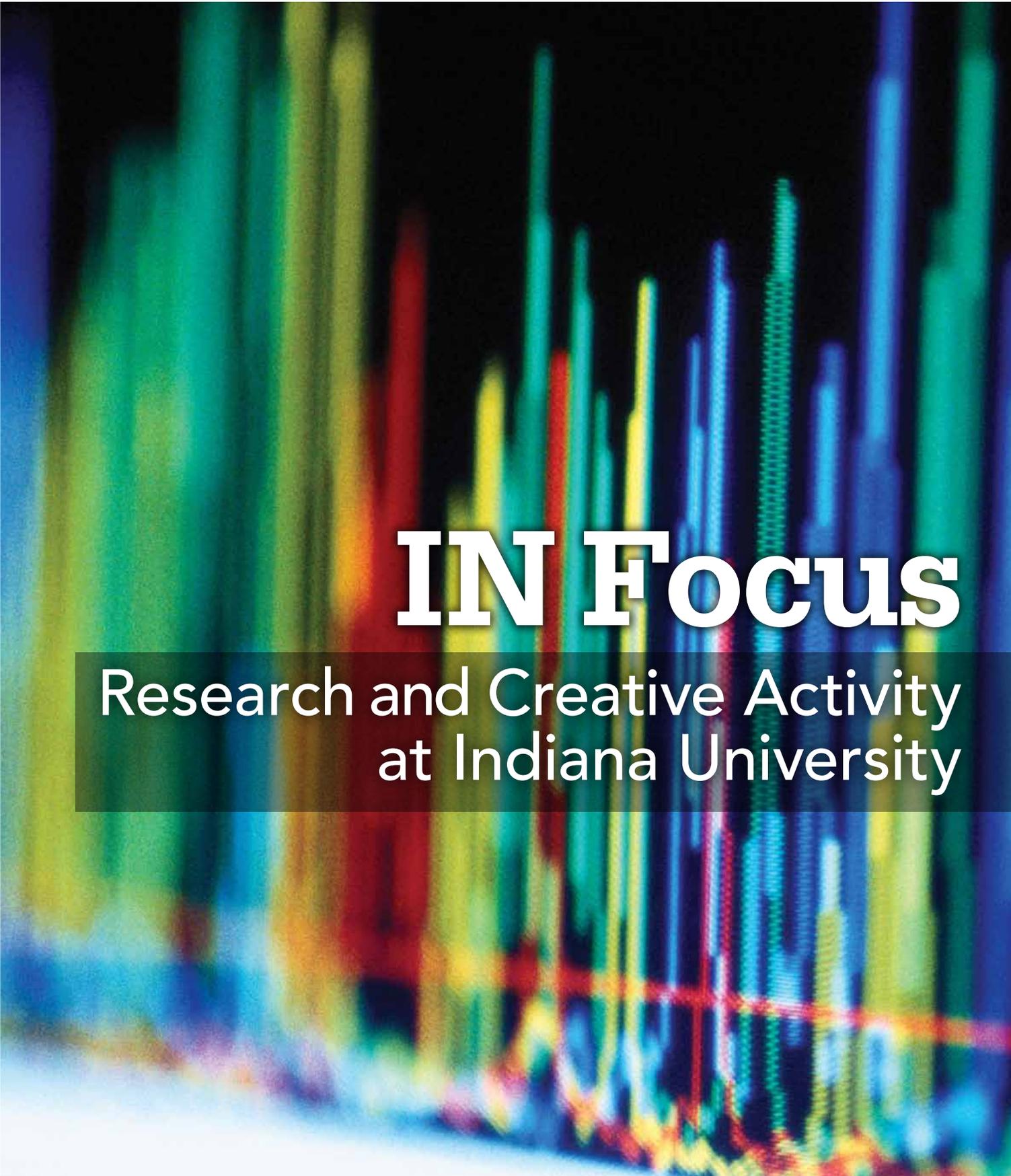




INDIANA UNIVERSITY

OFFICE OF THE VICE PRESIDENT  
FOR RESEARCH

# ANNUAL REPORT 2010

The background of the lower half of the cover is an abstract, blurred image of vertical lines in various colors (green, blue, red, yellow) against a dark background, resembling a data visualization or a spectrum.

# IN FOCUS

Research and Creative Activity  
at Indiana University

Editor  
Lauren Bryant

Designer  
Kelly Carnahan

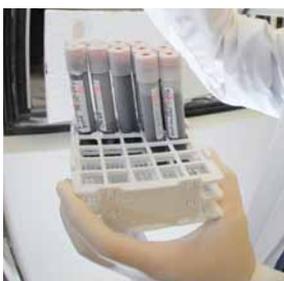
Writers  
Cindy Fox Aisen, Lauren Bryant, Kevin Fryling, Eric Schoch, Jeremy Shere, Daphne Siefert-Herron

Photographers  
Aaron Bernstein, Jocelyn Bowie, John Gentry, Dan Konow, Natalie Mazanowski, Chris Meyer, Jo Morrissey, Ann Schertz, Eric Schoch

Published by the Office of the Vice President for Research

Copyright © 2011, Trustees of Indiana University

PAGE 2: IU Distinguished Professor **Elinor Ostrom** receives the Nobel Prize in Economic Sciences from King Carl XVI Gustaf of Sweden on December 10, 2009. ©The Nobel Foundation 2009; photo by Hans Mehlin



# Contents

## People

|                     |    |
|---------------------|----|
| Sciences            | 4  |
| Neurosciences       | 8  |
| Arts and Humanities | 12 |
| Informatics         | 16 |
| Social Sciences     | 20 |
| Public Health       | 22 |

## Global Outreach 24

## Innovation 30

## Growth

|  |    |
|--|----|
| Awards by Direct Source  | 36 |
| Technology Commercialization   | 36 |
| National Institutes of Health and National Science Foundation Sponsored Program Activity | 36 |
| Sponsored Program Expenditures   | 37 |
| Expenditures by Source   | 37 |
| Expenditures by Federal Agency   | 37 |
| Expenditures by Unit   | 37 |

# Research and Creative Activity at Indiana University

It's my great pleasure to present the 2010 Indiana University Vice President for Research annual report covering the research activities of Indiana University-Purdue University Indianapolis, Indiana University Bloomington, and the IU regional campuses.

Since arriving in Indiana in August 2010, I have been impressed by the far-reaching accomplishments of IU faculty at each of the university's eight campuses. At the top of any list of recent accomplishments is Distinguished Professor Elinor Ostrom's 2009 Nobel Prize award in economics. On the heels of that triumph, IU achieved a record \$603.9 million in grants and awards for research and other sponsored programs during the 2009–10 fiscal year. IU's research expenditures, an indicator of activity and growth, were \$475 million. Notably, awards from the National Institutes of Health and the National Science Foundation were up 37.8 percent over the previous year.

The work of IU faculty is reshaping fields ranging from music and literature to the rapidly emerging area of epigenetics. Epigenetics—the study of how gene regulation and expression are altered without changing the DNA sequence itself—has been identified by the National Institutes of Health as having exceptional potential to improve human health and the treatment of cancer, autoimmune disease, mental disorders, and diabetes, among other illnesses. At last count, more than 50 IU researchers were actively engaged in the field, continuing a long tradition of cutting-edge interdisciplinary biomedical and genomic research at IU.

IU's expertise in genetics research is deeply rooted—historically, IU has played a pivotal role in the discovery of the biochemical basis of genetic codes. Four individuals connected with IU in the 1940s won Nobel Prizes. Herman Muller was awarded the Nobel Prize in 1946. His colleague Salvador Luria, an IU professor of bacteriology, did the foundational work for later research on the genetic material of bacteriophages that won him a Nobel Prize in 1969. Luria's research was a building block for the research of James Watson, a student of Luria's. Watson, who received his PhD from IU in 1950, was awarded the Nobel Prize in 1962 (with Francis Crick



From left, Vice President Jorge José and President Michael McRobbie

and Maurice Wilkins) for discovering the double-helix structure of DNA. Luria also had Renato Dulbecco as an IU faculty colleague and collaborator. Dulbecco won the Nobel Prize for virology in 1975.

IU's faculty tradition of excellence also includes 21 members of the National Academies, 55 Fellows of the American Association for the Advancement of Science, eight Pulitzer Prize winners, and four recipients of the MacArthur Fellowship, among many other prestigious honors.

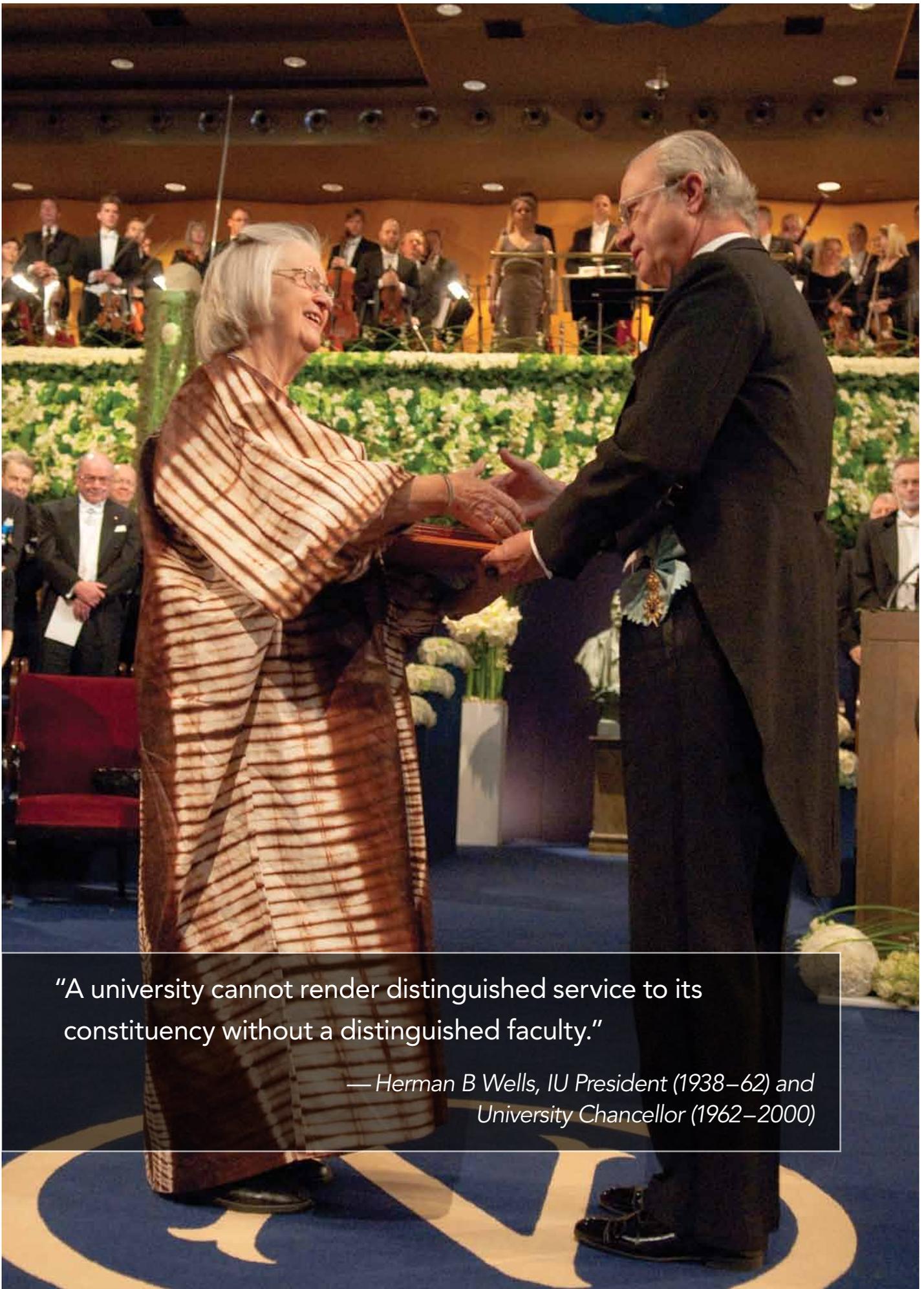
In short, Indiana University's excellence extends widely over different fields of inquiry. With a university community of nearly 5,000 full-time faculty, we can include only a small sample of their achievements over the last year in these pages. We hope, however, that we have highlighted a representative group of researchers whose projects and collaborations demonstrate significant contributions to general knowledge.

