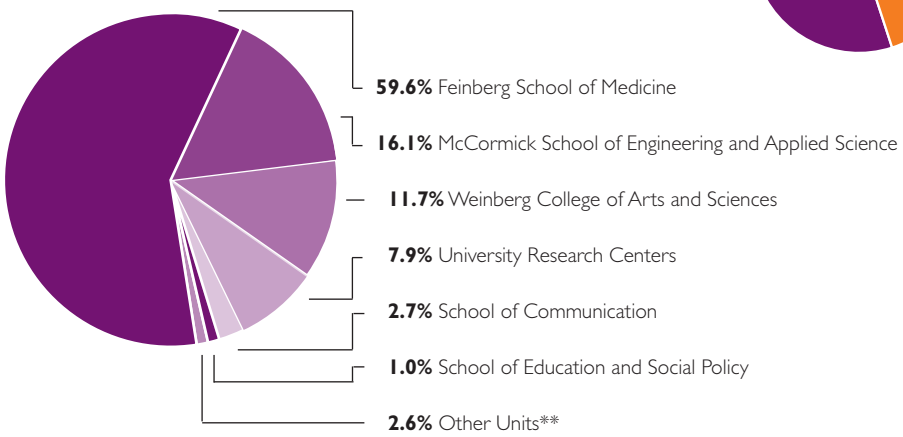
Sponsored Research Proposals, continued on p. 46 >

Proposals by Sponsor*





Proposals by Administrative Unit*



*Percentages do not total 100% because of rounding.
**Central Administration, School of Continuing Studies, Kellogg School of Management, School of Law, Medill School of Journalism, and School of Music.

Sponsored Research Proposals, continued from p. 45

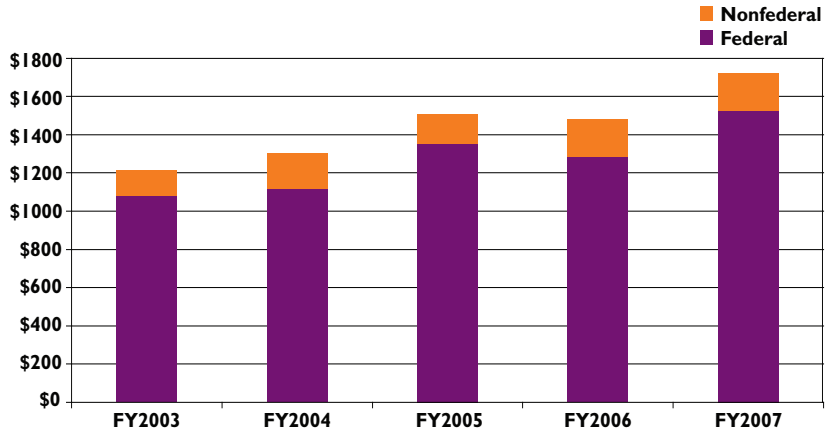
The School of Communication was essentially flat over fiscal year 2006 at $46.5 million, but this was more than double the $31.2 million realized in fiscal year 2005. The School of Education's $16.8 million is significantly lower than the $24.5 million proposed in fiscal year 2006 and the $50.0 million in fiscal year 2005.

The Office for Research changed the methodology for counting proposal activity during fiscal year 2007. In prior years, no proposal resubmissions were counted in the totals; starting in fiscal year 2007, revised resubmissions are included. Prior years' proposal activity has been recalculated using the new methodology; all data and explanatory text refer to these recalculations.

