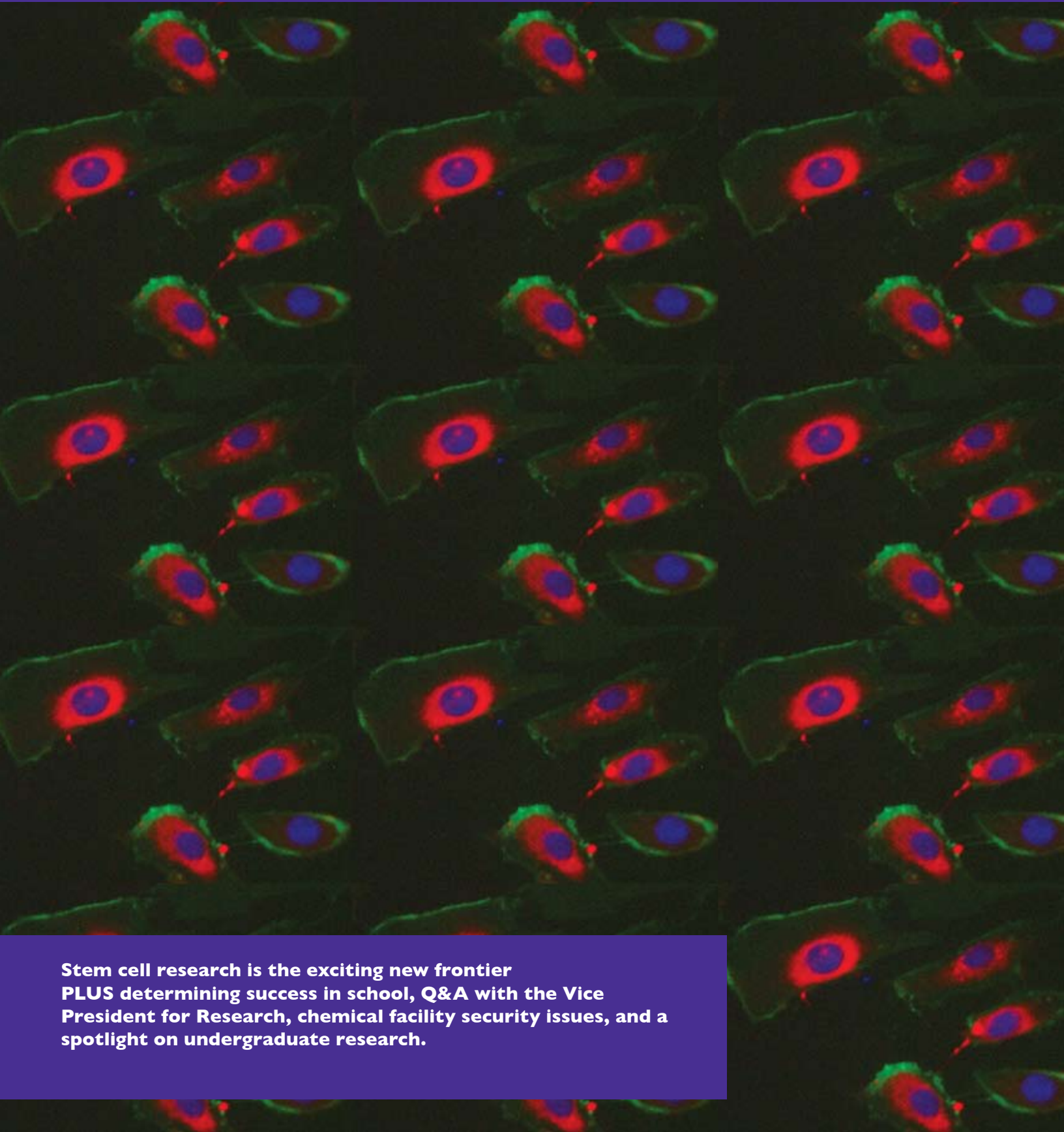


CenterPiece

Research Scholarship, Collaboration, and Outreach at Northwestern University

SPRING 2008



**Stem cell research is the exciting new frontier
PLUS determining success in school, Q&A with the Vice
President for Research, chemical facility security issues, and a
spotlight on undergraduate research.**

Office for Research News Briefs

CenterPiece Live

Northwestern's Office for Research is hosting the second annual **CenterPiece Live** on May 23, between 9 a.m. and 12:15 p.m. at the McCormick Tribune Forum, 1870 Campus Drive. Six center directors will present overviews of the innovative research being conducted at their centers. This event celebrates multidisciplinary research at Northwestern and provides opportunities for making new connections among investigators, students, and disciplines. All faculty, postdocs, research staff, graduate students, and other interested individuals are invited to attend the sessions. Lunch will be served. For more information and a schedule, see www.northwestern.edu/research/.

New Institute of Sustainable Practices

Northwestern signed a letter of understanding with Argonne National Laboratory to create the Institute of Sustainable Practices, dealing with core issues of the energy problem. **Kimberly Gray**, civil and environmental engineering, represents Northwestern in the partnership. The institute will facilitate joint research and educational initiatives to achieve sustainability in human and ecological systems. The institute's scope encompasses energy and other natural resources, and its work will include development of tools for assessing and monitoring sustainability. For more information, contact Kimberly Gray at k-gray@northwestern.edu.

Tobin Marks Leads NU Response to Dow Methane Challenge

Northwestern has received a research grant of \$3.35 million over three years from the Dow Chemical Company as part of the 2007 Dow Methane Challenge. The challenge was initiated by Dow in March 2007 to identify collaborators and approaches in the area of conversion of methane to chemicals. Methane is the major component of natural gas.

Approximately 100 proposals from top universities, institutes, and companies around the world were received in response to the challenge. Ten finalists were asked to submit detailed, confidential proposals. From those, judges selected the teams led by Northwestern and Cardiff University in Wales to receive the challenge grants. Northwestern's team is led by **Tobin J. Marks**, chemistry and materials science. The team includes five Northwestern colleagues, two scientists from Argonne National Laboratory, and a collaborator from the University of Virginia.

Justine Cassell Wins Women of Vision Award

Justine Cassell, communication studies and electrical engineering and computer science and director of the Center for Technology and Society, has been named the winner of the 2008 Women of Vision Award for Leadership from the Anita Borg Institute for Women and Technology.

Cassell is being recognized in the field of computer science for her development of the Embodied Conversational Agent, a virtual human with the capacity to interact with people using both language and nonverbal behavior. Cassell will receive the award in early May. The Anita Borg Institute provides resources and

programs for industry, academia, and government to help them recruit, retain, and develop women leaders in high-tech fields resulting in higher levels of technology innovation.

Northwestern Hosts American Theoretical Chemistry Conference

The American Theoretical Chemistry Conference will be held July 19–24, 2008, on Northwestern's Evanston campus. The conference is held every three years and is widely attended by theoretical chemists from both the United States and abroad. This year the conference will include speakers from related disciplines whose work is of considerable importance to theoretical chemistry, thus further encouraging cross-fertilization. Among the topics to be covered are dynamics, statistical mechanics, biochemistry, materials, nano/info, charge and energy transfer, and electronic structure. For more information, see www.actc.chem.northwestern.edu.

Science to the People, Right Now

Science in Society is a new web site that showcases how the research taking place at Northwestern and around the world will affect individuals and their communities. The site features articles, news, and resources for seminars and other events at the University that engage the public in matters related to the sciences.



It was created to facilitate the exploration of science with reliable and thought-provoking information, directly from Northwestern faculty and researchers and their colleagues. Learn more at www.scienceinsociety.northwestern.edu. Science in Society is sponsored by the Office for Research and the Center for Genetice Medicine.

Research Administration Comings and Goings

Frank J. DiSanto, associate vice president for research operations, left Northwestern to accept a position at Rensselaer Polytechnic Institute in upstate New York. A search committee has been appointed to fill his position. **Don E. Workman**, the current executive director of the Office for the Protection of Research Subjects, will serve as interim AVP-RO.

Timothy J. Fournier, associate vice president for research integrity and director of the Office for Research Integrity, will take on the position of chief operating officer and senior associate dean for finance and administration at Northwestern University in Qatar beginning in May.

Replacing Fournier is **Ann K. Adams**. Adams had been serving as an associate general counsel at The George Washington University in Washington D.C. Adams was an associate general counsel in Northwestern's Office of General Counsel from 1998 to 2003, where she had a diverse portfolio of responsibilities, including research, technology transfer and other intellectual property matters.

CenterPiece, a magazine about research scholarship, collaboration, and outreach at Northwestern University is published twice a year by the Office for Research. The Office for Research promotes, facilitates, and enhances research at Northwestern University.

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

Office for Research Planning, Finance, and Communication

Meg A. McDonald, Executive Director

Joan T. Naper, Director of Research Communications

Kathleen P. Mandell, Senior Editor

Editors

Joan T. Naper, Kathleen P. Mandell

Tom Fredrickson, University Relations

Contributing Writer

Patricia McVary

Design, Art Direction & Production

Kathleen P. Mandell

Cover **Human blood may be a viable source of cells for regenerative medicine.** Stem cells have the potential to develop into more than one type of specialized cell. Stem cells are the parents of progenitor cells, and progenitor cells are the parents of specialized cells. In this study, progenitor cells isolated from the blood of healthy, adult volunteers were coaxed into forming specialized (endothelial) cells that may be harnessed for the development of blood vessel replacements for blocked or damaged arteries. In this image, the red, green, and purple stains were used to confirm the identity of the endothelial cells. Image courtesy of Karen A. Lapidos, senior research associate in the laboratory of Guillermo A. Amezcua, biomedical engineering.