This report is organized to highlight a number of prominent strengths at Indiana University. In areas as diverse as epigenetics, neurosciences, fine arts, informatics, social sciences, and the humanities, IU faculty members are transforming their fields and having local, national, and international impact.

We hope you will enjoy learning about the excellent creative and scholarly work going on in all corners of Indiana University. To learn more, please visit our website at <http://www.iu.edu/~vpr/>.

Sincerely,

Jorge José  
Vice President for Research  
James H. Rudy Professor of Physics  
Professor of Integrative and Cellular Physiology, IU School of Medicine

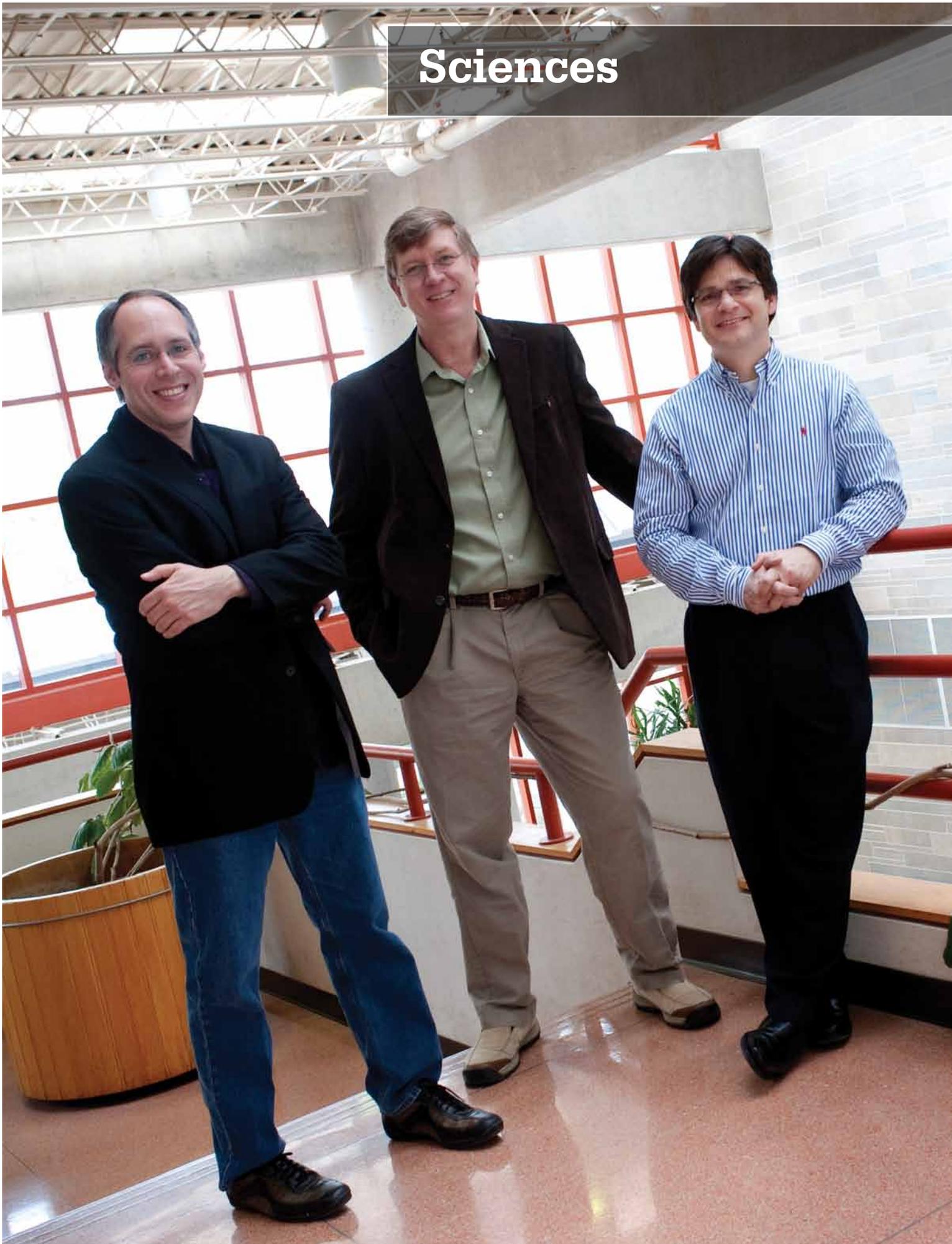


“A university cannot render distinguished service to its constituency without a distinguished faculty.”

— *Herman B Wells, IU President (1938–62) and University Chancellor (1962–2000)*

People

# Sciences



“The overall hypothesis of the National Institutes of Health Roadmap Epigenomics Program is that the origins of health and susceptibility to disease are, in part, the result of epigenetic regulation of the genetic blueprint.”

—from *commonfund.nih.gov*

## Around the next bend in plant biology

With grants from the National Institutes of Health, Monsanto, the National Science Foundation, and the Indiana University Collaborative Research Grants program, biologist and biochemist **Craig Pikaard** is breaking new ground in the study of plant epigenetics—how plant genes are activated and silenced, or suppressed, in response to chromosome modifications.

“Understanding gene silencing has relevance to normal development,” says Pikaard, the Carlos O. Miller Professor of plant growth and development at IU Bloomington and a Fellow of the American Association for the Advancement of Science. “It affects the stability of chromosomes and genetic information and can help us better understand diseases such as cancer, in which tumor suppressor genes are frequently silenced.”

As principal investigator of a \$1.35 million NIH grant, Pikaard leads a team investigating nucleolar dominance—an epigenetic phenomenon occurring in genetic hybrids where ribosomal RNA genes inherited from only one of the parents are functional. Pikaard’s research has shown that nucleolar dominance occurs due to the silencing of one set of parental RNA genes. Continued research is focusing on understanding precisely how and why this silencing happens.

Pikaard is making use of a second NIH grant totalling \$1.08 million to study the structure and purpose of RNA polymerases IV and V—two plant-specific enzymes discovered in Pikaard’s lab. While the enzymes are similar in structure to enzymes responsible for making RNAs that encode proteins, Pikaard has found that RNA polymerases IV and V produce RNAs that silence regions of the genome.

In related research, the Monsanto company has granted Pikaard \$200,000 to compare how RNA polymerase IV and V do their jobs in maize and *Arabidopsis*—a type of mustard plant that is widely used for plant genetic research.

Alongside his lab research, Pikaard has received two grants—from the NSF and the IUCRG—to foster collaborative efforts in plant epigenetics. The NSF grant, for which Pikaard is one of three co-investigators, will fund the establishment of an international consortium focused on plant epigenomics (a field combining genomics and epigenetics), while Pikaard will use IUCRG funds to establish a plant biology informatics partnership with Haixu Tang of the IU School of Informatics and Computing.

“I enjoy the creative process of working with incredibly smart and energetic people in the lab. Together, we try to design experiments or new approaches that can help us figure out how genetic and epigenetic processes work at a molecular level,” Pikaard says. “We are searchers and explorers, always eager to see what is around the next bend.”

*From left, Scott Michaels, associate professor of biology, and Craig Pikaard, Carlos O. Miller Professor of plant growth and development, both in the Department of Biology, College of Arts and Sciences at IU Bloomington; and Kenneth Nephew, professor of medical sciences, cellular and integrative physiology, and obstetrics in the Medical Sciences program at IU Bloomington.*

## To flower or not to flower

Since joining Indiana University Bloomington in 2003, **Scott Michaels** has focused his research on the role that modifications of proteins called histones play in the regulation of gene expression and development in plants. Histones are instrumental in packaging DNA inside the nucleus. Some histone modifications promote gene expression, whereas others cause genes to be silenced.

“Our interest in histone modifications began with studies of flowering time,” says Michaels, an associate professor of biology who has received a National Science Foundation CAREER Award and is currently funded by the NSF and the National Institutes of Health.

Biennial plants such as carrots, beets, or cabbage have a two-year growth cycle. They grow vegetatively for the first year, overwinter, then flower the second year. The long period of cold exposure experienced during winter, known as vernalization, promotes flowering in the second year. In the model plant *Arabidopsis*, histone modifications play a critical role in vernalization. Prior to cold treatment, a floral repressor called FLC is highly expressed and prevents flowering. During the winter, however, repressive modifications are added to the histones associated with the FLC gene, turning FLC off and allowing the plants to flower the following spring.

“When we began investigating how flowering time is controlled, we had no idea that it would lead us to histone modifications,” Michaels says, “but now our laboratory is broadly interested in these modifications.”

Recently, the Michaels lab discovered a novel class of histone-modifying enzymes that play a critical role in controlling DNA replication. Mutants lacking these enzymes over-replicated, copying some regions of the genome more times than they should.

“Over-replication is very dangerous to an organism, as it leads to genome instability, which is often associated with cancer,” says Michaels. “Part of the beauty of studying histone modifications is that they are so well conserved between plants and animals. Thus, discoveries in plants can often have major impacts in animal research and vice versa.”

## Epigenetics and cancer

**Kenneth Nephew’s** pioneering research on cancer epigenetics—the role that genes and factors that influence their expression play in the development of cancer—is changing the way scientists and physicians understand and battle the disease.

Nephew’s research is supported in part by a \$9 million National Cancer Institute grant awarded to the OSU-IU Center for Cancer Systems Biology, a center co-administered by Nephew and Ohio State researcher Timothy Huang. Originally funded in 2004 with \$8 million in NCI support, Nephew’s team is studying epigenetic changes in prostate, breast, and ovarian cancer cells that cause resistance to hormonal therapy or traditional chemotherapy.

Nephew, who is professor of medical sciences, cellular and integrative physiology, and obstetrics in the Medical Sciences program at IU Bloomington, says one major objective of the research is to identify genetic markers in cancer patients that will help determine how well anti-hormone treatment and chemotherapy will work.

With additional funding from the NCI and the Ovarian Cancer Research Fund, Nephew is studying ovarian cancer stem cells, the highly drug-resistant cells thought to be precursors to ovarian tumors. The goal, he says, is to “eradicate these highly malignant cells by using targeted therapies and novel epigenetic therapies.”

In one project, Nephew and others prepared the new drug SGI-110 for clinical trials in patients with recurring ovarian cancer—the fifth leading cause of cancer death in women.

Working with colleagues at the IU Simon Cancer Center, Nephew investigated the chemical properties of SGI-110 and how it affects genes in ovarian cancer stem cells that give rise to the disease. He focused on how well the experimental drug helped to eradicate ovarian cancer stem cells the first time a patient has the disease. “If we can get rid of these cells the first time around, we believe the cancer is less likely to come back,” Nephew says.

In 2010, Nephew also conducted a study of the breast cancer drug fulvestrant, finding that the drug may be most effective against cancer cells that express two key proteins. Although fulvestrant has been used to treat breast cancer since the late 1980s, scientists have limited understanding of how it works. Like many cancer drugs, fulvestrant can have unpleasant side effects. Nephew hopes his research will allow doctors to better determine when to prescribe the medication.

“If biopsied cancer cells can be shown beforehand to be resistant or unresponsive to fulvestrant,” he says, “the doctor may spare the patient unnecessary side effects from a drug that may not help them in the first place.”

## Understanding alcoholism

Understanding diseases caused by a single gene mutation is difficult enough, but at the Indiana University School of Medicine, **Howard Edenberg** is working on the genetics and genomics of complex disease, where many genes, interacting with each other and with the environment, are involved.

Edenberg, Distinguished Professor and Chancellor’s Professor of biochemistry and molecular biology, focuses on the genetics of alcoholism and of bipolar disorder, diseases in which dozens, even hundreds, of genes may play roles. A gene that plays an important alcohol-related role for some individuals—affecting how someone experiences an alcoholic “high,” for example—may have little impact in other individuals, making the isolation of important genetic factors a difficult enterprise.