Effect of Resubmissions on Proposal Volume: 2003 – 2007

FISCAL YEAR	PRIOR METHODOLOGY	NEW METHODOLOGY
FY2003	$1,036,096,971	$1,214,422,363
FY2004	$1,098,914,952	$1,306,954,470
FY2005	$1,248,331,000	$1,507,077,968
FY2006	$1,215,452,559	$1,484,006,247
FY2007	N/A	$1,721,301,068

Proposals by Fiscal Year (Dollars in Millions)



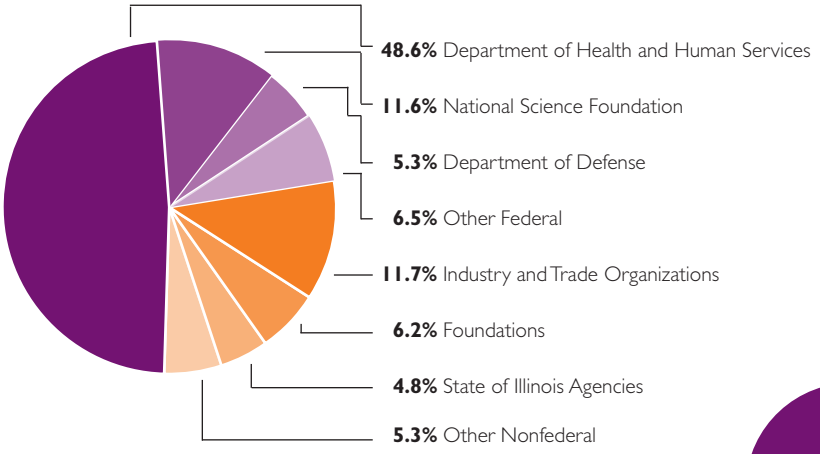
Sponsored Research Awards

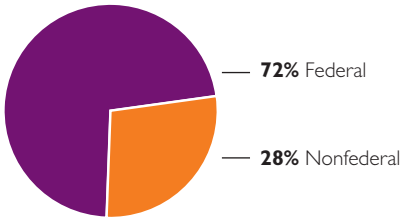
Northwestern University's research volume exceeded $400 million for the first time, increasing almost 8.5 percent to $416.4 million in fiscal year 2007 from $383.8 million in fiscal year 2006. The new total award volume is the highest in University history. The record award volume was matched by a record number of grants – 2,379 compared to 2,227 in fiscal year 2006 and 2,285 a year earlier.

The federal government continued to be the largest source of sponsored research funding, with $299.6 million awarded. The majority of federal funds were from the National Institutes of Health (Department of Health and Human Services) at $202.1 million; the National Science Foundation accounted for $48.5 million. The growth in

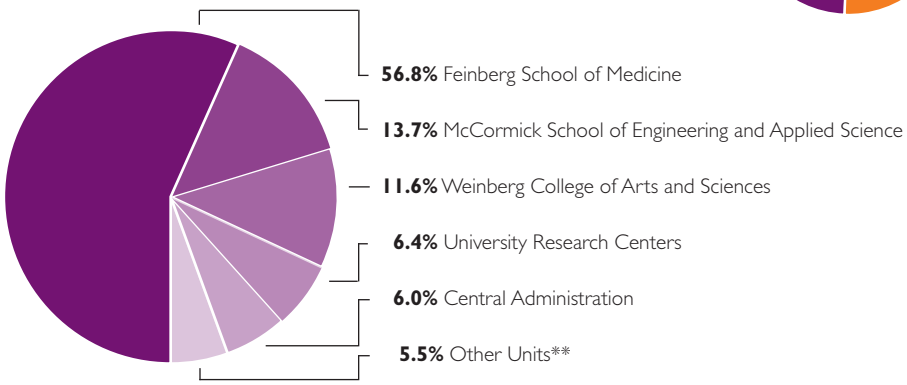
Sponsored Research Awards, continued on p. 48 >

Awards by Sponsor*





Awards by Administrative Unit



* Percentages do not total 100 percent because of rounding.

** School of Communication, School of Continuing Education, School of Education and Social Policy, Kellogg School of Management, School of Law, Medill School of Journalism, and School of Music.