Address all correspondence to:

Joan T. Naper

Director of Research Communications

Northwestern University

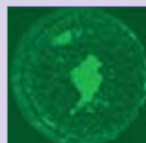
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Evanston, Illinois 60208

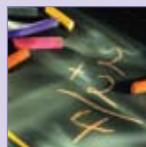
This publication is available online at: www.research.northwestern.edu/research/publications/centerpiece.

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Stem Cell Research at
Northwestern**



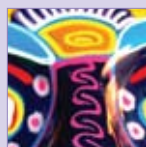
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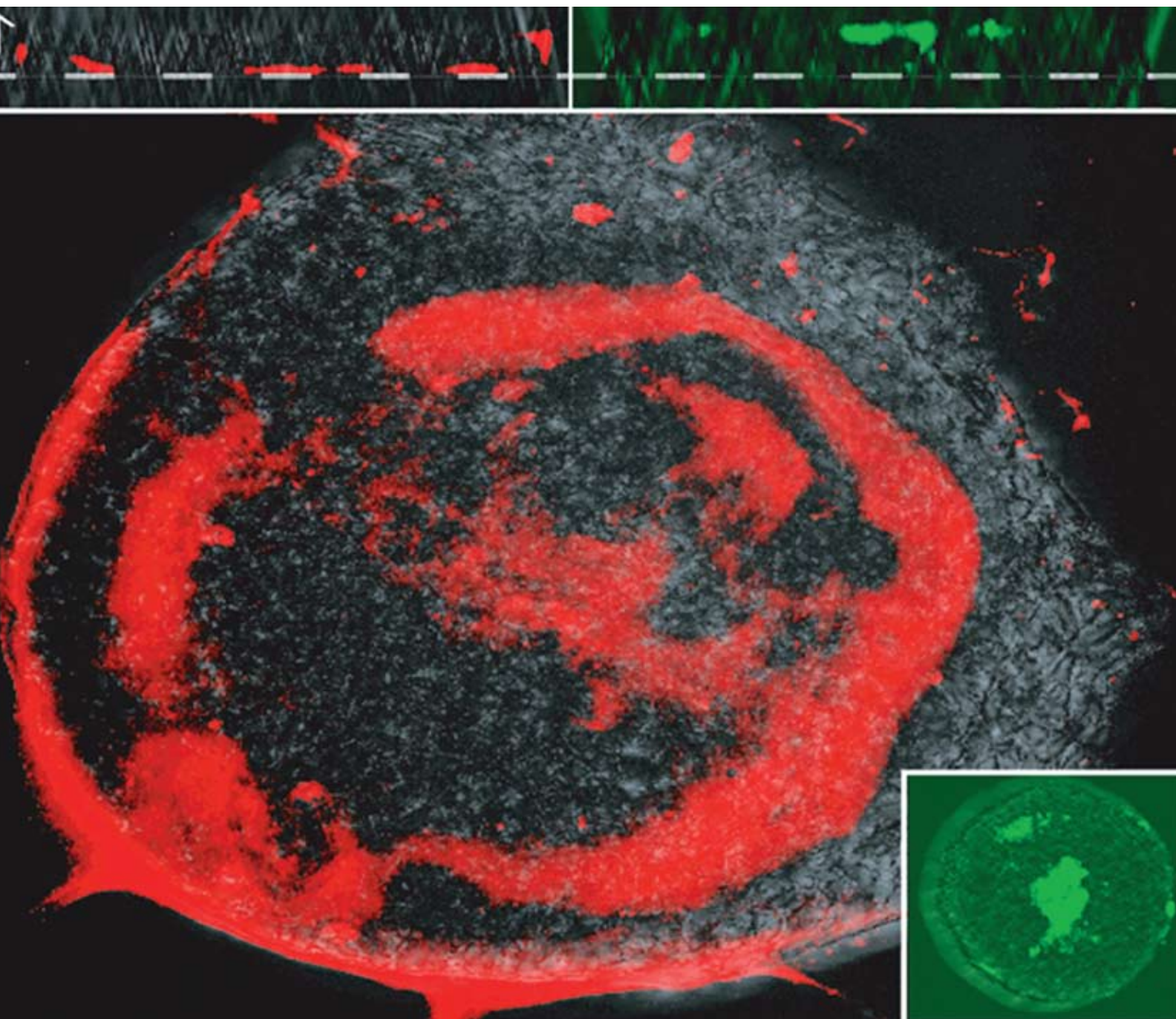
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Aggressive cancer cells have been shown to express a potent embryonic molecule called Nodal that is essential for human embryonic stem cells to retain their stem cell nature. This work tested whether the environment of human embryonic stem cells could act to regulate the Nodal molecule produced by the aggressive cancer cells and result in a suppression of their tumorigenic nature. It was discovered that the human embryonic stem cells make a molecule called Lefty that regulates Nodal. This molecule is secreted into the human embryonic stem cell environment and can inhibit the Nodal produced by cancer cells, resulting in a suppression of the tumorigenic characteristics of the cancer cells. The image shows fluorescently labeled proteins Lefty (red) and Nodal (green) in human embryonic stem cells growing on a mixture of solidified proteins called a matrix, forming a supportive environment for the stem cells. The top images show a cross section of human embryonic stem cells and matrix. The protein Lefty can be found secreted around the human embryonic stem cell cells and in the matrix. Nodal, on the other hand, is found only on the outside surface of the growing human embryonic stem cells. The large image is a projection through the human embryonic stem cells and matrix and shows that Lefty is distributed throughout the matrix environment of the human embryonic stem cells while the inset shows Nodal occurs only on the outside surface of the human embryonic stem cells. From: Human embryonic stem cell microenvironment suppresses the tumorigenic phenotype of aggressive cancer cells. Postovit, L.-M., Margaryan, N.V., Seftor, E.A., Kirschmann, D.A., Lipavsky, A., Wheaton, W.W., Abbott, D.E., Seftor, R.E.B. and Hendrix, M.J.C., *Proc. Natl. Acad. Sci., USA* 105: 4329-4334, 2008.

EXPLORING A NEW FRONTIER:

STEM CELL RESEARCH AT NORTHWESTERN

MENTION STEM CELL RESEARCH AND MOST PEOPLE WILL HAVE A STRONG REACTION. SOME OPPOSE IT. MANY DO NOT UNDERSTAND IT. OTHERS SEE IT AS AN AMAZING SOURCE OF REVOLUTIONARY MEDICAL ADVANCEMENT.

Many research scientists and teachers at Northwestern fall into the third group. They have seen the potential of stem cells in treating diseases and conditions such as Parkinson's, juvenile diabetes, spinal cord injuries, and cancer.

Stem cells are undifferentiated cells that can both renew or replicate themselves and differentiate into other specialized cells. In other words, stem cells can divide indefinitely to provide as much tissue as needed for therapy, and they can be coaxed to develop into virtually any type of body cell.

The science of stem cell technology is fairly new. In 1998 a team of scientists from the University of Wisconsin-Madison was the first to isolate stem cells and keep them alive in the laboratory. Last year two American scientists—Mario R. Capecchi of the University of Utah and Oliver Smithies of the University of North Carolina—and Welsh scientist Sir Martin J. Evans from Cardiff University won the Nobel Prize in Physiology or Medicine for their “discoveries of principles for introducing specific gene modifications in mice by the use of embryonic stem cells.”

ORIGINS AND TYPES OF STEM CELLS

What has pulled this scientific discovery into the headlines so that nearly every American has an opinion about stem cells is their source: human embryos. Embryonic stem cells are derived from a very early stage in human development. These cells are pluripotent, meaning that they have the potential to produce all of the body's cell types. There also are other types of stem cells: adult stem cells are found in certain tissues in humans and appear to be limited to producing certain types of specialized cells. Recently, scientists also have identified stem cells in umbilical cord blood and the placenta that can give rise to the various types of blood cells. »

Embryonic stem cells can be derived in two different ways. One is that, with a donor's consent, they can be transplanted from frozen embryos stored at *in vitro* fertility clinics because they are in excess of a recipient's clinical need. When they are no longer needed for uterine transplantations, they are typically discarded.

The second way of deriving embryonic stem cells is through somatic cell nuclear transfer. This involves removing the nucleus of a donor's unfertilized egg and replacing it with the nucleus of an adult cell. No sperm is used in this procedure and, thus, there is no fertilization. Embryonic stem cells that have proliferated in cell cultures for six or more months without differentiating are pluripotent. These proliferated cells, if they appear genetically normal, are referred to as an embryonic stem cell line.

POLITICS AND MORAL AND ETHICAL ISSUES

The furor arising from the creation of embryonic stem cell lines comes from those who find moral or ethical issues with the cells' origins and the process and means by which they are derived, explains Laurie Zoloth, bioethics and medical humanities and religion, and director of Northwestern's Center for Bioethics, Science and Society.