Edenberg is one of four principal investigators for the Collaborative Study on the Genetics of Alcoholism, a national study that has been following alcoholism in families for more than 20 years with the goal of identifying alcoholism-related genes.

“We have found, and continue to find, evidence for genes that

affect risk for alcoholism and are studying how they affect behaviors during adolescence, the peak years of risk,” Edenberg explains. “We are elucidating mechanisms by which the genes affect risk and are beginning studies of the epigenetics of alcoholism in a prospective study of adolescents.”

In addition to more fully understanding complex diseases like alcoholism, genetic studies and related studies in cells and animal models may also “lead to treatment modalities that are more individually targeted to a person’s genetic makeup, and therefore more effective,” Edenberg says.

Edenberg also is director of the Center for Medical Genomics at the School of Medicine, which provides microarray and high-throughput genotyping services to researchers. Recently, using an NIH Shared Equipment Grant, the center installed a next-generation DNA sequencer that will support the search for new variations in genes associated with alcoholism risks and epigenetic studies of changes in gene expression patterns. Edenberg says the sequencer, along with the rest of the center’s resources, are “meant to be used by many scientists for all sorts of experiments.”

## Tantalizing hints from basic science

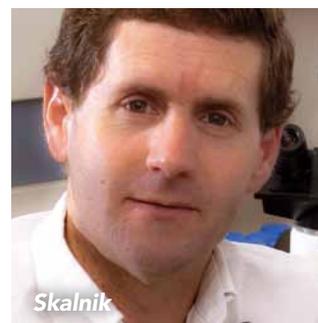
As an organism develops, nearly every cell contains the same DNA, but control over expression of that DNA determines whether a given cell will be a neuron, liver cell, infection-fighting macrophage, or one of the countless other types of cells in the body. That process of changing DNA expression without changing the DNA sequence itself—epigenetics—is where Indiana University scientist **David Skalnik** focuses his laboratory’s efforts.

A molecular biologist at the Wells Center for Pediatric Research at the IU School of Medicine, Skalnik recently was named associate dean for research and graduate education and professor of biology at the IU-Purdue University Indianapolis School of Science. He remains an adjunct investigator at the Wells Center.

In earlier research, Skalnik identified a protein that appears to play an important role in the control of DNA expression. It also appears to be crucial to the process of hematopoiesis, in which all of the body’s blood cells are manufactured, by the billions, in the bone marrow. Skalnik’s lab found that the lack of the protein results in the inability of epigenetic factors to do their job of turning on and shutting down different sections of DNA.

One question that has Skalnik’s attention is why there are so many enzymes to perform the same chemical reaction involved in epigenetic control. “The presumption is that mammals have a complicated development program that has to be accomplished, genes have to be regulated in intricate ways, and we need multiple enzymes to do it efficiently,” he says.

Skalnik has tied the epigenetic enzymes his team has studied to a protein that also is known to be involved with leukemia. “It’s a tantalizing hint,” he says. “From a basic science perspective, we’ve come across a linkage to a protein linked to leukemia.”



## Genes, ethics, and the law

As scientists at Indiana University are breaking ground in genetic and genomic sciences, IU colleagues are hard at work assessing related ethical and legal issues.

Biobanks of human biological material and other data repositories generate concerns about privacy and rights that reach far beyond the traditional realm of medical research. **Eric Meslin**, professor of medicine, directs the IU Center for Bioethics at the School of Medicine, where the Predictive Health Ethics Research program serves as a resource regarding issues arising from genomic medicine. Meslin is also co-director of the Center for Law, Ethics and Applied Research in Health Information, which IU formed with a Lilly Endowment grant in fall 2010 to address the myriad issues generated by the expansion of health information.

At IU Bloomington, scholars such as **Yvonne Cripps** at the Maurer School of Law are examining complex questions of freedom that arise as genetic science advances. The Harry T. Ice Chair of Law, Cripps is also a senior fellow at the University of Cambridge Centre for Public Law. Author of *Controlling Technology: Genetic Engineering and the Law*, the first comprehensive treatment of the legal implications of biotechnology, and an expert in patent law, Cripps is contributing to the international debate on whether we can, or should, patent parts of ourselves. She has written and consulted on patenting of human genes such as BRCA1 and BRCA2 (genes associated with hereditary breast and ovarian cancers) and is intrigued by the legal implications of what she calls the “fascinating science” of epigenetics. As Cripps said during an interview on the BBC World Service’s “The Forum” program last year: “I find it most fascinating that our genes, or the expression of them, may be affected by, for example, what our grandmothers ate.”



## Neurosciences

### Personalized medicine in psychiatry

Psychiatrist and molecular biologist **Alexander B. Niculescu** has a motto: “Personalized diagnosis and treatment, for every patient, in every doctor’s office.” He credits his ambitious objectives to the influence of former mentors, particularly Nobel Laureates Gerald M. Edelman and Francis Crick, who provided examples of the importance of working on the right problems that can significantly move a field forward.

Thanks to a 2010 National Institutes of Health Director’s New Innovator Award totaling \$1.5 million, one of only 52 across all fields of medical science, Niculescu can expand his work on personalized medicine in psychiatry and developing blood tests for mood disorders (bipolar disorder, depression). Niculescu is an associate professor of psychiatry at the Indiana University School of Medicine and director of the Laboratory of Neurophenomics.

Diagnosing mood disorders can be difficult, typically involving lengthy observation and multiple interviews with psychiatrists and other health professionals. Consequently, millions of people suffering from bipolar disorder and depression go undiagnosed for long periods or are not diagnosed correctly and fail to receive adequate treatment. In 2008, Niculescu and colleagues published the first blood test for mood disorders in the journal *Molecular Psychiatry*,

describing a panel of 10 RNA biomarkers in the blood with predictive value for mood state (mania, depression). In 2009, they followed with work on a blood test for psychosis (hallucinations, delusions), also published in *Molecular Psychiatry*. In 2010, Niculescu and colleagues published a prototype genetic risk prediction test for bipolar disorder based on DNA.

Niculescu’s research, which also includes projects investigating the genetic underpinnings of schizophrenia and alcoholism, could dramatically change the landscape of how we understand psychiatric disorders and their diagnosis, and enable the development of new medications.

Niculescu emphasizes that all these tests are still in the research realm and need more time and resources to advance the science and improve parameters before they can be used in routine clinical practice. DNA genetic tests to predict risk of developing psychiatric disorders or blood RNA biomarker tests to objectively track severity of symptoms and response to treatment will be a significant improvement over largely subjective methods of diagnosis used today, but the role of careful clinical assessment, personal history, and family history remain important as part of comprehensive and integrative diagnostic and treatment plans. Better diagnosis can lead not only to better treatments but also to earlier intervention, including prevention strategies.

Niculescu himself remains a practicing psychiatrist, working with military veterans, and draws inspiration and motivation for his research from his clinical work with patients.

## Combating co-abuse

Americans spend hundreds of billions of dollars consuming alcohol and tobacco, and then dealing with the economic and health impacts of abusing those drugs. One key to reducing that impact, says Indiana University School of Medicine's **William McBride**, is better understanding the mechanisms in the brain involved with addictive behaviors.

McBride, professor of psychiatry and a researcher at the Institute of Psychiatric Research and the Stark Neurosciences Research Institute in Indianapolis, has extensive experience using animal models to study the effects in the brain of alcohol and tobacco abuse. IU is known for lines of animals that have been selectively bred for alcohol research. Normally, rats and mice aren't interested in alcohol, but IU researchers were among the first to develop, through careful breeding techniques, lines that will pick alcohol over water when given a choice. Complementary lines of rats and mice that prefer not to drink alcohol also have been bred.

Recently, with a \$2.5 million Grand Opportunities award from the National Institutes of Health, McBride has begun studying the reinforcing effects in the brain of alcohol and tobacco use.

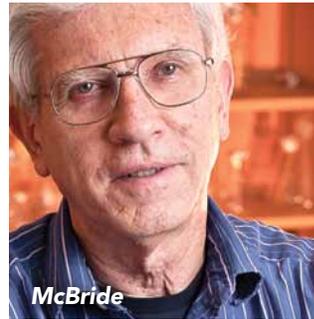
"People dependent on alcohol are four to five times more likely to be dependent on smoking and vice versa," says McBride.

IU is well-positioned to study those interdependencies. "There are labs elsewhere that study, using animal models, mechanisms underlying alcohol drinking and mechanisms underlying nicotine use," McBride says, "but few labs are capable of looking at both, and looking at the brain mechanisms involved in reinforcing effects of alcohol and nicotine on each other."

McBride and his colleagues have developed techniques to access the brain's reward mechanisms and measure the activity and responses of neurons to a history of alcohol or nicotine use—the neuroadaptations the brain undergoes in response to the history of substances it has encountered.

The researchers also are looking for changes in genes that regulate the function of receptors, asking whether gene expression patterns are different in cases of alcohol dependence versus nicotine dependence, and in co-abuse versus abuse of just one of the substances.

"What we think is happening is that co-abuse is having a compound effect that you don't see with the use of one or the other," McBride says. "You'll see overlapping genes, but there are some changes in gene expression that will be unique with co-abuse of alcohol and nicotine. Those are the ones that we're really trying to figure out. If we can find those, then we have a real good handle on how to combat co-abuse."



McBride



Saykin

## Illuminating Alzheimer's

At the hazy intersections where genetics and medical imaging meet, **Andrew J. Saykin** is looking for clues to early detection of Alzheimer's and other neurodegenerative diseases.

As director of the Indiana University Center for Neuroimaging, Saykin leads a broad-based research initiative that is improving our understanding of brain activities and how they are affected by disease, using modern PET and MRI techniques in combination with genomics and other biomarkers.

Saykin's research interests range from Alzheimer's to the issues of cognitive impairment that arise from chemotherapy. He is currently one of the leaders of the national Alzheimer's Disease Neuroimaging Initiative, a collaborative effort of the National Institutes of Health and private industry. Now in its third phase, ADNI is following about 800 patients (and 200 healthy control participants) with varying levels of cognitive impairment that have been identified as increasing the risk of developing Alzheimer's.

In late 2010, a Saykin-led research group reported the results of a study that added a new gene to the list of those that may be linked to the development of Alzheimer's. The study was reported in the journal *Neurology*.