Sponsored Research Awards, continued from p. 47

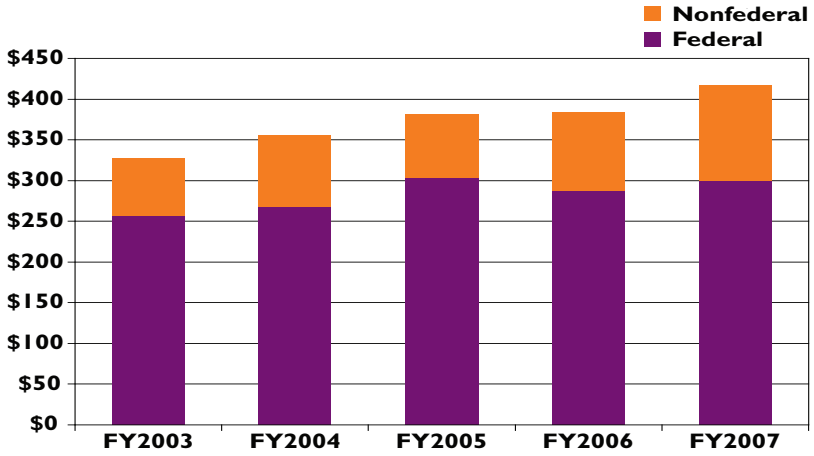
NSF funding is significant, up from $36.8 million last year and $42.4 million in fiscal year 2005.

$48.6 million was received from industry, a very significant increase from the $30.0 million in fiscal year 2006 and more than double the $20 million received in five years ago. Foundations accounted for $25.8 million and the State of Illinois awarded $20.2 million.

The Feinberg School of Medicine had both the largest dollar amount and largest number of grants in the University in fiscal year 2007. Feinberg received $236.4 million, a 16.7 percent increase over the $202.5 million of fiscal year 2006. $160.1 million of awards for 2007 were received from the NIH; $42.7 million was received from industry, up from $23.2 million in fiscal year 2006.

Significant percentage gains were seen in both the School of Education and Social Policy, with a 32.1 percent increase to $8.2 million from $6.2 million, and the School of Communication, which was up 18.7 percent to $7.6 million from $6.4 million the year before. Other major recipients of fiscal year 2007 awards included the McCormick School of Engineering and Applied Science at $56.9 million, an increase of 10.2 percent. Weinberg College of Arts and Sciences received $48.1 million, a decline of 4 percent; University Research Centers declined 40%, to $26.7 million, much of which is due to the restructuring of several centers during fiscal year 2006.

Sponsored Research Awards (Dollars in Millions)



National Science Foundation Award Summary by Top Institutions*
(Dollars in Thousands)

UNIVERSITY	2001	2001 RANK	2002	2003	2004	2005	2006	2006 RANK	% INCREASE 2001–2006
Cornell (Endowed)	72,203	3	78,992	85,814	94,306	90,192	88,904	3	23.1%
Columbia	59,607	7	65,700	72,586	70,424	69,901	72,084	6	20.9%
MIT	49,116	10	60,468	67,024	69,337	62,011	55,766	11	13.5%
Stanford	42,580	16	47,657	54,387	68,203	48,678	53,778	12	26.3%
Princeton	25,971	38	29,003	28,881	38,864	38,554	44,301	20	70.6%
University of Chicago	26,783	35	29,561	38,606	31,990	45,960	40,623	25	51.7%
Northwestern	**30,781**	**29**	**28,065**	**32,170**	**42,475**	**29,503**	**33,234**	**34**	**8.0%**
Duke	19,877	52	31,517	31,166	29,434	33,227	31,884	36	60.4%
Harvard	27,442	34	32,592	44,466	46,370	32,394	29,15	40	6.2%
Johns Hopkins	24,759	41	33,041	29,396	30,170	27,748	28,856	41	16.5%
Yale	13,891	65	21,557	24,469	24,142	27,001	27,791	43	100.1%
University of Pennsylvania	24,962	39	26,667	23,426	33,006	28,300	27,415	45	9.8%
Rice	18,568	55	19,815	27,656	25,623	20,481	26,221	48	41.2%
Washington University	7,792	98	21,867	15,063	10,831	15,254	18,565	68	138.3%
University of Rochester	7,869	97	14,277	14,129	10,841	7,703	13,297	82	69.0%
NSF Total Funding	**4,459,900**		**4,774,100**	**5,369,300**	**5,577,800**	**5,472,800**	**5,645,800**		**26.6%**