Laurie Zoloth

were destroyed before August 9, 2001—the day he announced his policy. He claimed there were “more than 60 genetically diverse stem cell lines,” enough “to explore the promise and potential



Phillip V. Spina III

Mary J.C. Hendrix

of stem cell research.” Since his ruling, researchers have discovered that all of the stem cell lines derived before August 9, 2001 are contaminated with animal molecules from the culture medium used to sustain them.

Although public opinion now stands at more than 60 percent in favor of greater federal support for this research, the president has twice vetoed the Stem Cell Research Enhancement Act. According to Northwestern scientists who have testified in support of the act, limiting stem cell research has only delayed advances in this science. Therefore, several states have considered legislation or funding mechanisms to support this research and to attract and retain stem cell researchers.

The Illinois legislature passed the Illinois Regenerative Medicine Act in August 2007, permitting the Illinois Regenerative Medicine Institute (IRMI) to conduct stem cell research on cells from any source. In 2006 three Northwestern scientists received IRMI stem cell grants totaling almost \$3.5 million: Guillermo Ameer, biomedical engineering; Mary J.C. Hendrix, president and scientific director of the Children's Memorial Research Center and professor in The Robert H. Lurie Comprehensive Cancer Center of Northwestern University and at the Feinberg School of Medicine; and Xiaozhong A. Wang, biochemistry, molecular biology and cell biology. These researchers and others at Northwestern currently are doing pioneering work on stem cells.

CONTROLLING MALIGNANT TUMOR CELLS

With support from IRMI and the National Cancer Institute, Hendrix and her colleagues have discovered that a protein governing the development of human embryonic stem cells also inhibits the growth and spread of malignant melanoma, the deadliest skin cancer. The protein, called Lefty, suppresses aggressive breast cancer cells as well. Lefty is secreted predominately by human embryonic stem cells and not by stem cells isolated from amniotic fluid, umbilical cord blood, adult bone marrow and placental cells.

This groundbreaking work by Hendrix and her colleagues is illuminating how aggressive melanoma cells, by becoming more like unspecialized stem cells, gain enhanced abilities to migrate, invade, and metastasize while remaining virtually undetected by the immune system.

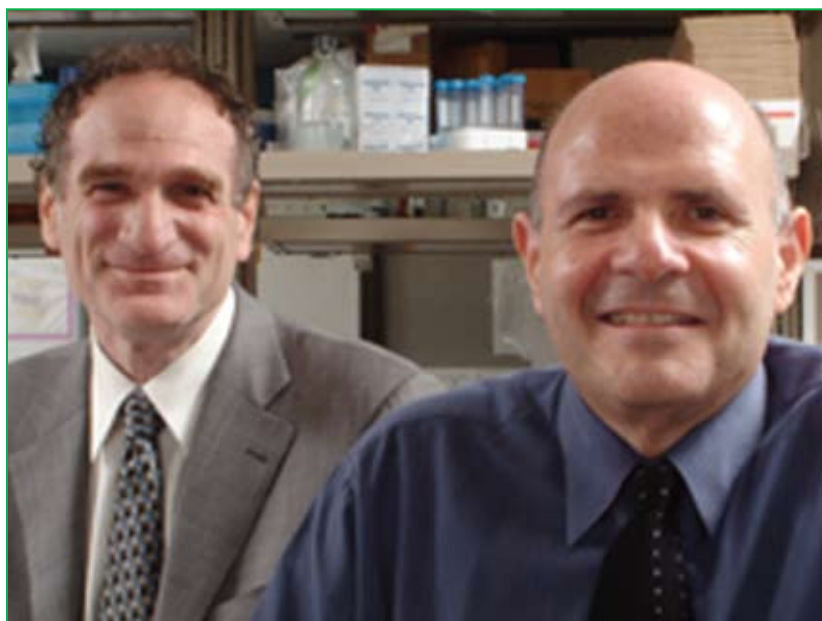
Results of the study are described in an article in the March 3 online version of the *Proceedings of the National Academy of Sciences*.

REPAIRING DAMAGED SPINAL CORDS

In 2005 Northwestern University was named a Center of Excellence in Translational Human Stem Cell Research by the National Institutes of Health, one of two institutions to receive the prestigious NIH Center of Excellence grant. The principal investigator at Northwestern is John A. Kessler, neurology, at the Feinberg School of Medicine.

Kessler directs research on the factors that influence the differentiation of human embryonic stem cells and works on combining unique biomaterials and human embryonic stem cells as a possible means to repair damaged spinal cords. Kessler is working with Samuel Stupp, materials science and engineering, chemistry and medicine, and director of the Institute for Bionanotechnology in Medicine, and his research group on regenerating the spinal cord. The nature of this research requires the marriage of medicine with technology, which is why Kessler and Stupp make such a powerful team.

By injecting molecules that were designed to self-assemble into nanostructures in spinal tissue, they have been able to rescue and regrow rapidly damaged neurons. The nanofibers—thousands of times thinner than a human hair—are the key to not only preventing the formation of harmful scar tissue that inhibits spinal cord healing, but also to stimulating the body into regenerating lost



John Kessler and Sam Stupp

David Joel

or damaged cells. Similar to earlier experiments that promoted bone growth, the Kessler-Stupp researchers now have successfully grown nerve cells using an artificial three-dimensional network of nanofibers, an important technique in regenerative medicine.

DEVELOPING REPLACEMENT BLOOD VESSELS

The funding given Guillermo Ameer, biomedical engineering, helps support studies of stem cell-based vascular tissue engineering to develop replacement blood vessels. Ameer and his collaborators believe their research may eventually eliminate the need to harvest existing blood vessels from patients with vascular disease in order to improve the performance of vascular grafts. »

For the *in vivo* approach to tissue or organ replacement, Ameer and his research team develop scaffolds and techniques conducive to the reconstitution or maintenance of normal tissue microarchitecture. Disruption of normal tissue microarchitecture can lead to scarring or degeneration resulting in loss of or impaired function. Thus, they are working with and studying novel biomaterials and processing techniques to produce scaffolds suitable for tissue engineering. In particular they are interested in understanding the effects of scaffold characteristics on cellular and tissue development in order to prevent deleterious processes.

USING BONE MARROW CELLS TO TREAT AUTOIMMUNE CONDITIONS

In the Feinberg division of immunotherapy for autoimmune diseases, division chief Richard K. Burt, medicine, leads a multidisciplinary clinic- and laboratory-based program developing ways to use bone marrow stem cells and immune cells to treat conditions such as lupus, multiple sclerosis, rheumatoid arthritis, Crohn's disease, systemic sclerosis, myasthenia gravis, chronic inflammatory demyelinating polyneuropathy, and autoimmune blindness.

Researchers in this program have used adult stem cell injections to repair the immune systems of patients with early-onset Type I diabetes. After the therapy, patients did not require insulin for up to 35 months.

Also in the study, patients with Type I diabetes were treated with a high dose of immune suppression drugs followed by an intravenous injection of their own blood stem cells, which had previously been removed and treated. Burt said this is the first time, to his knowledge, that patients with Type I diabetes have been treated with their own stem cells.

"I think this treatment helped the body regenerate its immune system," said Burt, senior author of the study that was published in the *Journal of the American Medical Association*. In addition, Burt and William H. Pearce, vascular surgery, performed the first stem cell injections



Jim Ziv

Douglas W. Losordo

into the legs of patients with peripheral vascular disease in the United States and will soon be developing a trial to use umbilical cord blood stem cells for peripheral vascular disease.

USING A PATIENT'S OWN ADULT STEM CELLS FOR TREATING BLOCKED ARTERIES

Douglas W. Losordo, director of Feinberg's Cardiovascular Research Institute and director of cardiovascular regenerative medicine at Northwestern Memorial Hospital, is an interventional cardiologist with an established basic science laboratory studying endothelial cell and stem cell biology, angiogenesis, and tissue repair and regeneration. He has launched the first U.S. trial in which a purified form of a subject's own adult stem cells is transplanted into leg muscles with severely blocked arteries to try to grow new small blood vessels and restore circulation. The first two subjects in the 20-site national trial recently underwent the stem cell transplant process at Northwestern Memorial Hospital.

The Northwestern-led Phase I/IIa study includes 75 people from around the country and targets patients who have exhausted all other medical options—including angioplasty, stents, and bypass surgery—to repair blocked circulation in their legs.

“They’re at the end of the therapeutic road and they’re ultimately facing potential amputation,” said Losordo, principal national investigator for the study. “This is hopefully a way to help them avoid that.

“The stem cells themselves can assemble into blood vessels,” Losordo said. “They can also secrete growth factors that stimulate and recruit other stem cells to come into the tissue and help with the repair. It’s an amazing biology we’re trying to leverage in these folks.”

“Northwestern Memorial Hospital has a major clinical program in bone marrow stem cell transplantation,” adds Kessler. “People sometimes forget that bone marrow transplantation is a stem cell therapy that has been used for more than 20 years.” Children’s Memorial Hospital also has an active program in pediatric bone marrow transplantation.

LOOKING INTO HOW STEM CELLS WORK

Xiaozhong (Alec) Wang, biochemistry, molecular biology, and cell biology, received funding from the IRMI to investigate genetic control of pluripotency and differentiation in stem cells to control self-renewal and multipotency. Multipotent stem cells can give rise to several other cell types, but those types are limited in number, says Wang. An example of a multipotent stem cell is a hematopoietic, or blood, stem cell that can develop into several types of blood cells but cannot develop into brain cells or other types of cells. At the end of the long series of cell divisions that form the embryo are cells that are terminally differentiated, or considered to be permanently committed to a specific function.