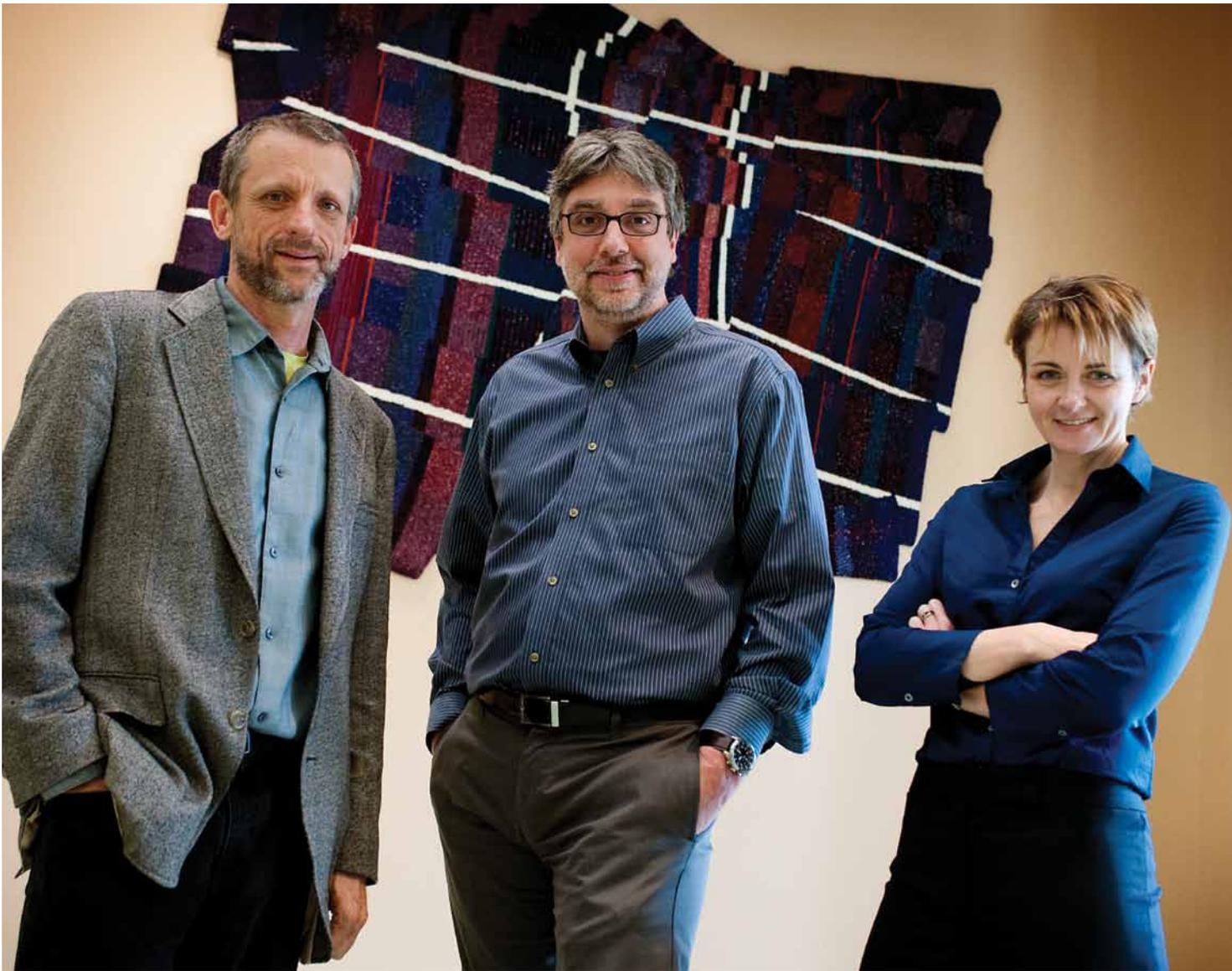
"This study was one of the first genome-wide analyses of biomarkers in cerebrospinal fluid, which has direct access to the brain and allows us to look at biochemical features that might be more directly tied to the disease," says Saykin, Raymond C. Beeler Professor of radiology and imaging sciences and professor of medical and molecular genetics at the IU School of Medicine.

In the genome-wide association study, researchers looked for genetic variations that could be related to the levels in cerebrospinal fluid of three proteins—beta amyloid, tau, and phosphorylated tau—that are linked to damage seen in brains of Alzheimer's patients.

The gene identified by the research, which had not previously surfaced in other studies looking for Alzheimer's-related markers, has been associated with a gene deletion syndrome that includes mental retardation, short stature, and epilepsy.

The gene is also involved in the formation of a DNA structure, heterochromatin, that plays a role in the activation and control of gene activity.

"The association of CSF tau and the EPC2 gene suggests a possible epigenetic mechanism that warrants follow-up in other samples," Saykin says.



## Building the brain's road map

In the emerging discipline of network neuroscience, Indiana University's **Olaf Sporns** is playing a diverse and important role. Sporns, professor of psychological and brain sciences in IU Bloomington's College of Arts and Sciences, is author of the recent book *Networks of the Brain*, published by MIT Press. Network approaches are, Sporns says, "opening up new horizons in neuroscience."

Sporns is devoting much of his current research to two projects being carried out in collaboration with other universities. The first project is to develop a "virtual brain," a powerful computational model that can simulate brain function. The second is the Human Connectome Project, established to map the human brain's major connections.

The Virtual Brain project is funded by the McDonnell Foundation. Scientists at 11 universities are compiling information pertaining to brain function and connectivity. The goal is to design a computer model of the human brain and investigate how brain injuries affect its function. The model would allow researchers to test the effects of neural stimulation or changes in neural connectivity as the brain recovers.

The Human Connectome Project seeks to discover the neural pathways that underlie brain function. This \$30 million, five-year project funded by the National Institutes of Health involves more than 30 collaborators from research institutions in England, Italy, Germany, and the United States, including Sporns at IU Bloomington. The study is using neuroimaging to examine the network architecture of connections in the brains of 1,200 healthy individuals. The researchers will also look at behavioral and genomic data to determine how these relate to brain connectivity.

Sporns likens the Connectome project to the Human Genome

*From left, Colin Allen, professor of history and philosophy of science and cognitive science; Olaf Sporns, professor of psychological and brain sciences; and Karin James, assistant professor of psychological and brain sciences, from the College of Arts and Sciences at Indiana University Bloomington. RIGHT Illustration from Neurographia universalis by Raymond Vieussens. Lugduni: J. Certe, 1685. Courtesy Lilly Library, Indiana University.*

project that first created a complete map of human genetic material. “Both projects will give us a unique map,” he says. “The Connectome project isn’t going to solve all of the problems we face in studying the brain but like the Human Genome project, it is going to provide us with a great foundation for asking new research questions and for understanding the network basis of neuroscience.

“I see the brain as one of the most challenging frontiers in science,” Sporns adds. “It’s an open area, an area where big discoveries are likely to be made in the near future.”

## ‘How can I tell what I think till I see what I say?’

The British novelist E.M. Forster posed this question in an essay on aspects of novel-writing, but the question may equally apply to the pint-size participants in research conducted by **Karin James**.

James is an assistant professor of psychological and brain sciences in the College of Arts and Sciences at IU Bloomington. Her recent research, featured in an October 2010 issue of the *Wall Street Journal*, focuses on connections between printing letters and enhanced brain activity in young children. “We’ve recently shown that when children look at letters, activity in parts of their brains becomes more like activity seen in literate adult brains, but only after the children have had practice printing letters,” James explains.

The changes in brain activation seen in James’s studies demonstrate that “learning by doing” can lay the foundation for, and potentially strengthen, the brain systems used for letter recognition.

“It seems there is something really important about manually manipulating and drawing out two-dimensional things we see all the time,” James told the *WSJ*. “Interestingly, the brain activation that results from printing letters is very different from drawing shapes,” she adds. “Only after printing letters, as opposed to seeing them without printing them, does the brain distinguish between letters and shapes.”

With support from the National Institutes of Health, among other sources, James and her colleagues pursue a variety of experiments in her Cognition and Action Neuroimaging Laboratory, using functional magnetic resonance imaging to look at how children’s brains respond or change under certain conditions.

In addition to the study of how children learn letters, James and her team members study how children’s perceptions of objects are influenced by motor manipulation, how children’s brains process music, and how direct experience changes the ways children process language. In the latter study, James’s lab has found that when children hear verbs they’ve learned, brain processing is different depending on how they learned the verb. Only after the children act on objects themselves (as opposed to watching someone else) do the multiple brain systems seen in adult verb processing come into play for the children.

“Again,” James says, “‘learning by doing’ sculpts brain function in important ways.”

## Seeking the right questions

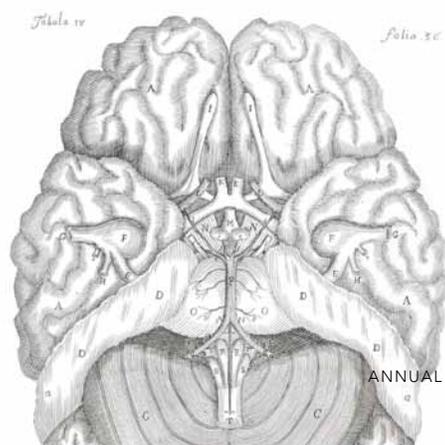
The powerful new imaging technologies employed by neuroscience to discover detailed information about our brains are also opening new frontiers for issues of privacy, human and animal welfare, and personal responsibility. This new frontier has a name, “neuroethics,” and **Colin Allen** is one of its foremost explorers.

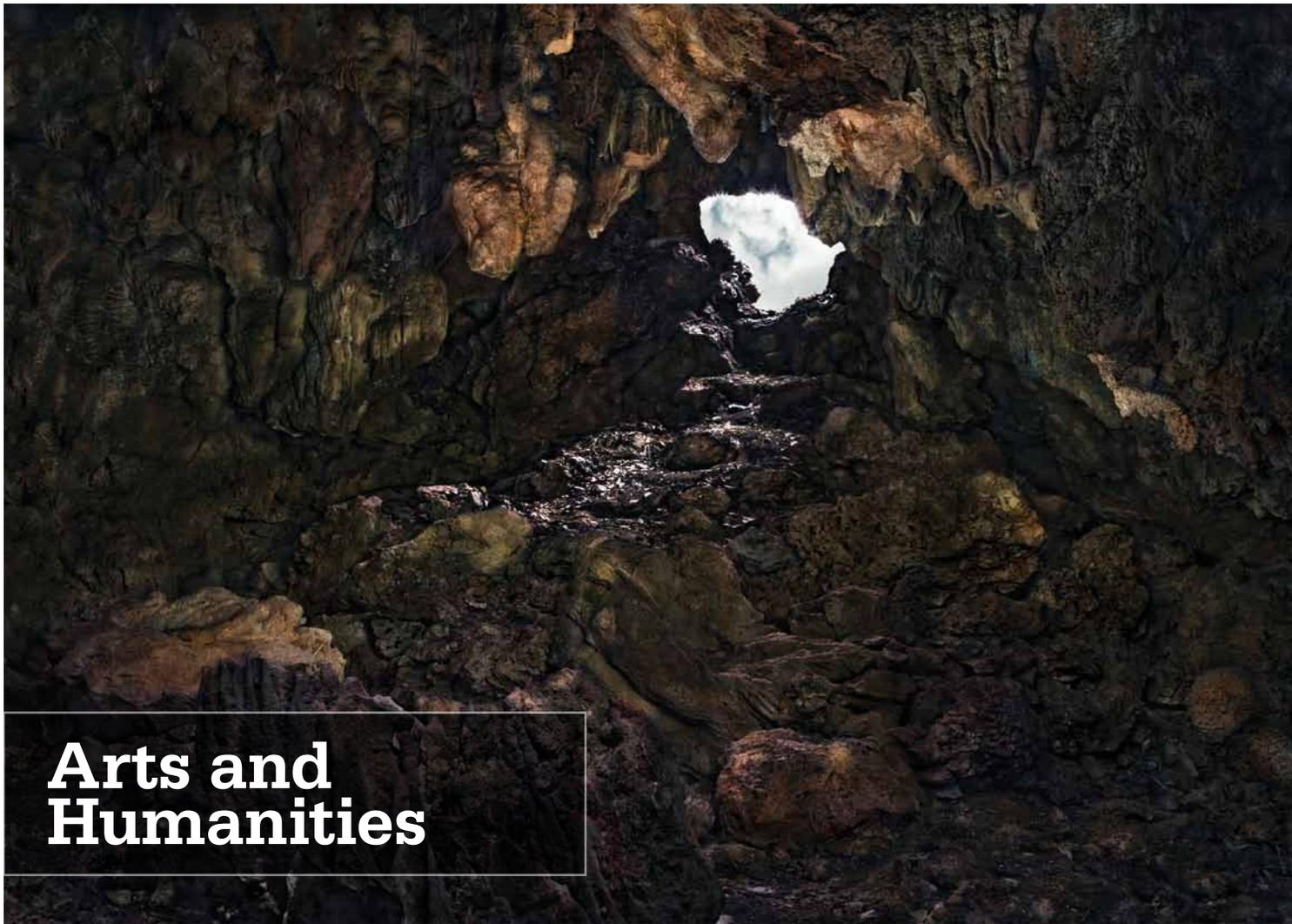
Allen, a professor of history and philosophy of science and cognitive science in the College of Arts and Sciences at Indiana University Bloomington, is co-author of books with titles such as *Moral Machines: Teaching Robots Right from Wrong* and *Species of Mind*. He has long been concerned with the social, political, and philosophical issues raised in the study of the mind, whether human, animal, or artificial. In 2009 and the first half of 2010, using a grant from IU’s New Frontiers in Arts and Humanities program, Allen co-organized a series of lectures on neuroethics, presented in collaboration with IU’s Poynter Center for the Study of American Institutions.