*Those categorized as "University"
Source: Budget Division, Office of Budget, Finance and Award Management, National Science Foundation, http://dellweb.bfa.nsf.gov/Top50Inst2/ and http://dellweb.bfa.nsf.gov/NSFHist.htm

National Institutes of Health Awards to Domestic Institutions of Higher Education
(Dollars in Thousands)

UNIVERSITY	2001	2001 RANK	2002	2003	2004	2005	2005 RANK	% INCREASE 2001–2005
Johns Hopkins	457,362	1	510,005	555,876	599,151	607,223	1	32.8%
University of Pennsylvania	376,032	2	418,547	434,457	464,077	471,350	2	25.3%
Washington University	303,650	5	343,792	383,225	388,308	394,788	5	30.0%
Duke	232,180	13	277,383	345,802	343,825	391,196	6	68.5%
Yale	256,664	10	289,900	303,459	323,614	336,743	10	31.2%
Columbia	248,892	11	269,845	291,304	303,715	330,755	11	32.9%
Harvard	270,226	8	273,148	301,641	325,665	321,224	12	18.9%
Stanford	224,781	14	247,636	271,770	301,734	305,561	14	35.9%
University of Chicago	131,241	27	142,531	192,968	178,566	194,717	23	48.4%
Cornell	152,197	23	161,811	164,648	185,957	192,563	24	26.5%
MIT	79,513	53	87,413	94,152	181,897	172,184	30	116.5%
Northwestern	**111,299**	**37**	**131,260**	**153,778**	**157,346**	**168,377**	**32**	**51.3%**
University of Rochester	121,954	32	136,498	151,563	157,549	162,312	34	33.1%
Princeton	33,262	84	36,569	38,766	38,329	37,660	99	13.2%
Rice	5,488	174	6,300	6,181	7,753	10,088	163	83.8%
NIH Total Awards	**16,784,682**		**19,074,465**	**21,866,798**	**22,900,577**	**23,410,118**		**39.5%**

Source: National Institutes of Health, Office of Extramural Research, DSA Pub Files, http://grants.nih.gov/grants/award/awardtr.htm

Sponsored Research Expenditures

Research expenditures reveal another year of growth, although the rate of growth continues to slow. Total expenditures (direct plus indirect) increased by 3.7 percent over fiscal year 2006 to $362.9 million. The five-year moving average confirms that this rate of growth is slowing: from 43.4 percent between fiscal years 2001 and 2005, 34.9 percent between fiscal years 2002 and 2006, and now to 30.1 percent between fiscal years 2003 and 2007.

The Feinberg School continued to grow, reaching $191.6 million in total expenditures. This increase of 5.2 percent followed a significant increase of 8.4 percent between fiscal years 2005 and 2006.

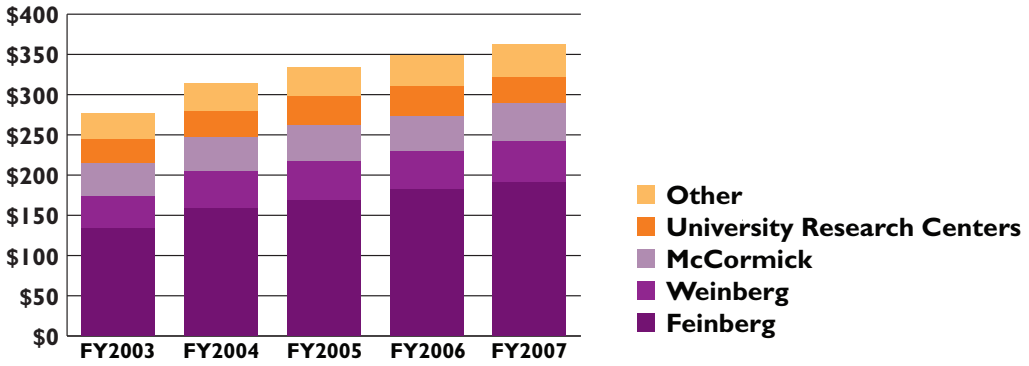
After a small decline between fiscal years 2005 and 2006, expenditures for McCormick and Weinberg increased in fiscal year 2007 when compared to either year. McCormick experienced a 6.9 percent increase in fiscal year 2007 to $46.6 million (up 2.8 percent over fiscal year 2005). Weinberg's expenditures totaled $51.4 million, an increase of 5.9 percent from fiscal year 2006 and an increase of 4.3 percent over fiscal year 2005. The School of Education, flat between fiscal years 2005 and 2006, grew total expenditures by 21.5 percent during fiscal year 2007 to $6.3 million.