STEM CELL SCIENCE OUTREACH

Ameer, Burt, Hendrix, Kessler, Losordo, Stupp, Wang, and Zoloth are but a few of the many

Northwestern research scientists who study stem cells, their origins and applications. Kessler, Losordo and Zoloth were among the speakers who represented the University at a conference held at Northwestern on February 22, the first of several planned nationwide by the Biotechnology Institute and National Academies. More than 100 people—including local high school and junior college educators—gathered to explore the minefields of teaching stem cell technology and other controversial sciences. The effort was sponsored at Northwestern by the Biotechnology Center at the Kellogg School of Management, the Office of STEM Education Partnerships, and the Office for Research Development along with the Chicago Council on Science and Technology and other regional university, industry and state partners. ▶

STEM CELL RESEARCH ONLINE

Guillermo Ameer, McCormick School of Engineering and Applied Science

www.ameerlab.northwestern.edu/research.html

Richard K. Burt, Feinberg School of Medicine

www.medicine.northwestern.edu/divisions/immunotherapy_autoimmune/

Mary J.C. Hendrix, Children’s Memorial Research Center

www.childrensmrc.org/cancer_genetics/

John A. Kessler, Feinberg School of Medicine

www.feinberg.northwestern.edu/igp/facindex/KesslerJ.html

Douglas W. Losordo, Feinberg School of Medicine

www.fcvri.northwestern.edu/index.html

Samuel I. Stupp, McCormick School of Engineering and Applied Science, Weinberg College of Arts and Sciences

www.nucats.northwestern.edu/iprofiles/stupp.html

Xiaozhong (Alec) Wang, Weinberg College

www.biochem.northwestern.edu/ibis/faculty/wang_x.htm

Laurie Zoloth, Feinberg School of Medicine

www.bioethics.northwestern.edu/faculty/zoloth.html

Chicagoland Stem Cell Education Symposium

www.regonline.com/stemcell

Early Math + Reading Skills = Success in School



Achieving Success Through Education and Employment: Greg Duncan

The debate continues. Which skills or behaviors present by the end of a child's preschool years will predict later academic success? There are those who maintain that socioemotional skills are crucial for later success in school, while others argue that concrete academic skills have a greater impact. Greg J. Duncan, education and social policy and a faculty fellow at the Institute for Policy Research, and his colleagues addressed just that in their study "School Readiness and Later Achievement," published in November in *Developmental Psychology*. They conclude that early math skills, followed by reading, are the strongest predictors of later achievement.



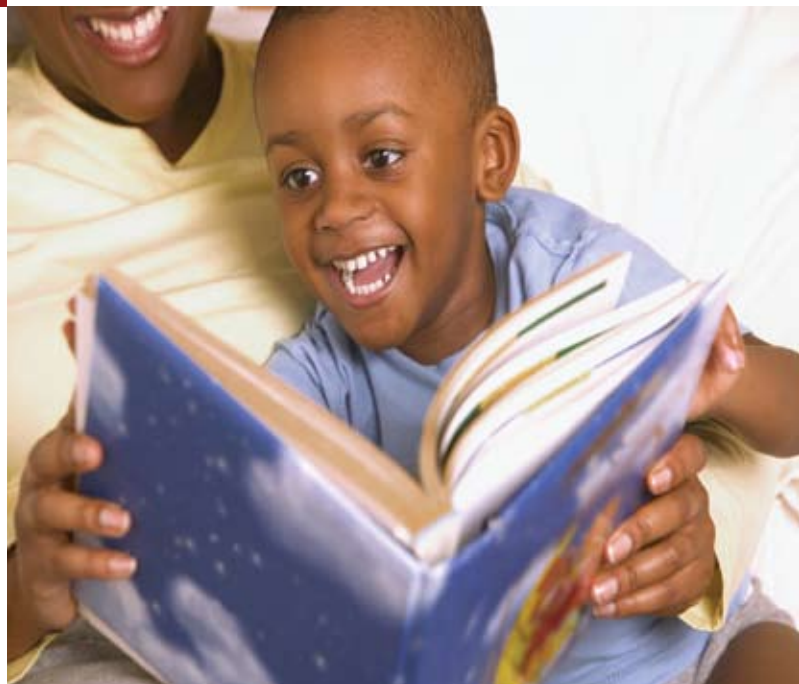
that reviewed the science of early childhood development and wrote the book *From Neurons to Neighborhoods*," he says. "In that book we concluded that socioemotional factors were every bit as important as cognitive factors for a child's school readiness. I wasn't convinced by the available evidence and hoped that I would have a chance to test it out. I got that chance to work with my coauthors in 2005." And so they set out to find what leads children to higher achievement. Their findings, in turn, would help educators in promoting those skills needed to enhance later success.

With funding from the Center for the Analysis of Pathways from Childhood to Adulthood at the University of Michigan, Duncan and his colleagues worked to relate early academic, attention,

Exploring the Sources of Higher Achievement

Some experts feel that early academic skills and socioemotional behaviors are interdependent in predicting later success. A child who possesses emotional self-regulation—or the ability to control emotional reactions such as anger or frustration—and is able to stay on task may be able to take advantage of learning opportunities. Likewise, a child who enters school with basic academic skills may be best able to master the primary school curricula.

Duncan was not so sure. "I served on a National Academy of Sciences committee



and socioemotional skills and behaviors to later achievement. Intended to be a developmental study, this meta-analysis utilized previous school-readiness studies. The researchers used six longitudinal studies, with the data sets taken from various sites. Two studies were nationally representative of U.S. children: the Early Childhood Longitudinal Study – Kindergarten Cohort, and the National Longitudinal Survey of Youth – Child Study. Two were multisite studies of U.S. children: the NICHD study of Early Child Care and Youth Development, and the Infant

Health and Development Program. One study was French-Canadian, the Montreal Longitudinal-Experimental Preschool Study, and one study was British, the 1970 British Birth Cohort Study. The data analyzed drew from nearly 36,000 children, and followed their progress at the preschool level and then again in middle school.

The authors measured the achievement outcomes by using teachers' reports, test scores, and grade retention. They measured attention and socioemotional outcomes through mothers' reports, teachers' reports, and observations. They understood that there are other determinants that can affect a child's ability to learn. As the six longitudinal studies included these variables, they were able to take measurements of race,

economic status, family life and parenting, among others, to be included as controls.

Duncan summarizes the findings in this way: "On average many factors contribute to later development. But we found that early math skills earned the highest 'score,' let's say a 30. Reading, then, was 20 and attention 10. But antisocial behavior, moodiness, sociability were very low—practically

zero." Interestingly, early math skills do not predict just future math skills. The investigators found that "early math skills affected reading as well as math at a later time."

Adding Fun to Childhood Skills

This is not to say that Duncan is an advocate of the all work and no play school of thought. He feels that play-based exercises can foster academic and



attention skills in a fun and engaging manner. The study gives as an example the Big Math for Little Kids program in which children's natural interest in exploring and manipulating numbers is used to enhance math skills. It is also important to note that even as academic skills upon entering school predict later success, the potential for productive interventions during the early school years remains.

Response to the study has been varied. "A group of cognitive psychologists, focused on early cognition in math and reading, were not surprised by my findings. But socioemotional psychologists, focused on behavioral aspects, were surprised," Duncan says. "We tried to poke holes in all the sets that we tested, but we had evidence against the criticism. Nothing seemed to change the findings."

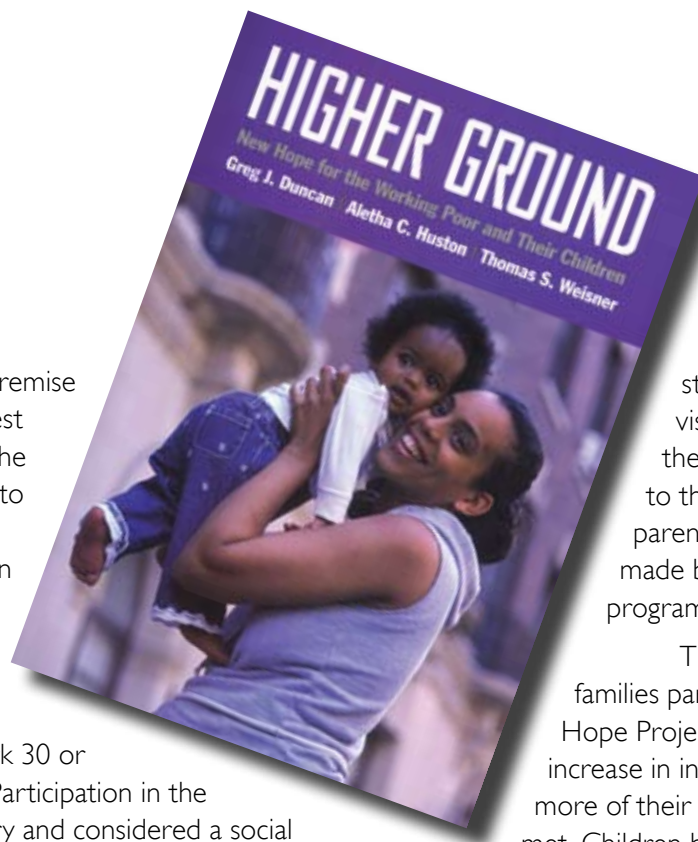
"But," he continues. "As more data become available, I hope that researchers can replicate or extend what we have done. I would hope that some researchers would test this study and try to poke holes in it, too."