Allen spent the remainder of 2010 in Germany as recipient of a Humboldt Research Award from the Alexander von Humboldt Foundation, which promotes international collaboration between scientists. Allen traveled to Ruhr-University in Bochum, Germany, to join a group of philosophers and neuroscientists studying animal cognition, while he works on a new book on the topic. During his fellowship year, Allen also delivered more than two dozen lectures in 10 countries.

Allen’s work in the philosophy of cognitive science has been supported by both the National Science Foundation and the National Endowment for the Humanities, which has funded Allen’s Indiana Philosophy Ontology (InPhO) project, an interactive web-based resource to help students and scholars explore the discipline of philosophy. Allen also is associate editor of the *Stanford Encyclopedia of Philosophy* and of *Noesis: Philosophical Research Online*, and a recent past president of Society for Philosophy and Psychology.

An intrepid cyclist, Allen is always interested in what’s over the next horizon, especially when it comes to cognition among nonhuman beings. “Part of my mission is to move philosophical and scientific debates about cognition beyond simple expressions of how hard it is to connect observable behavior to mental states,” he says. “What is the right story to tell? What are the right questions to be asking?”





# Arts and Humanities

## Imaging history

Born in New York City, raised in Tokyo and in Houston, Texas, **Osamu James Nakagawa** calls photography his “expressive bridge” between cultures. In his digital photography projects *Banta*, *Remains*, and *Gama*, Nakagawa uses his art to explore questions of identity and the past by reflecting on the history of Okinawa during World War II.

*Banta* deals with an area known as the “Suicide Cliffs” because of the large number of Okinawans who took their own lives there immediately prior to and during the Battle of Okinawa in 1945. *Remains*, another installment in the World War II series, depicts remnants of the Battles of Okinawa and Saipan (1944), representing different interpretations of the events. *Gama*, a project that Nakagawa expanded using a 2009 Guggenheim Fellowship, enters into the darkness of Okinawan caves that also were sites of the mass deaths at the end of World War II. The images in these projects, according to Nakagawa, “are an exploration of historically and politically loaded landscapes.”

An associate professor of photography in the Hope School of Fine Arts at Indiana University Bloomington, Nakagawa’s work has been supported in part by IU’s New Frontiers for Arts & Humanities program. His photography is shown internationally in museums and galleries and is included in numerous public collections such as the Metropolitan Museum of Art, the International Museum of Photography at George Eastman House, the Corcoran Museum of Fine Arts, the Tokyo Metropolitan Museum of Photography, Sakima Art Museum in Okinawa (where his solo exhibition was named *Best Photography Exhibition in 2009* by Japanese photography critic Mariko Takeuchi), and the Museum of Fine Arts, Houston. In 2010, Nakagawa was honored with the Higashikawa New Photographer of the Year Award in Japan, presented to photographers whose work has significance in the history of photography or as a unique expression of the art of photography.



**Nakagawa**

ABOVE *Gama #01*, by Osamu James Nakagawa, used with permission of the artist.



Curtis



Harper

## Unmatched resource

When **Edward Curtis IV** was studying the history of Islam as a graduate student in the late 1990s, he had no idea that his research specialization would “become the subject of so many headlines,” he says.

Today, as a professor of religious studies at Indiana University-Purdue University Indianapolis and the Millennium Chair in the School of Liberal Arts, Curtis is author of *Muslims in America: A Short History*, which *Publisher’s Weekly* called “a fine and succinct history . . . unmatched for its breadth of sources” and named to its list of 100 best books of 2009. Most recently, Curtis completed work as general editor of the two-volume *Encyclopedia of Muslim-American History* (2010), which *Choice* magazine called “an impressive overview . . . the most comprehensive of its kind.” A former National Endowment for the Humanities Fellow at the National Humanities Center, Curtis has also been awarded Carnegie, Mellon, and Fulbright fellowships. His most recent Fulbright Scholar Fellowship took him to Amman, Jordan, for a year.

An acknowledged authority on Islam in America, Curtis hopes his work will help non-Muslim Americans learn more about Muslim Americans as “ordinary (and sometimes extraordinary) human beings who have contributed to the making of America.” He feels grateful, he says, that “my research has allowed me to confront people’s fears of each other.”

## ‘A life that works’

A memoirist, short-story writer, photographer, filmmaker, and poet, **Jean Harper** has no trouble crossing the boundaries of genres. Harper, an associate professor of English at Indiana University East, spent part of 2010 as a fellow at the MacDowell Colony in New Hampshire, where resident artists have included James Baldwin, Michael Chabon, Louise Erdrich, Jonathan Franzen, and Wendy Wasserstein.

At MacDowell, Harper worked on her newest nonfiction book, tentatively titled *Horses and Divorces*. Harper also recently held the Curtis Harnack Residency at the Yaddo artists’ colony in Saratoga Springs, NY, and was awarded the Goldfarb Residency for Creative Nonfiction at the Virginia Center for the Creative Arts. With

funding from IU’s New Frontiers in Arts & Humanities program, she is now involved in new work on poetry.

About living, working, and writing in eastern Indiana, Harper has written: “What do I have here, where jobs are scarce and salaries are low . . . and a good latte is hard to find? I have a decent job teaching students who surprise me at times with their passion and hunger to learn. I have a core group of colleagues I admire and love to work with. I have time to write. I have rent that is reasonable, a place to board my horse I could never afford on the East Coast or West. I have long roads with wide horizons. I have the joy of finding beauty in corn and beans, combines shrouded in clouds of dust; . . . of making amidst the factories and farms and small half-gone towns a life that works.”

## Western medicine, modern China

The introduction of Western medicine in China, particularly through early 20th-century missionary activity, has been one of the most important influences in modern Chinese history. Historical records of the spread of “new medicine” in China are extensive, but invasions, wars, and revolutions have hindered access to these records for many decades.

**William Schneider**, professor of history at Indiana University-Purdue University Indianapolis, intends to open up the history of modern medicine in China. With funding from IU’s New Frontiers in Arts and Humanities program and the Henry Luce Foundation, Schneider is bringing together the IUPUI Medical Humanities Program, which he directs, with the IU Center on Philanthropy and the Center for the History of Medicine at Peking University to study the history of hospitals, medical schools, and other institutions supported by Western philanthropy and missionary efforts in China.

The project includes two conferences (one in Indianapolis and one in Peking) and will identify major archival holdings and historical documents within and outside China. Ultimately, documents from the conferences and archival materials will be made available online.

“Medicine was a very important field for Westerners working in China,” says Schneider, who also holds appointments in the School of Medicine and the Center on Philanthropy at IUPUI. “The archives and records in the West are documented and well-known, but not those in China. A major goal of our work is to increase the access Chinese scholars have to sources in the West in addition to helping them identify resources in China.”

Zhang Daqing, director of the Center for History of Medicine at Peking University, concurs that the project will “greatly accelerate international collaboration and offer an excellent opportunity for all the scholars in China and elsewhere.”

## 'Music is more with us than ever'

**J. Peter Burkholder**, a Distinguished Professor of musicology in the Jacobs School of Music at Indiana University Bloomington, has said he adopts a "Darwinian model" when it comes to the scholarly study of music. "Evolution doesn't happen in a vacuum. Individual species contend with each other, and what survives reproduces and carries its characteristics to the next generation," he says.

The process of musical adaptation is at the heart of Burkholder's scholarship—he studies musical borrowing, or how one piece of music gets adapted into a new piece. An expert on American composer Charles Ives, Burkholder's early books and articles demonstrated Ives's borrowing techniques throughout the composer's career.

In fall 2010, Burkholder was named an honorary member of the

American Musicological Society, the youngest person to receive the highest honor the society bestows on its members. Considered the equivalent of a lifetime achievement award, the AMS honorary membership acknowledges Burkholder as a leader in research on 20th-century music, as a music history pedagogue, and for his service to the American Musicological Society as a former board member, vice president, and president.

Burkholder's numerous works, including the co-edited *Norton Anthology of Western Music* and journal articles on musical history and musical meaning, have earned him two ASCAP Deems Taylor Awards for outstanding print, broadcast and new media coverage of music. Burkholder has also accomplished a landmark rewriting of the 986-page *A History of Western Music*, the most widely used textbook of its kind.

Burkholder says the evolution of the study of musical history means an expansion of options for research that is both exhilarating and overwhelming: "Music is more with us than ever. We have constant access to music if we want. Now, the availability of music means that each of us can become our own musical world."



Burkholder



## Picturing America

When the National Endowment for the Humanities launched its Picturing America initiative in 2008, NEH Chairman Bruce Cole called the program a tool of democracy, “bringing us face to face with the people, places, and events that have shaped our country” and providing “an innovative way to experience America’s history through our nation’s art.” With a \$204,000 grant from the NEH Picturing America program, **Christopher Irmscher**, an expert on American literature, is using the work of John James Audubon to inspire America’s teachers.

## A requiem for the innocent

Terrorism may seem an unlikely musical inspiration, but not for **Jorge Muñiz**. Studying for his doctorate in Manhattan in 2001, Muñiz was a direct witness of the September 11 attacks. “During the days that came after that darkest hour,” Muñiz says, “I experienced something I had never felt so strongly before, a sense of unity . . . and of our common values not only as Western civilization, but as humanity. It has never left me since.”

Moved as well by terrorist attacks and bombings in Madrid, Muñiz, a Spanish-American and assistant professor of music at Indiana University South Bend, decided to compose *Requiem for the Innocent*, a work that expresses both longing for peace and a prayer for the souls of the departed.

Employing religious texts from Christianity, Islam, and Judaism and using five languages (Arabic, English, Greek, Hebrew, Latin, and Spanish), Muñiz worked for more than a year on the complex composition, supported in part by IU’s New Frontiers in the Arts & Humanities program and the Office of the Vice Chancellor of Academic Affairs at IU South Bend. The completed oratorio features seven movements and is performed by a baritone soloist, two mixed choruses, a male chorus, a children’s chorus, and orchestra.

In fall 2010, the South Bend Symphony Orchestra presented the world premiere of *Requiem for the Innocent* as a featured event during the 20th anniversary of the Ernestine M. Raclin School of the Arts at IU South Bend. A record-setting crowd of more than 1,400 attendees heard the debut performance, which a review called “magnificent . . . a creation that is profound, mature, and well-proportioned.”

“This piece is a religious piece,” Muñiz says. “It is faith-based, not only for those who left but also for us who are left behind. I wanted this to be a piece of hope.”

Irmscher is a professor of English in the College of Arts and Sciences at Indiana University Bloomington. His earlier work on Henry Wadsworth Longfellow led to the book *Public Poet, Private Man: Henry Wadsworth Longfellow at 200* (Harvard University Press), following a web exhibition that Irmscher curated for Harvard’s Houghton Library. With the recent Picturing America grant, Irmscher is directing a four-week summer institute for K–12 teachers.