Total expenditures in the University research centers declined 9.4 percent to $33.3 million, while those in the School of Communication declined 11.8 percent to $5.7 million. Taken over two years, however, total expenditures in the School of Communication are still up 8.9 percent over fiscal year 2005.

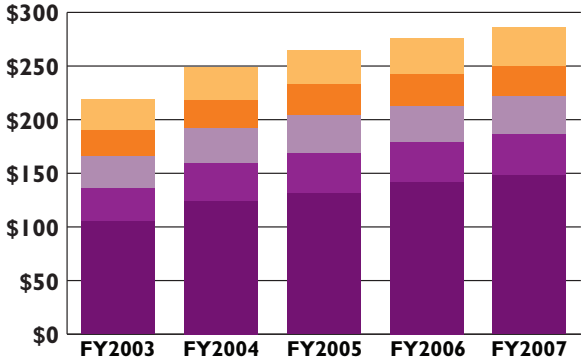
Indirect expenditures increased by 3.8 percent to $77.4 million in fiscal year 2007. Indirect expenditures in Feinberg increased by 8.3 percent. The gains in indirect cost recovery by McCormick and Weinberg were more than offset by decreases in other Evanston schools and units.

Expenditures by Unit (Dollars in Millions)

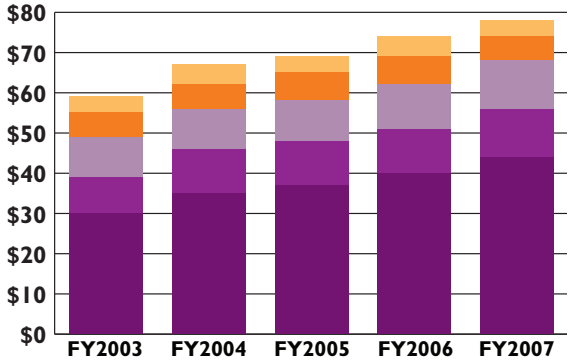
Total Expenditures



Direct Expenditures



Indirect Expenditures



Top Institutions in Total Research and Development Expenditures for Science and Engineering (Dollars in Thousands)

UNIVERSITY	2000	2000 RANK	2001	2002	2003	2004	2005	2005 RANK	% INCREASE 2000–2005
Johns Hopkins	901,156	1	999,246	1,140,235	1,244,132	1,375,014	1,443,792	1	60.2%
Stanford	457,822	8	482,906	538,474	603,227	671,046	714,897	7	56.2%
University of Pennsylvania	430,389	9	469,852	522,269	564,635	596,756	654,982	9	52.2%
Duke	356,625	19	375,133	441,533	520,191	520,871	630,752	10	76.9%
Cornell	410,393	13	443,828	496,123	554,760	575,554	606,804	13	47.9%
MIT	426,299	11	435,495	446,786	485,764	543,448	580,742	14	36.2%
Columbia	319,693	24	354,497	405,403	437,669	468,484	535,424	18	67.5%
Washington University	362,216	17	406,642	416,960	474,328	489,565	531,846	19	46.8%
Harvard	341,810	22	372,107	401,367	408,707	454,495	447,196	27	30.8%
Yale	296,706	28	321,514	354,243	387,644	422,828	431,618	30	45.5%
Northwestern	**245,774**	**36**	**257,933**	**282,154**	**319,722**	**358,947**	**387,242**	**33**	**57.6%**
University of Rochester	197,335	47	234,261	261,601	285,768	312,303	345,337	38	75.0%
University of Chicago	170,678	58	194,125	225,264	247,332	272,390	293,970	55	72.2%
Princeton	134,875	83	149,411	164,408	179,951	188,373	202,380	79	50.1%
Rice	41,840	143	42,675	48,169	52,367	60,872	63,102	149	50.8%