Working One's Way out of Poverty

Duncan also is working on another project that could eventually serve as a model program to improve child and family outcomes. The New Hope Project is a three-year experimental



Greg Duncan



program testing the premise that work is the best way out of poverty. The goal of the study was to provide a model for a national policy that can best help working families. This was not a welfare program. The participants were required to work 30 or more hours a week. Participation in the program was voluntary and considered a social contract. Any adult with low family income living in Milwaukee's poorest neighborhood was eligible to enter. In turn New Hope supplemented the participants' income in order to raise them above the poverty level. New Hope also subsidized childcare and health insurance for the families.

Duncan describes the project as combining "rigorous random assignment with a detailed ethnography." Participants were chosen by random assignment. Half of the group (678) had access to the benefits. The other half (679) were a comparison group and, therefore, ineligible for the project. According to the study, the researchers were interested in whether people assigned to New Hope "earned more, worked more, improved their well-being and parenting, and saw their children benefit more than people assigned to the comparison group."

All participants filled out a survey when they applied to the program and then again two years later. A subgroup of 745 families who had young children were asked to complete a survey two and five years after the program ended. In addition, 44 families with young children (chosen at random, half from the program and half from the control group) agreed to participate in an ethnographic

study. Field workers made visits to the families, asking them questions pertaining to their life, work, and parenting. These visits were made both during and after the program.

The results showed that families participating in the New Hope Project experienced an increase in income and childcare and more of their medical needs were met. Children benefited greatly by this program. "We found that the children in the New Hope group, particularly boys, performed better in school and had fewer behavioral problems," Duncan says. In some cases, positive effects of the program were apparent several years after the study ended.

Duncan is co-author with Aletha Huston (University of Texas) and Tom Weisner (UCLA), of a recently published book on the program, *Higher Ground: New Hope for the Working Poor and Their Children* (Russell Sage Foundation, 2007). "I'm an economist so I tend to think in terms of graphs and tables. As that can be difficult to read, we decided to tell the story of New Hope through the stories of its participants," Duncan explains.

Duncan and his associates are currently working on an eight-year follow-up to the study. "We hope to get a five-state demonstration of the project. Ideally, the federal government will conduct a competition among the states and select the five with the best proposals for trying out New Hope," Duncan says. "This is the way that social policy ought to proceed." ■

—By Patricia McVary



CenterPiece

Q&A

VICE PRESIDENT FOR RESEARCH JAY WALSH

Joseph (Jay) Walsh began his service as the University's Vice President for Research on December 1, 2007. Walsh formerly served as senior associate dean of McCormick School of Engineering and Applied Science, where he is a professor of biomedical engineering. Walsh interrupted his busy schedule in early March to sit down for this interview with *CenterPiece*.

➤ How does your background as a researcher and faculty member influence the way you envision the future of Northwestern's Office for Research?

A great university adds value to society. It adds value in two ways. One is that we educate students—undergraduates, graduate students, and I would expand that to include postdocs. The other is the discovery and invention of knowledge via our research mission. Thus, a great university recognizes areas of societal need and produces graduates and research results to address those needs.

One could make a list of societal needs. In some areas, such as the biomedical sciences, the needs are broad and expansive, and in other areas the needs are more focused. The real question we should be asking ourselves is, "As a university—and thus as individual faculty members—what importance does our work have to society?" When writing proposals, faculty members must explicitly address that issue. If you don't address that issue, you don't get funded. And certainly a lot more people are interested in your work if you're addressing an issue of great societal importance. This view of the university to impact society drives me to consider the directions that Northwestern should be taking.

➤ How do you intend to use the funds recently received from the sale of Northwestern's royalty interest in the Lyrica drug?

This University is in a fortunate place with the infusion of Lyrica funds. A reasonable fraction of the funds is coming into the Office for Research. The President and the Provost have made it clear that the goal is to use the funds to provide an environment that is world class. That means we will bring in world-class faculty—so some of these funds will be used for start-up packages for new faculty. And we will have world-class facilities to provide faculty, students, and research staff with unparalleled opportunities.

➤ What, in your mind, are the challenges of interdisciplinarity? And the rewards?

There are challenges at three levels. One is to have a culture of interdisciplinarity. I don't think anyone here invented that culture, but all of us at Northwestern are lucky to be living in an environment where this culture exists. The next level of challenge is to develop structures—centers, institutes, research groups, and so on—within the University that promote interdisciplinarity. Such structures must exist across the University as a whole, within the schools, and indeed within individual departments. Structures form a part of the culture that leads to even more interdisciplinary activities. And lest we think too narrowly, these structures include, for example, teaching courses across departments, schools, and our two campuses. The challenge in both teaching and research is to break out of the usual boundaries that one typically grew up in and cross those boundaries to work with or actively recruit collaborators from other areas.

Which leads to the third challenge, the most local challenge, which is on the individual level.

Doing interdisciplinary work means learning the language, motivation, and culture of another discipline. What is valued in one discipline is not always valued in another. It is a challenge to adapt. And it is a challenge to convince yourself and your colleagues that a new interdisciplinary activity will have impact.

So what are the rewards of interdisciplinary research? There are many! But on the most fundamental level, you have this cross-fertilization that allows you to explore areas you never thought of within your own discipline and to add value—indeed, to add transformative ideas and perspectives—to the adapted, now interdisciplinary area. Frankly, that's exciting. What's interesting about life is new discoveries. Usually you find new discoveries in places you never anticipated.

➡ **In what ways can we better collaborate with Argonne National Laboratory and FermiLab?**

Northwestern is fortunate to have two national labs in close proximity to our campuses. This is quite unusual. Argonne and FermiLab have opportunities and challenges.

While many national labs have a single focus, Argonne is a multipurpose national lab. That gives us the opportunity to work with a wide range of world-class researchers. Argonne also has a number of unique facilities. And they are truly interested in expanding their collaborations to include more of Northwestern's faculty, postdocs, and students.

FermiLab is a single purpose lab; it does high-energy physics, which includes astrophysics as well. But while the collaborations are not as broad, we have some deep collaborations with them, mainly through the physics and astronomy department. We see these growing and including other departments in the McCormick School as well as the basic sciences.

Northwestern has recently become part of the governing structure for both of these labs, therefore we have more input into what is happening. So the opportunities are becoming

clearer. The challenge is that they're not immediately in our backyard. Each of them is an hour to an hour-and-a-half drive away. So it's our goal to have a shuttle between here and Argonne, further develop the relationships, and work to collapse the distance. There's also telecommuting that can happen. The key is to develop collaborations between the faculty here and the researchers out there. Some of this will happen through joint appointments. We have a few now; we'll have more as time goes on.

One of the most significant challenges is that there have been recent budgetary cuts in the Department of Energy that have affected both Argonne and FermiLab. We don't expect these will last for long because of the importance to the nation of the research done at these labs. Nonetheless, it remains a short-term challenge to work through with them. It also represents an opportunity for us to further develop these partnerships as the budgetary situation improves.

➡ **What kinds of partnerships would you like to see with the University of Chicago and other local universities?**

Great universities collaborate with other great universities. We are fortunate to have several great institutions in our back yard—not just the University of Chicago and the University of Illinois at Chicago, but also the Field Museum, the Shedd Aquarium, the Chicago Botanic Garden, the Art Institute of Chicago, the Museum of Science and Industry, and the Adler Planetarium, just to name a few. In the biomedical area, the Chicago Biomedical Consortium has initiated this process of collaboration, but the opportunity exists to expand beyond the biomedical area to other areas for deeper collaborations.

Consider for a moment the University of Chicago. The fact is that neither Northwestern nor the University of Chicago is big enough to cover all areas. While there is certainly overlap and there is certainly competition, there are other areas where one university has strength and the other has no activity. The most obvious area is engineering, a discipline at Northwestern

but not at the University of Chicago. But even within disciplines we share, there are differential strengths. Their economics department and our economics department are also very different. We can collaborate in many areas without taking away from either school. And that's just looking at the other private research university in town. I could talk at length about the synergistic opportunities that exist with the other institutions in the Chicago area.

➡ **What is Bayh-Dole and what kind of pressure does it put on academia?**

[The Bayh-Dole Act, (P.L. 96-517, Patent and Trademark Act Amendments of 1980) created a uniform patent policy among the many federal agencies that fund research, enabling small businesses and non-profit organizations, including universities, to retain title to inventions made under federally-funded research programs. This legislation was co-sponsored by Senators Birch Bayh of Indiana and Robert Dole of Kansas.]

Most people look at Bayh-Dole and think 'This was passed in the 1980s. How can you say this law has a significant impact on academia?' The fact is that it is only now that we're beginning to feel the full impact. Bayh-Dole is both a stick and a carrot. It is a stick in the sense that the law says that the American public is funding research at universities for societal good, so universities have the responsibilities to take the discoveries and the inventions and bring them to society.

It is a carrot in the sense that the law allows us to own the intellectual property we invented, and to use that to start new ventures, or to license it to existing companies and therefore provide value to society and, frankly, to provide revenues for the University.