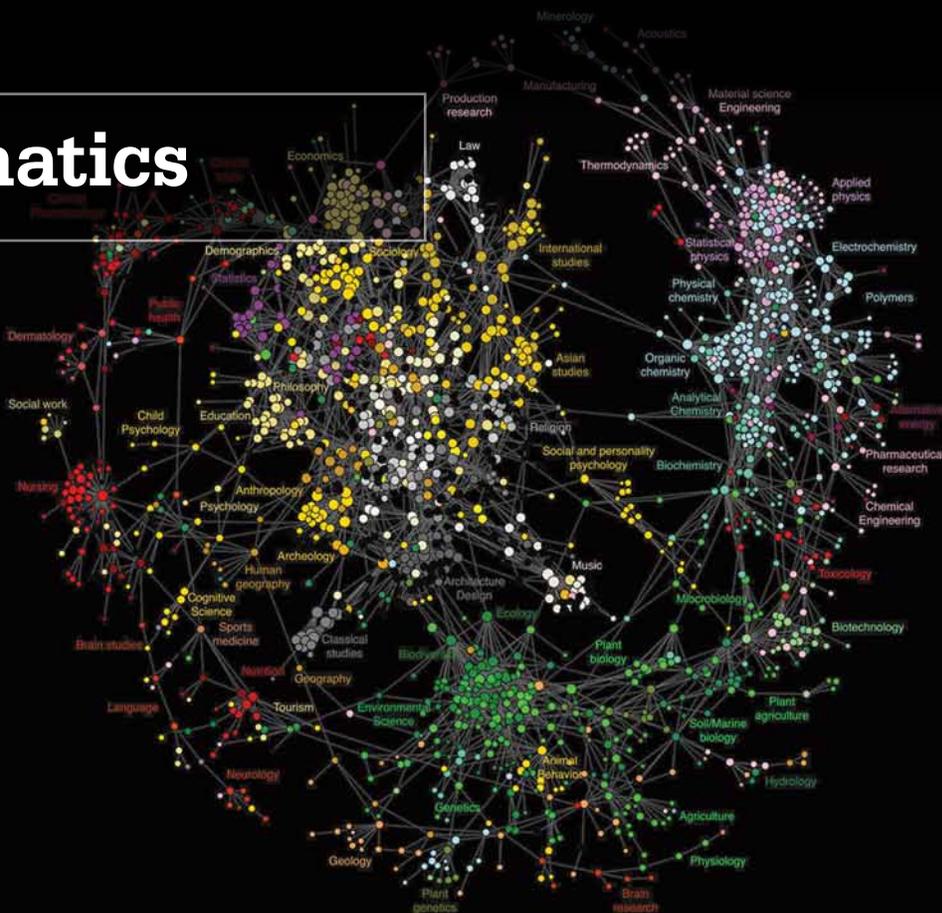
The institute, called Picturing John James Audubon, offers participants an opportunity to study Audubon’s art and writing in historical context with the goal of stimulating participants to pursue further research. Participants at IU benefit especially from the resources at the Lilly Library, which holds a Double Elephant Folio of Audubon’s *Birds of America* (an identical *Birds* manuscript sold for \$11.5 million).

Widely consulted as an Audubon expert, Irmscher has edited a collection of Audubon’s writings and drawings for the Library of America and appeared in the PBS film *Drawn from Life: John James Audubon*. Irmscher notes that the 19th-century artist didn’t fit the creative genius stereotype: “It’s unusual for art,” he says. “We tend to think of artists as solitary geniuses who produce exceptional masterpieces, but from the beginning, [Audubon] wanted to produce images as prints so people could have all of the birds of America in their hands, so to speak.”



**RIGHT** Cardinal Grosbeak (Northern Cardinal). From John James Audubon, *Birds of America*. New York: Published by J.J. Audubon; Philadelphia: J.B. Chevalier, 1840-1844. Courtesy, The Lilly Library, Indiana University Bloomington.

# Informatics



## How complex networks work

With an average 140 million tweets per day being sent by people around the world, Twitter is undeniably a powerful communications network. It's also a powerful predictor of the stock market.

Measurements of the collective public mood derived from millions of tweets can predict the rise and fall of the Dow Jones Industrial Average up to a week in advance with an accuracy of 87.6 percent. That was the finding of **Johan Bollen**, associate professor of informatics at Indiana University Bloomington, and doctoral student Huina Mao after analyzing more than 9.8 million tweets from 2.7 million users over 10 months. Bollen and Mao posted their National Science Foundation-funded research to the open access science archive arXiv in 2010 (with Google returning nearly 70,000 hits on the study in just two days).

After correlating Dow Jones and public mood values and implementing a prediction model, Bollen demonstrated that public mood had the ability to significantly improve the accuracy of the most basic models currently in use to predict Dow Jones closing values. "The calmness index appears to be a good predictor of whether the Dow Jones Industrial Average goes up or down between two and six days later," Bollen says.

In 2010, Bollen also received a \$349,000 grant from the Andrew W. Mellon Foundation, shared with the National Information Standards Organization, to build upon the METrics from Scholarly Usage of Resources (MESUR) project that he created with earlier Mellon funding. The new funding will support evolution of the MESUR project to a community-supported, sustainable scholarly assessment framework. MESUR's databases include data from more than 110,000 journals, newspapers, and magazines, along with usage reports covering more than 2,000 institutions, resulting in large-scale, longitudinal maps of the scholarly community and a survey of more than 40 different metrics of scholarly impact.

As a member of the Center for Complex Networks and Systems Research (CNetS) at IU, Bollen was also part of a research team that launched Truthy.indiana.edu in 2010. The Truthy project (named after a word coined by Stephen Colbert) is a sophisticated Twitter-based research tool that combines data mining, social network analysis, and crowd-sourcing to track the diffusion of misinformation in social media. During the 2010 midterm elections, Truthy identified several suspicious "memes," coming from accounts that generated thousands of tweets or retweets supporting, or smearing, candidates. After detection by the Truthy team, several of these accounts were shut down by Twitter.

ABOVE A map of science generated with usage data from Johan Bollen's METrics from Scholarly Usage of Resources (MESUR) project showing primary traffic patterns as users move from one scientific article and journal to the next.



McDonald, Börner, and Ding

## A national network for research

Information scientist **Katy Börner**, along with Indiana University colleagues **Ying Ding** (School of Library and Information Science), **Robert H. McDonald** (IU Libraries), and **William K. Barnett** (IU Research Technologies), are working to build a comprehensive national network that will facilitate collaboration among researchers working in a wide variety of scientific disciplines.

With funding from the National Institutes of Health, Börner is leading a team of 22 faculty, staff, and students to implement an IU version of VIVO—a web application originally developed by researchers at Cornell to help scientists with mutual interests more easily find each other, share information, and potentially collaborate. Currently being piloted at IU and other schools including the University of Florida, Weill Cornell Medical College, Washington University in St. Louis, the Scripps Research Institute, and the Ponce School of Medicine in Puerto Rico, VIVO makes available information on the people, departments, facilities, and other resources that constitute a university’s research and scholarship environment in the sciences.

“Many researchers have profiles and evolving networks on multiple but incompatible sites such as Facebook and Google, but these tools do not completely address their needs,” Börner says.

VIVO is designed specifically to meet those needs. In many ways, VIVO works like a regular website, allowing users to search for people, articles, and other information. But it also enables scientists to collect information and assemble it on a unique page that, in effect, creates their own network of researchers, published articles, data, and other elements. Börner’s team at IU’s Cyberinfrastructure for Network Science Center leads the social networking team handling the data analysis and visualization parts of the project.

Besides her work on VIVO, Börner collaborated on multiple visualization-related projects throughout 2010, including *Scaling Philanthropy: Providing New Insight About Million Dollar Gifts*

(funded by the Bill & Melinda Gates Foundation), *Analyzing and Mapping the Interdisciplinarity of NSF Proposals* (funded by the National Science Foundation), and *Mapping the Emergence and Development of Scientific Disciplines* (funded by the James S. McDonnell Foundation).

In 2010, Börner also published her latest book, *Atlas of Science: Visualizing What We Know* (MIT Press), a wide-ranging exploration of mapping scientific information.

## Cloud computing

As a part of the Indiana University Pervasive Technology Institute, the Digital Science Center at IU Bloomington is home to researchers who are defining powerful new computational techniques as they explore the world of grid and cloud computing technologies.

Cloud computing—often compared to the electrical grid that provides service without requiring the user to know or understand where the power is generated—means on-demand access via the Internet to computational, software, storage, and data services.

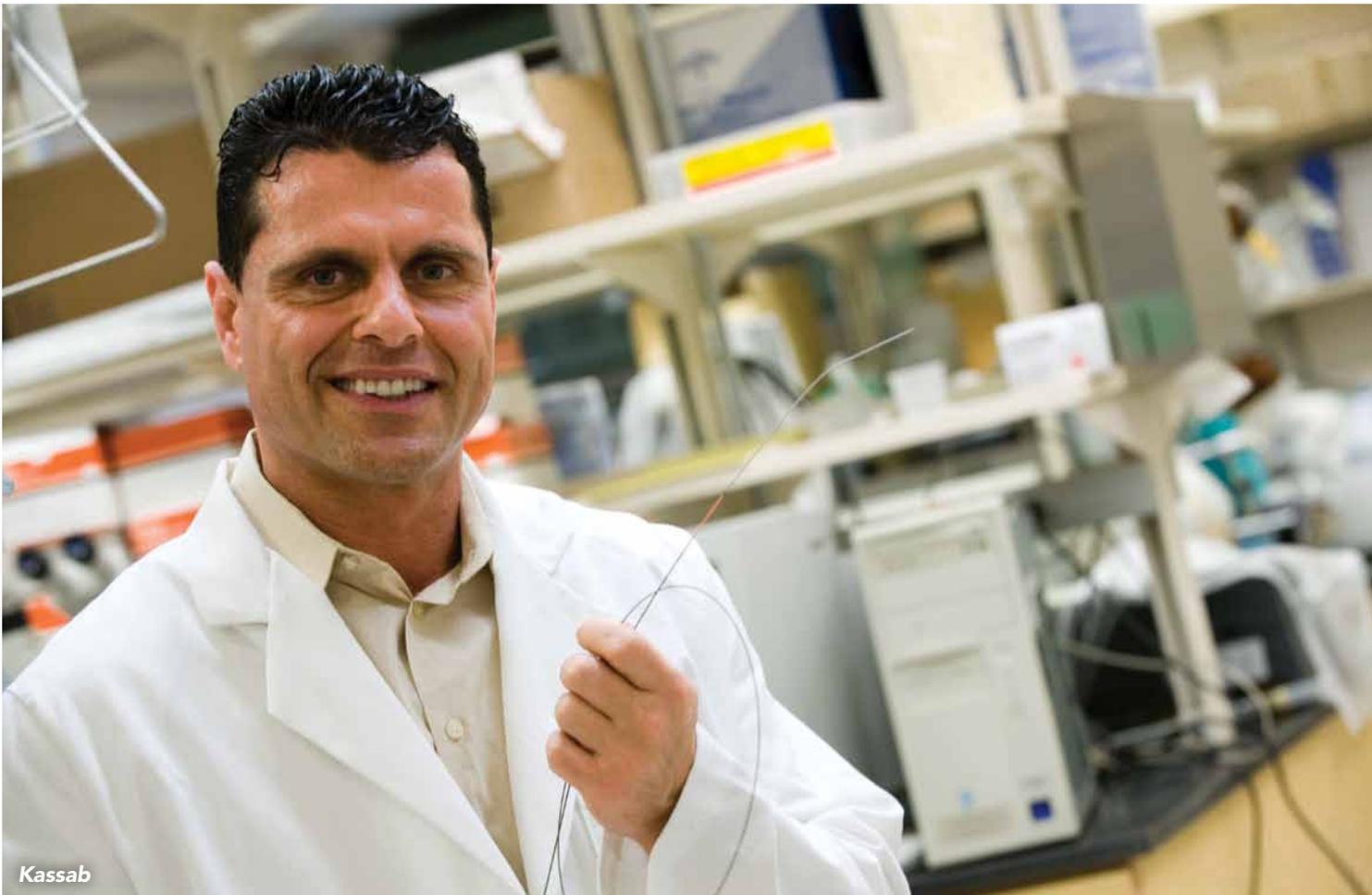
**Geoffrey C. Fox**, Distinguished Professor of informatics, computing, and physics in the School of Informatics and Computing, leads IU’s Digital Science Center. A leader in the field of high-performance computing for nearly four decades, Fox serves as principal investigator for FutureGrid, a \$15 million collaborative project that began in 2009 funded largely by the National Science Foundation. FutureGrid is a national grid- and cloud-computing test bed allowing numerous scientists to work together on new cloud technologies. These technologies have the potential to revolutionize how business is conducted and how scientific research is achieved. FutureGrid research will be used by the U.S. government to create a national next-generation supercomputing network.