Source: www.nsf.gov/statistics/nsf07318

Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions (Dollars in Thousands)

UNIVERSITY	2001	2001 RANK	2002	2003	2004	2005	2005 RANK	% INCREASE 2001–2005
Johns Hopkins	992,324	1	1,136,498	1,137,366	1,271,778	1,233,948	1	24.3%
University of Pennsylvania	438,186	3	479,852	495,264	534,038	558,151	3	27.4%
Stanford	369,715	8	409,122	467,153	507,877	485,552	6	31.3%
Duke	288,888	19	355,278	412,069	415,102	459,165	9	58.9%
Columbia	348,388	10	372,920	412,694	406,085	447,169	10	28.4%
Harvard	352,230	9	356,534	384,891	424,737	441,259	11	25.3%
Washington University	331,560	12	381,484	419,014	407,282	428,109	13	29.1%
Yale	295,710	18	334,392	349,560	371,476	384,420	15	30.0%
Cornell	314,491	14	327,452	334,108	371,062	360,549	19	14.6%
MIT	282,091	21	291,012	291,879	354,073	359,771	20	27.5%
University of Rochester	181,153	32	203,199	228,985	249,468	261,637	27	44.4%
University of Chicago	173,911	36	177,002	208,139	223,489	246,241	31	41.6%
Northwestern	**175,962**	**35**	**187,112**	213,558	**231,640**	**230,477**	**34**	**31.0%**
Princeton	93,553	76	98,889	107,933	108,486	117,207	73	25.3%
Rice	37,131	N/A	38,854	51,472	50,740	45,855	N/A	23.5%

Source: www.nsf.gov/statistics/nsf07333/; October 19, 2007

December 2007

Organization Chart

Professional Staff

December 2007

Office for Research
Joseph (Jay) T. Walsh, Vice President for Research

Lewis J. Smith, Associate Vice President for Research

Frank J. DiSanto, Associate Vice President for Research Operations

Dawn Bradley, Assistant to the Associate Vice President for Research Operations

Center for Comparative Medicine
Philippe J. Baneux, Executive Director

Thomas J. Welsh, Special Assistant to Executive Director

Steven M. Knable, Director of Business Operations

Lisa A. Forman, Assistant Director and Clinical Veterinarian

Chad A. Roberts, Business Manager

Lot S. Bercasio, Business Administrator

Diana M. Berger, Clinical Veterinarian

Patricia M. Cahill, Clinical Veterinarian

Charlette M. Cain, Clinical Veterinarian

Mary Ann Carroll, Manager, Husbandry and Facilities

Jeremiah W. Dunlap, Assistant Manager, Quality and Training

Walter Dwight Johnson, Supervisor, Animal Care and Health

Susan Kaye Kallay, Program Administrator

Jennifer D. Kipp, Supervisor, Animal Care and Health

Katherine Denise Lancaster, Administrative Coordinator

Tyrone Land, Supervisor, Animal Care and Health

Stephen I. Levin, Clinical Veterinarian

Carolyn M. Malinowski, Manager, Quality and Training

Carolyn A. Pelham, Supervisor, Animal Care and Health

Giovanni Pompilio, Supervisor, Animal Care and Health

Matthew James Taylor, Assistant Manager, Quality and Training

Robert A. Williams, Manager, Husbandry and Facilities

Robert Charles Wortman, Supervisor, Animal Care and Health

Nicolette A. Zielinski-Mozny, Clinical Veterinarian

Homeland Security Innovation and Entrepreneurship Center
Breton L. Johnson, Director