Lyrice is a very good example of this. The original Lyrice patents happened in the late 1980s, not long after Bayh-Dole was passed. It's just now that we are seeing the impact both for patients and universities. Lyrice isn't the first patent to make money, it just happens to be the biggest. There will be other discoveries made here at Northwestern and at our peer institutions that will have significant social and financial impact and will have a large

impact on the finances of the university that owns the intellectual property.

What Bayh-Dole is doing is changing the University from one where we produce graduates and publish new knowledge to one where we also take those discoveries and create a direct economic impact. There was always an indirect economic impact: we produced graduates and published papers and both went on to affect business. Now there's a more direct economic impact.

➡ **What trends are influencing academic research today?**

Because of the interdisciplinary nature of research, discoveries are being made by teams, not individuals (which requires coordination, but the good research teams are nimble). The pace of discoveries is also increasing. There was a time, probably 30 to 40 years ago, when a researcher made a discovery and published it. The research article would come out in print and the journal would show up in the library and someone would read it. Now, a researcher submits to a publication, the editorial review is fast—weeks—and the manuscript is available online at a searchable site in another few weeks. This is affecting how research is done.

It used to be that academic research was a slow, contemplative process. And while it is still contemplative, it is no longer a slow process.

Part of this also is driven by changes in the process by which one gets funding. The government agencies that fund the vast majority of our research look to industry and academia for input on where and in what fields future work should happen.

Finally, it is clear that academia is where the basic research is coming from in this country. That's a change from 40 years ago. What we've seen over the past couple of decades is that fundamental research is being done more and more within academia and less within industries. Indeed industry is teaming with academia for the research end of R and D. This is a large-scale trend that will continue to further influence academic research. ▀

HOMELAND SECURITY RULES ON CHEMICAL FACILITY ANTI-TERRORISM STANDARDS

IS NORTHWESTERN SUBJECT TO DEPARTMENT OF HOMELAND SECURITY REGULATION AS A CHEMICAL FACILITY?

Authorities on terrorism agree that one of the most serious terrorist threats imaginable would be an attack on a chemical facility. Hundreds of thousands of lives could be at risk from a chemical cloud released from such an attack. One of the measures signed into law to protect Americans is the Appropriations Act of 2007, which gives the Department of Homeland Security (DHS) the authority to regulate the security of “high-risk” chemical facilities.

IS NORTHWESTERN A “HIGH-RISK” CHEMICAL FACILITY?

That classification will depend upon the results of an inventory of so-called chemicals of interest—COIs—chemical substances determined by the DHS to be potentially dangerous or that meet other risk-related criteria.

WHAT ARE CHEMICALS OF INTEREST?

Many considered the list of chemicals of interest that the DHS originally published in April 2007 to be seriously flawed, and so it postponed full implementation of the law and opened up a public comment period. The DHS received more than 5,000 comments and published a revised list on November 20, 2007. The list includes specified quantities of such chemicals as propane, chlorine, and ammonium nitrate. The final list of chemicals, known as Appendix A, is available at: www.dhs.gov/xlibrary/assets/-chemsec_appendixachemicalofinterestlist.pdf.

CAN NORTHWESTERN BE CLASSIFIED AS A CHEMICAL FACILITY?

The DHS defines a chemical facility as “any establishment that possesses or plans to possess, at any relevant point in time, a quantity of a chemical substance determined by the Secretary [of Homeland Security] to be potentially dangerous or that meets other risk-related criteria identified” by the DHS.

“Northwestern, like most research universities, possesses such large inventories of hazardous chemicals that it is a virtual certainty that we possess at least some chemicals of interest, such as nitric acid, that are common in laboratories,” says Todd Leasia, director of research safety. “But we don’t yet know to which risk tier DHS will assign us.”

“The presence or amount of a particular chemical is not an indicator of a facility’s coverage under this rule,” reads the preamble to the DHS regulation. The presence of



Todd Leasia, director, Office for Research Safety

jim Ziv

SECURITY ISSUES

To determine the chemicals and quantities listed in Appendix A, the DHS examined three security issues:

- 1 Release is defined as quantities of toxic, flammable, or explosive chemicals that have the potential to endanger humans if intentionally released or detonated.
- 2 Theft or diversion applies to chemicals that have the potential, if stolen or diverted, to be used as weapons or easily converted into weapons.
- 3 Sabotage or contamination concerns chemicals that, if mixed with other readily available materials, can endanger human life or health.

a certain chemical is a baseline threshold that requires a facility to complete and submit an inventory report of COIs called a Top Screen. If a facility's Top Screen puts it into the "high-risk" tier, it then must complete further security actions such as a security vulnerability assessment and site security plans. High-risk facilities would be required to perform appropriate background checks on and ensure appropriate credentials for facility personnel and unescorted visitors with access to restricted areas or critical assets.

During winter quarter, Northwestern faculty and research staff completed an inventory of COIs using ChemTracker, a subscription data collection tool already in use for Environmental Protection Agency reporting requirements, and the results were sent to the DHS. Leasia says it may take several months before the DHS determines the University's risk level, but he thinks Northwestern, and most other universities, will be given a low level of security risk, making it subject to accountability but with little other regulation. If any faculty members or other University employees come into possession of a regulated COI after the initial Top Screen, they must report it to the University's Office for Research Safety (ORS) and enter it into ChemTracker. ORS is developing policies and procedures for the maintenance of COI inventories and reporting the possession of new COIs.

Non-compliance with these regulations comes with a stiff price tag: The 2007 legislation authorizes the DHS to impose civil penalties of up to \$25,000 per day and shut down facilities that fail to comply with the regulations.

For more information about Chemical Facility Anti-Terrorism Standards at Northwestern, contact ORS at www.research/northwestern.edu/ors. ▶

How Chemicals Have Been Used as Terrorist Weapons

- ♦ In 1985, federal law enforcement authorities discovered that a small survivalist group in the Ozark Mountains known as the Covenant, the Sword, and the Arm of the Lord possessed a drum containing 30 gallons of potassium cyanide, a metallic salt that, under certain circumstances, releases cyanide, with the apparent intent to poison water supplies in New York, Chicago, and Washington, D.C.
- ♦ The Aum-Shinrikyo sect used the nerve gas sarin to attack civilian targets in Japan during 1994 and 1995.
- ♦ In November 2002, British security officials arrested three men who were reportedly planning a cyanide attack on the London subway, and on January 5, 2003, British authorities arrested six men in a north London apartment who were suspected of preparing to produce ricin, a natural poison derived from castor beans. (The ricin was never found, however, and the case was ultimately dismissed.)
- ♦ In October 2003, a package containing ricin and a note threatening to poison water supplies was discovered in a South Carolina postal facility, becoming the first potential chemical terrorism event involving ricin in the United States.
- ♦ An attack on Glasgow International Airport occurred on June 30, 2007, when a dark green Jeep Cherokee loaded with propane canisters was driven into the glass doors of the main airport terminal and set ablaze.
- ♦ Chlorine is used as a disinfectant or purifier and as an ingredient in plastics and other products. Routinely transported in liquid form, it can turn into a deadly gas when exposed to air. A 2007 United Nations report found that at least 10 attacks in Iraq involved explosives attached to chlorine canisters.

SEVERE

HIGH

ELEVATED

GUARDED

LOW



Brian Chaikind

"Solving the Supply Side Problem of Marine Natural Product Chemistry: A Directed Approach"

Faculty Advisor: John Hudson, anthropology

All photographs in this article are from the Undergraduate Research Symposium held in May 2007. This year's event will be held on May 19, 2008. See more information on p. 23.



Claire M. Schmerberg explains one of her projects to faculty judges David Ferster, neurobiology and physiology, and Richard Gaber, biochemistry, molecular biology and cell biology.

"Morphological Differences in the Post-Pubertal Medial Amygdala are Dependent on Gonadal Condition"

Advisor: Catherine S. Woolley, neurobiology and physiology

Schmerberg's other project was **"Hydroquinine-based Chiral Ionic Liquids"**

Advisor: SonBinh T. Nguyen, chemistry

Research Training Begins with Undergraduates

The average age for new investigators when they receive their first funding has increased to 41.7 for a PhD and 43.2 for an MD, according to the National Institutes of Health. What if a researcher started learning the fundamentals of sponsored research at an earlier age? Would that help jumpstart a research career? No one can answer this question yet, but Northwestern's Undergraduate Research Grant Program, part of the provost's office, is ensuring that Northwestern undergraduates have the opportunity to acquire basic research skills. The URG Program has been in existence for ten years, but it has strengthened in recent years, especially with support from President Bienen. »



Ellen Cantrell
"El Camino de Santiago: Writing on the Collective Experience"
 Advisor: Brian Bouldrey, English



Muthiah Vaduganathan
"The Relationship Between Bone Mineral Density and Osteoarthritis in a Familial Setting"
 Advisor: Shari M. Ling, National Institute on Aging, NIH



Maureen Gilmour explains her research project to faculty judge Stephen Carr, associate dean, materials science and engineering. **"Ankle-Mate"**

Advisor: Stacy Benjamin, design engineer, Segal Design Institute

Variety of Grants Available

Research grants are available to undergraduate students to fund academic and creative projects designed and carried out under faculty supervision. Academic year grants provide up to \$1,000, and summer grants offer a stipend of \$3,000. Additional funds for international research travel also are available. New this year are conference travel grants for a maximum of \$500 for students to present their research findings or creative productions at professional conferences. This summer, pilot Immersion Language Grants will be offered for intensive language training.