The Digital Science Center develops applications for a range of research disciplines including polar science, biology, particle physics, and chemical informatics. During 2010, the center acquired 21 new research grants totaling more than \$5.1 million.

In fall 2010, the Pervasive Technology Institute and Digital Science Center hosted the prestigious IEEE International Conference on Cloud Computing Technology and Science (CloudCom 2010), with Fox serving as general chair. The conference brought hundreds of cloud-computing researchers from around the world to Indiana to discuss the future of scientific research

and business using cloud technologies. By hosting events such as CloudCom and leading large-scale research projects such as FutureGrid, Geoffrey Fox, the Digital Science Center, and the Pervasive Technology Institute have established IU as an international leader in cloud-computing research.





Kassab

## Remodeling the heart

Heart disease is the leading cause of death in the United States. Studying how increased blood pressure affects blood vessels and leads to heart disease is a main focus for bioengineering specialist **Ghassan Kassab** and a team of researchers at the School of Engineering and Technology at Indiana University-Purdue University Indianapolis.

Kassab is Thomas J. Linnemeier Guidant Chair in the Department of Biomedical Engineering as well as professor of surgery and cellular and integrative physiology. Kassab and his research group study the biomechanics of the cardiovascular system, focusing on cardiovascular engineering, especially vascular systems, coronary circulation, and tissue remodeling. “Reductionists” in the group dissect systems down to their molecular, cellular, and tissue levels through basic research. “Integrationists” create systems through mathematical modeling to understand the integrated functioning of organs.

Kassab’s research and invention have launched four companies thus far. Three of these companies address different aspects of heart disease, including the Indianapolis-based FlowCo, launched with funding from Biocrossroads and other venture funds. Instead of using ultrasound to assess artery characteristics for stent procedures, the device to be marketed through FlowCo uses electrical impedance to measure flow in the arteries, resulting in a more precise and less expensive measuring device.

The fourth company addresses an epidemic not unrelated to heart disease—obesity—and offers patients an alternative to bariatric surgery that does not alter the anatomy or physiology of the stomach. Five grants from the National Institutes of Health, as well as funding from the American Heart Association, have supported Kassab’s collaborative research.

## Early warnings systems for better health

Each year, more than 19 million Americans stop smoking for more than one day, yet as few as 5 percent maintain abstinence for one year. Most return to smoking within one month. In **Anna McDaniel’s** view, information technologies can help.

An expert in consumer health informatics and nursing informatics, McDaniel’s research focuses on how information technologies may be used to promote positive health behaviors. In one project, McDaniel is partnering with Free & Clear Inc., the largest telephone counseling program for nicotine dependence in the United States, to test the effectiveness of interactive voice-response technology (IVR) for enhancing existing quit-line services to prevent smoking relapse. Preliminary results of the study indicate that frequent IVR monitoring during the immediate post-quit period is associated with significant reduction in smoking lapses after quitting.

The associate dean and Chancellor’s Professor at the Indiana

University School of Nursing in Indianapolis, McDaniel is also recognized for her pioneering use of video gaming technologies to promote health. During 2010, McDaniel and her team worked with Indiana-based company Gabriel Interactive to develop and test Ocean's Secret, an anti-smoking video game designed especially for girls ages 8–12. Players learn about the consequences of smoking and how tobacco companies use advertising to try to manipulate youth. A national field test in collaboration with Girls Inc. is being conducted in 2011.

McDaniel is also collaborating with Michigan State University researchers and the IU Informatics Research Institute on a cancer patient portal. McDaniel's team has designed a web portal to provide cancer patients experiencing distressing treatment symptoms with access to evidence-based cancer information and interactive interventions. Patients and their caregivers may log in to report symptoms and find out how family members can help with symptom management. Ultimately, McDaniel says, patient portals have the potential to serve as "an early warning system" regarding side effects of drugs and may increase responsiveness to patients by avoiding "telephone tag" with nurses.

"Patient portals provide patients with critical information about when they need to be seen or heard right away," McDaniel says. "If the situation is not at a critical level, the patient portal still lets providers know that the symptom or problem is there."

## Leading a health information revolution

Mention electronic medical records or health information exchange and the Regenstrief Institute quickly enters the conversation.

From dementia care to doctor-patient communication, researchers rely on the Regenstrief Institute for medical informatics and health-care research data.

The keystone of many institute research activities, the Regenstrief Medical Records System, is one of the nation's longest continually operating electronic medical record systems. The RMRS was one of the first to generate physician reminders through its computerized physician order entry system. Through its commitment to clinical standards, interoperability, and interchange of medical data, the Regenstrief Institute has extensive health-information exchange experience at local, regional, and national levels.

"For Indiana, and potentially for many regions across the United States, success in the electronic delivery of better patient care should also lead to success in realizing a whole new set of economic opportunities in the 21st century."

— *Dishwashers to Digital Medical Records: Indiana's Leadership in Health Information Technology, a Biocrossroads report*

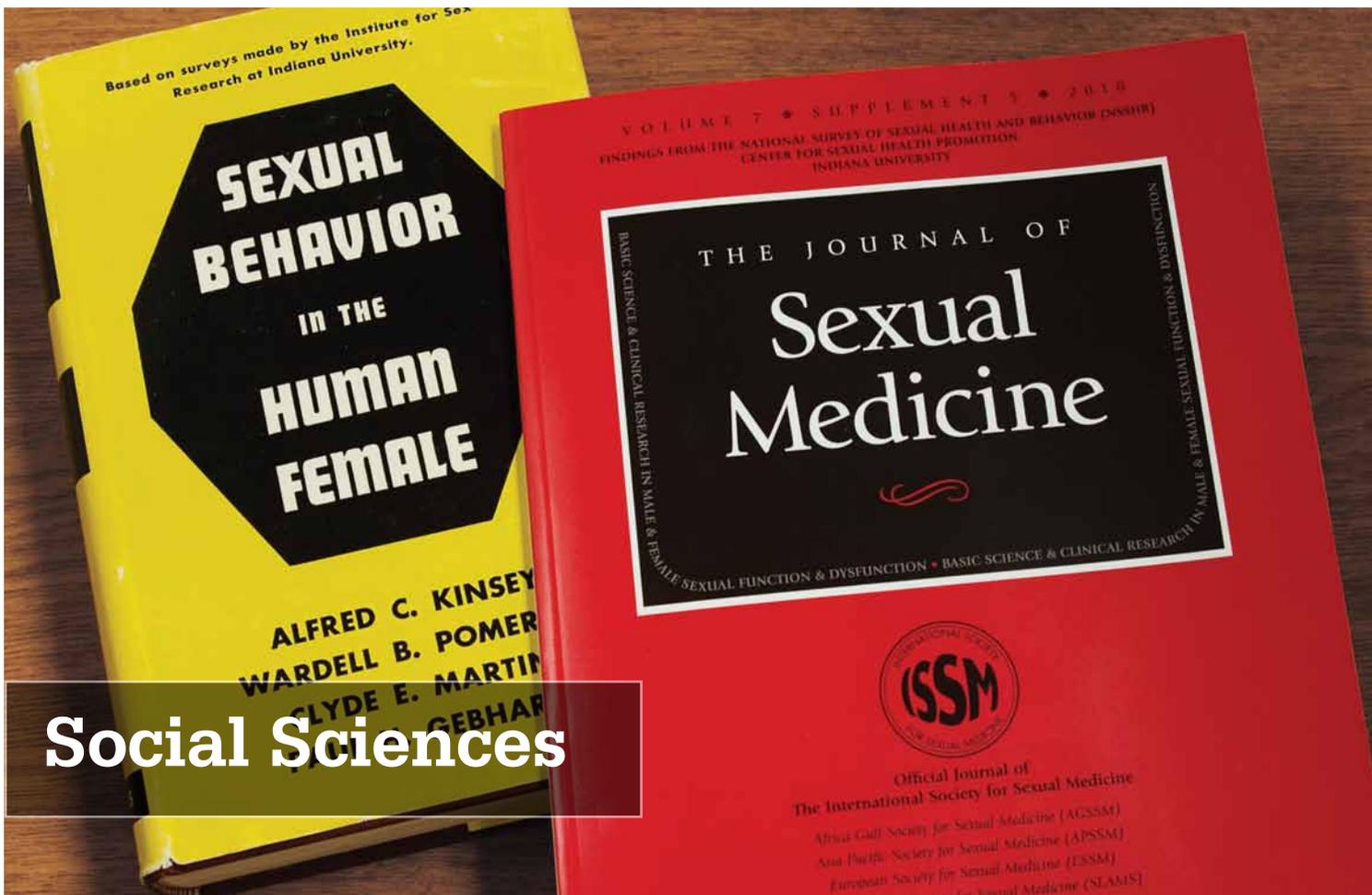


Established in 1969 by philanthropist Sam Regenstrief on the Indiana University-Purdue University Indianapolis campus, Regenstrief is closely affiliated with the IU School of Medicine. **William Tierney**, Chancellor's Professor, Sam Regenstrief Professor of health services research, and professor of medicine at the IU School of Medicine, is president and chief executive officer. Tierney also serves as associate dean for clinical effectiveness research at the School of Medicine. His research concerns the effects of computer-based interventions on improving health-care quality and lowering costs of health-care delivery.

In 2010, the World Health Organization designated the Regenstrief Institute's medical informatics group as the world's first WHO Collaborating Center for Medical Informatics. The institute's groundbreaking work on open-source community development in resource-constrained environments was critical to the WHO collaboration. Regenstrief Institute and School of Medicine researchers co-founded the Open Medical Record System, now the most widely implemented open-source electronic medical record system in the developing world.

In a 2010 essay appearing in the journal *Health Affairs*, Tierney and colleagues identified steps toward helping developing countries cross the "digital divide" and realize the potential of e-health systems such as the ones developed by the Regenstrief Institute.

"We have shown in Kenya that in spite of problems such as scarce resources, lack of trained personnel, ethnic tension, and even lack of dependable electricity, we can capture data electronically that have been used to enhance health-care delivery and outcomes along with community-based public health," said Tierney, who was previously director of research for the IU-AMPATH health-care program in Africa. "The investment in e-health pays for itself both financially and in terms of enhancing quality of care and accountability."



## Social Sciences

### Studying sexual health

More than 60 years ago, Alfred Kinsey and his research team released the first large-scale systematic studies of sexual behavior in the human male and female. In 2010, Indiana University sexual-health researchers released findings from the largest nationally representative study of sexual and sexual-health behaviors ever fielded.

The National Survey of Sexual Health and Behavior (NSSHB), conducted by researchers from the Center for Sexual Health Promotion at IU's School of Health, Physical Education and Recreation, is a comprehensive study of sexual and sexual-health-related behaviors. The survey included 5,865 adolescents and adults ages 14 to 94. Papers from the study available online were downloaded by more than 75,000 people in just six months.

The researchers say the survey will inform the development of public health programs.

"These data about sexual behaviors and condom use in contemporary America are critically needed by medical and public health professionals who are on the front lines addressing issues such as HIV, sexually transmissible infections, and unintended pregnancy,"

says **Michael Reece**, director of the Center for Sexual Health Promotion. The center was among IU Bloomington programs cited as part of the campus's 2010 Carnegie Foundation Community Engagement classification acknowledging significant commitment and responsiveness toward communities.

When it comes to responsible sexual behaviors among U.S. adults, those over the age of 40 have the lowest rates of condom use, while condom use is higher among black and Hispanic Americans. **Debby Herbenick**, associate director of the Center for Sexual Health Promotion, says the study helps both the public and professionals to understand how condom use patterns vary across stages in people's relationships and across ages.

A unique feature of the study was the inclusion of adolescents. **J. Dennis Fortenberry**, professor of pediatrics in the IU School of Medicine, led the adolescent aspects of the study. Additional co-authors include Stephanie Sanders of The Kinsey Institute for Research in Sex, Gender, and Reproduction and the Department of Gender Studies; and Vanessa Schick, Brian Dodge, and Susan Middlestadt of the Center for Sexual Health Promotion. The study was funded by Church & Dwight Co. Inc., maker of Trojan® brand sexual-health products.