Patricia M. Statwick, Assistant Director

Instrument Shop
Jeffrey L. Sundwell, Manager

Yongjia Qian, Cryogenics Engineer

Office for the Protection of Research Subjects
Institutional Animal Care and Use Committee (ACUC) and Institutional Review Board (IRB)
Don E. Workman, Executive Director

MaryAnn Domitila Jurgus, Director, ACUC

Debra Gibson Tice, Assistant Director, IRB Operations

Erica Renee Armstrong, Assistant Director, ACUC

Sandra C. Burbridge, IRB Project Coordinator

Laurence Butaud Rebbaa, IRB Training and Quality Assurance Manager

Mary Carolyn Cardona, IRB Project Coordinator

Deborah Yordy Coleman, IRB Project Coordinator

Keren P. Dimah, Senior IRB Coordinator

Andrew C. Ellis, IRB Manager

Kurt P. Gillon, ACUC Coordinator

Piper Hawkins-Green, IRB Project Coordinator

Debbie Jean Haywood, ACUC Coordinator

Michael Sean Kelley, eIRB System Specialist

Heidi D. Levin, ACUC Coordinator

Lisa M. Linn, Senior IRB Coordinator

Tasha Kim Osafo, Senior IRB Coordinator

Mitch Saulisbury-Robertson, Senior IRB Coordinator

Lucas T. Sikorski, IRB Project Coordinator

Braden VanBuskirk, IRB Project Coordinator

Eileen M. Yates, Senior IRB Coordinator

Office for Research Development
Holly J. Falk-Krzesinski, Director

Dean Grosshandler, Associate Director

Latonia Trimuel, Administrative Coordinator

Office for Research Information Systems
Daniel E. Volocyk, Director

Steve D. Acuna, Senior User Support Systems Specialist

Brenda L. Bryant, Senior Systems Analyst/Program Project Manager

Kimberley I. Heuer, Senior Systems Analyst/Programmer

Janet E. MacDermid, Systems Analyst/Programmer

Professional Staff, continued on next page >

Tera Moskal, Senior Systems Analyst/Program Project Manager

Steven F. Moyano, Senior Systems Analyst/Program Project Manager

Avram J. Neurohr, Senior Systems Analyst/ Programmer

John D. Serafin, Web Administrator

Lawrence Jonathan Sklar, System Manager

Loc Q. Truong, Senior Systems Analyst/Programmer

Office for Research Integrity

Timothy J. Fournier, Associate Vice President

Lauran Andrea Qualkenbush, Associate Director

Jean Marie Carroll, Research Compliance Coordinator

Julia M. Janowick, Senior Compliance Analyst

Office for Research Planning, Finance, and Communication

Meg A. McDonald, Executive Director

Joan T. Naper, Director, Research Communications

Mary C. Tobin, Director, Administration and Resource Planning

William C. Higgins, Assistant Director, Finance and Administration

Barbara R. Beeuwsaert, Business Manager

Kathleen P. Mandell, Senior Editor

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L. Todd Leasia, Executive Director

George B. Morton, Assistant Director, Research Safety

Bruce Jerome Sanza, Assistant Director, Radiation Safety

Reginald K. Blythe, Laboratory Safety Specialist

Promise Christine Ceasar, Health and Safety Specialist

Sage Devereaux, Laboratory Safety Specialist

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Left: Two-photon laser scanning microscope image of a living striatal medium spiny neuron in the brain of a mouse. Memories are thought to be stored in the shape and function of spines. Figure from the laboratory of D. James Surmeier, Feinberg School of Medicine. See page 35.

Center: Determination of genotype for a single genetic variant in 1,800 mothers and their offspring. Figure from William L. Lowe, Jr., Feinberg School of Medicine.
See page 27.

Right: Looking up through the trees. Mary Zimmerman, School of Communication travelled in Scotland and used such images as inspiration for set designs for Donizetti's opera *Lucia di Lammermoor.* Photo by Daniel Ostling, School of Communication.
See page 42.