"The Office of the Provost spearheads the effort, but those efforts have spawned others within the schools and colleges of the University," says Christopher Hayden, assistant to the associate provost for undergraduate education and coordinator of the URG Program.

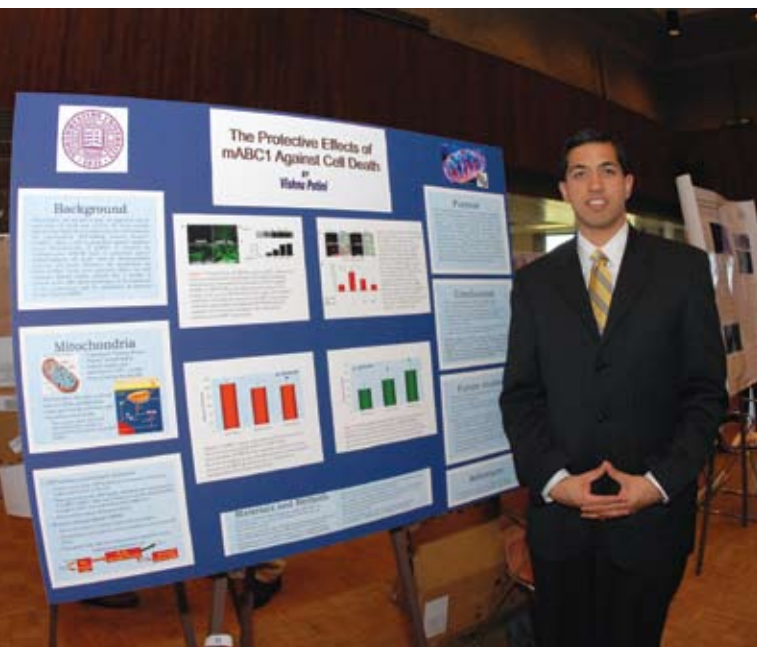
The students who are awarded the grants are fairly evenly dispersed among the disciplines: a third each in the sciences, social sciences, and humanities and creative arts. In the sciences, the awardees are typically students who want to get more involved in lab work. In the social sciences, arts, and humanities, students are inspired by course topics or interests to further explore.

The majority of academic year grants, about 75 to 80 percent, are awarded to seniors. Juniors and some sophomores generally seek the summer grants, which receive no class or tuition credits. Students are encouraged to apply for matching grants in the sponsoring departments. »



Allison Valenta (mezzo soprano) and Sergiy Komirenko (piano) **"Francis Poulenc's *Poèmes de Ronsard*: A Performance"**

Advisors: Karen Brunssen and James Giles, performance studies



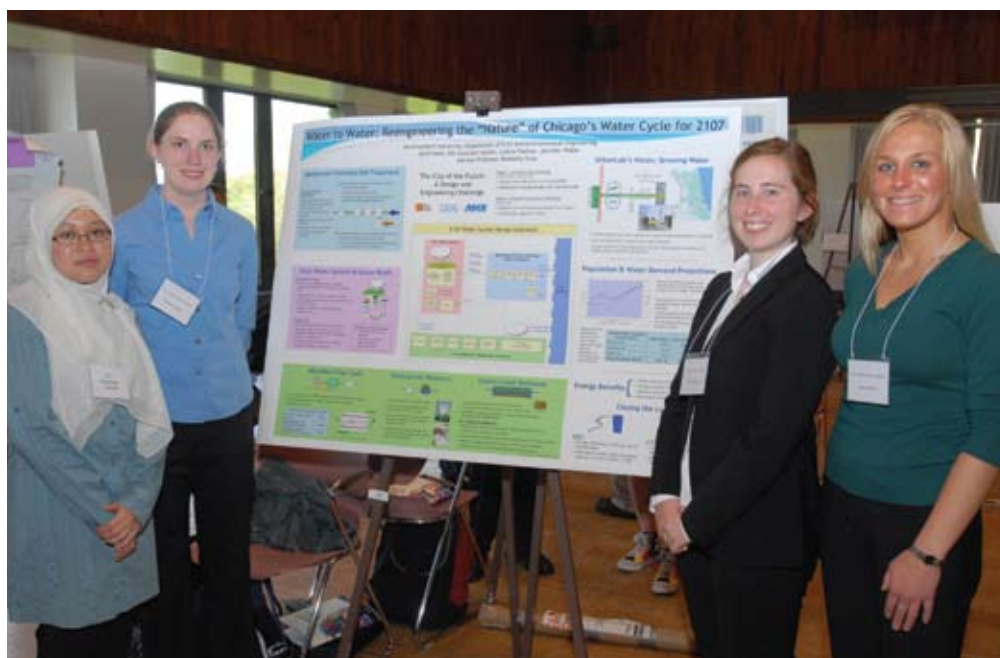
Vishnu C. Potini

"The Protective Effects of mABCI Against Cell Death as Mediated through the Inhibition of Reactive Oxygen Species"

Advisor: Hossein Ardehali, cardiology and molecular pharmacology and biological chemistry

Three-Step Process

The research process goes through three steps, according to Hayden. First, is the pre-research preparation, in which students develop and write a research proposal that outlines their rationale and hypothesis for the original project. The provost's office and the supervising faculty member advise the student during this phase. Students then submit their proposals, and a faculty committee gives feedback and decides upon the awards. Proposals can be reworked and resubmitted if they aren't approved on first submission. Hayden says that a majority of proposals are awarded grants, although often not on the first try. The third step, that also must be outlined in the proposal, involves the creation of a post-research or academic product in which students analyze and reflect on their research experience—such as a thesis, major paper, or artistic work. The importance of this third step led to the launch of the new conference travel grants.



Sitzuraidah Abidin, Jennifer Raber, Caitlin Feehan and Julia Hand are pictured with their poster.

"Water to Water: Reengineering the 'Nature' of Chicago's Water Cycle for the 22nd Century"

Advisor: Kimberly Gray, civil and environmental engineering



Jonathan Moore
 "Health Care for 'All Kids'—The Springfield and Evanston Perspectives"
 Advisor: Susan Thistle, sociology

Presenting Student Research

Students present their work at the end of the school year in the Undergraduate Research Symposium. More than 130 students presented at last year's symposium in poster sessions, paper sessions, and, for the first time, in creative arts performances. This year's symposium will be held Monday, May 19, in the Norris Center and is free and open to the public.

"Students develop their skill sets for thinking creatively, conceiving of, carrying out, and completing their projects," says Hayden. "This process helps make Northwestern an incredible training ground for Fulbrights and other external grants for graduate study such as NSF and Gates Cambridge." Twenty-four Northwestern students received Fulbright awards for 2007-08, fourth highest among all universities in the country.

For more information about the program, contact urg@northwestern.edu or online at www.northwestern.edu/undergrad-research. ▶

Photographs by Mary Hanlon.



Undergraduate Research Symposium

OFFICE OF THE PROVOST

A day of original research and creative works at Northwestern
 The Undergraduate Research Symposium celebrates outstanding student projects and artistic performances

Monday, May 19
 Norris University Center
 Free and open to the public

For more information and to apply online, see www.northwestern.edu/provost/students/research_symposium/
 Applications due by April 21

 NORTHWESTERN UNIVERSITY



University Research Centers

Northwestern University has a long history of leadership in interdisciplinary research programs and centers. Twenty University centers—as well as more than 90 school-based centers—support interdisciplinary research that spans a wide spectrum of areas. At Northwestern—research thrives.

Argonne/Northwestern Solar Energy Research Center

Director: Michael Wasielewski

e-mail: m-wasielewski@northwestern.edu

Helping the world meet increasing energy needs through solar energy is the goal of a new research center established by the U.S. Department of Energy's Argonne National Laboratory and Northwestern University. Argonne-Northwestern Solar Energy Research Center, or ANSER Center, combines and expands research interests of both institutions to address the grand scientific challenges posed by the need for economically viable solar energy use.

Roberta Buffett Center for International and Comparative Studies

Director: Andrew B. Wachtel

www.cics.northwestern.edu

Founded in 1998, this center promotes collaborative scholarship across the University on crucial world problems. With more than 180 affiliated faculty members, BCICS is a hub of internationally focused research, education, and outreach at Northwestern.

Center for Applied Psychological and Family Studies

Director: William M. Pinsof

e-mail: family-institute@northwestern.edu

CAPFS's mission is to enhance the biopsychosocial health and well-being of individuals, families, and larger groups by educating and training mental health professionals and by conducting research to improve mental health services.

Center for Catalysis and Surface Science

Director: Peter C. Stair

www.northwestern.edu/catalysis

For more than 60 years, Northwestern University has been at the forefront of catalysis research. In 1984 the University formally established the CCSS to consolidate research activities in catalysis and related surface science. Catalysis, the chemical reaction created by a catalyst, is an important tool in cleaning up pollution and conserving energy.

Center for Drug Discovery and Chemical Biology

Directors: Linda J. Van Eldik and D. Martin Watterson

www.northwestern.edu/research/cddcb

CDDCB evolved from the faculty-initiated Drug Discovery Program that was established in 1996 to facilitate interdisciplinary research and educational activities. Research at the center focuses on the interface between molecular and integrative basic sciences and the facilitation of the translation of preclinical discoveries into clinical applications.

Center for Functional Genomics

Director: Joseph S. Takahashi

www.genome.northwestern.edu

CFG has as its mission to unify basic research efforts at Northwestern University focused on understanding gene function. CFG is home to two major initiatives to develop and share mouse genetic resources for the study of nervous system function and behavior.

Center for Reproductive Science

Director: Kelly E. Mayo

www.northwestern.edu/research/crs

CRS was formed in 1987, and it currently coordinates the research and training efforts of 42 faculty in 13 departments. Center research extends from basic research investigations into the molecular processes that occur in living organisms, through applied studies relevant to efficient animal husbandry, and into clinical practices that directly impact human health with respect to fertility and infertility.

Center for Sleep and Circadian Biology

Director: Fred W. Turek

www.northwestern.edu/cscb

CSCB integrates basic and clinical research on circadian rhythms and sleep into a unified program at Northwestern. The center's 20 faculty members in Evanston and Chicago have built a large sleep research program to complement their work on biological rhythms in humans and animal subjects.

Center for Technology and Social Behavior

Director: Justine M. Cassell

<http://ctsbnorthwestern.edu>

CTSB supports researchers in their quest to understand the role that technology plays in our everyday social interactions and to facilitate the development of the next generation of technologies that will work towards supporting positive social ends.

Center for Cancer Nanotechnology Excellence

Director: Chad A. Mirkin

www.ccne.northwestern.edu

NU-CCNE supports multidisciplinary teams of nanoscientists, cancer biologists, engineers, and clinicians who work collaboratively to develop nanomaterials and nanodevices for cancer therapeutics, drug delivery, imaging, diagnostics, and monitoring applications.

Chemistry of Life Processes Institute

Director: Thomas V. O'Halloran

www.clp.chem.northwestern.edu

CLP research facilities will bring together in Silverman Hall the disciplines of chemistry, biology, engineering, and computational science. Previous significant developments by University chemistry and biology groups have attained widespread recognition for important biomedical and systems-level research.

Institute for Bionanotechnology in Medicine

Director: Samuel I. Stupp

www.ibnam.northwestern.edu

IBNAM, established in 2000, bridges the frontiers of medicine, engineering, and science. Advancements in biology and engineering, coupled with the emerging areas of nanoscience and nanotechnology, have potential to profoundly enhance human health and revolutionize the way medicine is practiced.

International Institute for Nanotechnology

Director: Chad A. Mirkin

www.nanotechnology.northwestern.edu

IIN was established as an umbrella organization for the multimillion dollar nanotechnology research efforts at Northwestern University and with collaborators around the world. The role of the institute is to support research in nanoscience and nanotechnology, house state-of-the-art nanomaterials characterization facilities, and bring together individual and group efforts aimed at developing new nanotechnologies.

Institute for Policy Research

Director: Fay Lomax Cook

www.northwestern.edu/ipr

IPR is an interdisciplinary public policy research institute that stimulates and supports social science research on significant public policy issues and disseminates the resulting findings to policy makers. IPR houses Cells to Society, a research project in which biomarkers are used to study the ways that societal problems affect human health.

Materials Research Center

Director: Monica Olvera de la Cruz

www.mrsec.northwestern.edu

The mission of MRC is to develop and support collaborative, interdisciplinary research and education in the science and engineering of materials that will benefit society. The center also operates a number of shared facilities that are available to the Northwestern community as well as to other institutions.

Nanoscale Science and Engineering Center

Director: Chad A. Mirkin

www.nsec.northwestern.edu

NSEC for Integrated Nanopatterning and Detection Technologies is driven by a vision to develop innovative biological and chemical detection systems capable of revolutionizing a variety of fields. Genuine medical benefits are now emerging as direct products of the center's research, including detection techniques for markers associated with diseases such as Alzheimer's disease and prostate cancer.

Northwestern Institute on Complex Systems

Directors: William L. Kath and Brian Uzzi

www.northwestern.edu/nico

NICO is a hub and facilitator of path-breaking research in the area of complexity science that transcends the boundaries of established disciplines and finds applications in many fields.

Northwestern Synchrotron Research Center

Directors: Wayne F. Anderson and Michael J. Bedzyk

<http://tomato.dnd.aps.anl.gov> and www.ls-cat.org/

NSRC oversees access to and use of Northwestern's two beamlines at Argonne National Laboratory's Advanced Photon Source for materials science and structural biology research.

Northwestern University Atomic and Nanoscale Characterization Experimental Center

Director: Vinayak P. Dravid

www.nuance.northwestern.edu

NUANCE is a centralized instrumentation facility that offers scanning and transmission electron microscopes, scanning probe and related lithography instrumentation for patterning, fabrication and localized measurements, and other state-of-the-art surface science instrumentation.

Spatial Intelligence and Learning Center

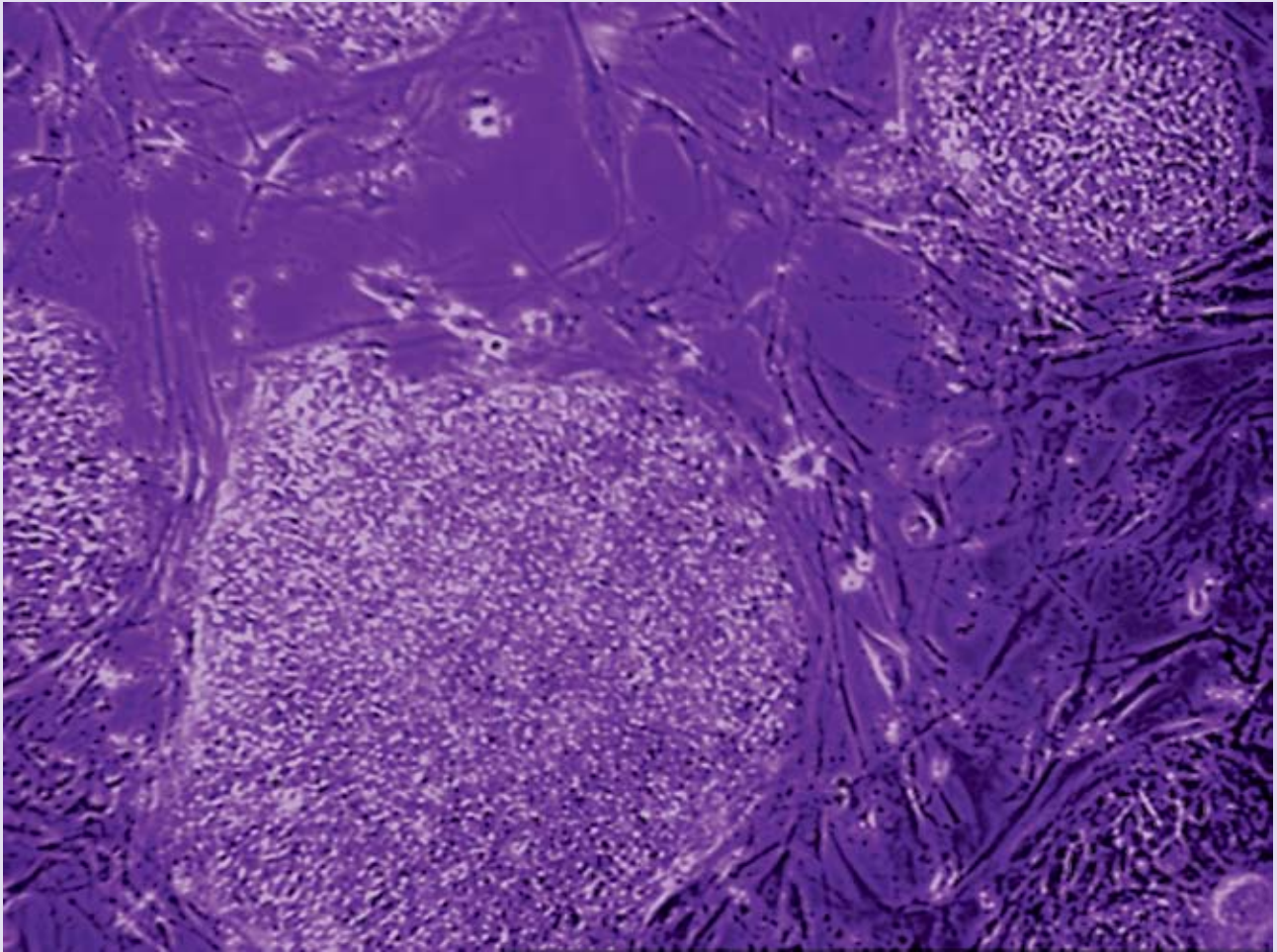
Director: Dedre Gentner

<http://spatiallearning.org>

SILC brings together scientists and educators from Temple University, Northwestern University, the University of Chicago, the University of Pennsylvania, and the Chicago Public Schools to understanding spatial learning and apply that knowledge to develop programs and technologies that will transform educational practice.

School-based centers

A listing of other Northwestern University Research Centers may be found online at www.research.northwestern.edu/research/centers/schoolCenters.html.



Human embryonic stem cells cultured on a feeder layer of mouse fibroblasts photographed using a magnification of 100X. The original black and white image was subsequently digitally colored for added resolution and contrast in the photograph. Image courtesy of Elisabeth A. Seftor, senior research scientist, Children's Memorial Research Center. See article on p. 2.



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Office for Research
633 Clark Street
Evanston, IL 60208-1108