ABOVE Sexual Behavior in the Human Male, by Alfred C. Kinsey at al., originally published 1948; Journal of Sexual Medicine, October 2010, containing findings from the National Survey of Sexual Health and Promotion

## The scholarship of standards

As a professor of business and marketing, **Subir Bandyopadhyay** is well aware of the importance of standards, measurement, and metrics. At the Indiana University Northwest School of Business and Economics, he is sharpening the school's assessment practices by researching student testing and comprehension standards.

In 2010, Bandyopadhyay received a Mack Fellowship, given to select full-time IU faculty members to advance the scholarship of teaching and learning through projects that will have an effect at IU and on scholarly teaching across the academy. In his fellowship project, Bandyopadhyay is investigating the need to balance national standardized tests, such as the Educational Testing Services Business Major Field Test, with Core Concept tests developed by individual universities that are modeled after the school's curriculum.

"Standardized ETS tests don't fit exactly our curriculum. There are certain things we teach that are not covered, such as ethics," Bandyopadhyay says. "So it's not the best fit of testing a student's comprehension."

Using both tests can give business schools a clearer picture of student comprehension and enable school officials to benchmark programs against other business schools, Bandyopadhyay adds.

While pursuing explorations in the scholarship of teaching and learning, Bandyopadhyay also continues his own marketing research. He recently completed a study examining the need for marketing in the nonprofit social service sector by asking questions about how different ethnic groups perceive social service agencies.

The study determined that the perceptions of African Americans and Hispanics about the quality of social services are strikingly different, both from the perceptions of Caucasians and between the groups themselves. The most significant differences, Bandyopadhyay says, concern topics related to family involvement and language barriers.

Bandyopadhyay hopes this research is a first step in filling a void for social service providers—the absence of a consumer profile that can help agencies deliver services to clients in the best way possible.

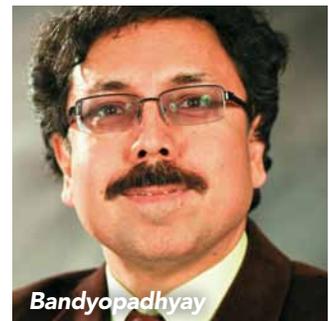
"With anything that is done, you have to quantify, assess, and document," says Bandyopadhyay.

## Confronting prejudice

Confrontation—expressing dissatisfaction with discrimination directly—can effectively reduce prejudice and empower victims. Yet people rarely say or do as much as they would like when they witness or experience discrimination. Research findings to date beg the question: Why are people reluctant to confront prejudice? **Leslie Ashburn-Nardo**, associate professor of psychology in the School of Science at Indiana University-Purdue University Indianapolis, is pursuing answers to that question.



Ashburn-Nardo



Bandyopadhyay



Herbenick



Reece

Ashburn-Nardo is a social psychologist whose research focuses on stereotyping and prejudice, particularly biases over which people have little conscious control. Along with colleagues from Butler University and Purdue University, she has developed the Confronting Prejudiced Responses (CPR) Model to describe factors that facilitate or inhibit confrontation.

Previous research on prejudice reduction, Ashburn-Nardo points out, demonstrates that confrontation reduces expressions of prejudice and empowers victims of prejudice—yet, despite these positive consequences, people often refrain from confronting prejudice. Her collaborative research project, funded by the National Science Foundation, is exploring why.

At IUPUI, Ashburn-Nardo is studying obstacles related to deciding how to respond and whether to take action against prejudice, including whether we feel sufficiently skilled and prepared to act and whether we think the benefits of confronting someone outweigh the costs of doing so. Ashburn-Nardo's colleagues are examining obstacles to confrontation in terms of a person's sense of urgency and perceptions of personal responsibility.

Understanding the factors that predict whether a person will confront prejudice will enable the development of programs that teach people how to use confrontation as a tool to deal with prejudice and incivility, Ashburn-Nardo says.

"Confrontation is not something we are taught how to do," she notes. "If people learn about the risks and benefits, they can make more informed decisions. If they know some of the risks they fear aren't really likely to happen, maybe they will be more inclined to speak up."



## Public health

### A global resource for breast cancer research

Continued advances in detecting, preventing, and treating breast cancer rely on a more complete understanding of the breast at each stage of development—from infancy to adulthood. That’s where the Susan G. Komen® for the Cure Tissue Bank at the Indiana University Simon Cancer Center comes in.

The Komen Tissue Bank is a unique resource that facilitates the comparison of healthy and diseased breast tissue. The only healthy breast tissue repository in the world, the bank currently maintains tissue specimens from more than 1,300 volunteer donors. Until recently, the bank could not supply all researchers with access to actual samples, but a \$1 million grant from the business software and hardware company Oracle is helping to change that.

The tissue bank is transforming specimens into digital data resources available online to any breast cancer researcher in the world. **Anna Maria Storniolo**, clinical professor of medicine at the IU School of Medicine, and **Susan Clare**, associate professor of surgery at the School of Medicine, are co-principal investigators helping to guide the tissue bank. The tissue bank team estimates several thousand researchers will use the digitized slides and tissue once the virtual bank is completed.

Clare herself is an unusual resource. With an M.D. and a Ph.D., she can be found in the operating room, treating breast cancer with

her surgical talents, but also in the laboratory, developing new therapies to attack breast cancer and measure how well those therapies are working.

Clare has, for example, explored the treatment of breast cancer using nanotechnology and proposes to deliver a “nanotherapeutic” to cancer cells using cells of the immune system. She also has been involved in developing a test for specific breast cancer biomarkers that could be administered at a patient’s bedside to tell doctors whether a breast cancer drug is working as expected. In short, Clare does “translational” research: research that takes laboratory discoveries and turns them into therapies for patient care.

“There are too few opportunities to synergize,” Clare says. “We need people who can do both the clinical work and the translational, to bring the two sides together.”

### Curbing STDs

With support from the Indiana Clinical and Translational Sciences Institute and the National Institutes of Health, Indiana University Bloomington researchers are exploring a poorly understood disease affecting many sexually active men.

The ICTSI, established in part with funding from the NIH, is a statewide collaboration between IU, Purdue University, University of Notre Dame, and public and private partners. ICTSI facilitates the translation of scientific discoveries in the lab into clinical trials and new patient treatments.

*Anna Maria Storniolo, left, and Susan Clare, far right, with Komen Tissue Bank volunteer Diane Doxey at a breast tissue collection event held at Fort Wayne Medical Oncology & Hematology in Fort Wayne, Ind., in November, 2010.*

**Barbara Van Der Pol**, assistant professor of epidemiology in the School of Health, Physical Education, and Recreation at IU Bloomington, and **David Nelson**, assistant professor of biology at IU Bloomington, are investigating idiopathic urethritis, a bacterial infection of the male urethra. “This is actually the main cause of male health-care visits to HMOs and other federal care institutions,” says Van Der Pol, citing a 2001 study in which nearly 70 percent of first-time clinical visits by men were related to the disease. Only one in five cases was effectively diagnosed and treated.

To investigate urethritis, Van Der Pol and Nelson collected samples from healthy young men in Indiana and patients at an STI/STD clinic in Indianapolis, then subjected the bacteria to high-tech molecular analysis. The study, funded by a \$6.1 million grant from the NIH’s Human Microbiome Project, is one of only eight projects chosen for the program nationwide. **J. Dennis Fortenberry**, professor of pediatrics at the IU School of Medicine and an expert on sexually transmitted diseases, serves as the principal investigator.

The project’s overall goal is to pinpoint the exact microbe combinations causing infection. Van Der Pol says preliminary tests found that some infected men lack a bacteria known to serve a protective function in women. Other subjects carried bacteria that, in women, may trigger miscarriage. Both findings suggest the study also may have an impact on women’s health research.

The research also could identify behaviors likely to cause urethritis, including the role of same- versus opposite-sex couplings or type of sexual activity. The next step is to use the new data to develop sexual-behavior recommendations for at-risk populations, empowering patients to improve their sexual health as well as avoid future clinical visits.

## Restoring waters

Without water, life on Earth would not exist—**Lenore Tedesco** is devoted to preserving, protecting, restoring, and sustaining Indiana’s water resources, especially streams, wetlands, and drinking water.

An environmental researcher and associate professor of earth sciences at Indiana University-Purdue University Indianapolis, Tedesco is director of the Center for Earth and Environmental Science, an IUPUI Signature Center. She is involved in a variety of collaborative research projects regarding water quality and use.

In two NASA-funded studies with IUPUI colleagues Lin Li and Meghna Babbar-Sebens, Tedesco is helping to develop remote sensing tools for mapping inland water quality and predicting response to climate change, using data collected from three Indiana reservoirs. Her research team is working with the U.S. Geological Survey and the IUPUI Polis Center to create a flood erosion hazard program for the state of Indiana. With support from the Indianapolis Parks Foundation, she is also developing stream and wetland restoration plans for Indianapolis park properties. And with international corporate partners, she is developing new strategies for treating and managing polluted runoff from agricultural fields before the runoff reaches water supply streams.

Tedesco maintains active leadership roles with the Upper White River and Eagle Creek Watershed Alliances, providing scientific expertise. She also has served as project director of the Central Indiana Water Resources Partnership with Veolia Water Indianapolis and with Citizens Energy Group, as they take over management of the Indianapolis water and wastewater system.

The applied research carried out by Tedesco and her colleagues at CEES is providing solutions to improve water resource management, but Tedesco makes it clear that education and outreach are just as important to water resource protection. “In suburban areas, you see evidence in the water of contamination from lawn care, household chemicals, even pet waste. People are just not in tune with the fact that what they do on land is going to end up in our water,” Tedesco says. “The first step is awareness, followed quickly by action items that people can embrace.”

## New tests for vision loss

The eye disease glaucoma affects some 70 million people worldwide and is a leading cause of blindness. With a \$2.35 million grant from the National Institutes of Health, **William H. Swanson**, a professor at the Indiana University School of Optometry in Bloomington, is advancing work to improve testing and treatment for this serious eye disease.

Swanson leads a research group conducting patient studies at clinics in Bloomington, Indianapolis, and New York City. Coupled with data from the United Kingdom, Swanson’s research team is working to improve methods of screening and testing for the presence, progression, and pattern of damage due to glaucoma.

Swanson’s research has already led to reconsideration of the widely held view that peripheral vision defects do not occur until after extensive loss of the ganglion cells, which transmit visual information from the retina to the brain. His research is now directed toward improving perimetry, or visual field, testing used to find certain patterns of vision loss, especially early changes in vision caused by nerve damage from glaucoma. Perimetry tests are also used to monitor whether treatment for glaucoma is preventing further vision loss.

With a new quantitative model for accurately comparing different clinical measures, along with development of a new test for glaucoma patients called contrast sensitivity perimetry (CSP), Swanson’s work is focused on optimizing protocols for CSP testing in clinics, testing the new model’s predictions in a large database, and developing a better understanding of how glaucoma damage is measured by CSP and other clinical methods.

“The potential public health benefit is substantial, given the large number of patients with glaucoma,” Swanson says.

Working with Swanson are Victor Malinovsky, a clinical professor at the IU School of Optometry’s Community Eye Care Center in Bloomington, and Bradley Sutton and Julie Torbit, both clinical professors at the IU Indianapolis Eye Care Center.



Daisy Sang and her newborn son, Ryan, at the Riley Mother & Baby Hospital in Eldoret, Kenya

# Global Outreach

# Global Outreach



## Access for all

More than 20 years ago, the Indiana University School of Medicine forged a partnership with the Moi University School of Medicine in Eldoret, Kenya, to develop leaders in health care for both countries. Since then, the Indiana-Kenya Partnership has created one of Africa's largest, most comprehensive, and effective HIV/AIDS control programs.

Known as AMPATH (Academic Model Providing Access to Healthcare), the program now treats more than 120,000 patients at more than 50 sites, including more than 25 satellite sites as well as 25 main clinics. The program has been nominated three times for the Nobel Peace Prize.

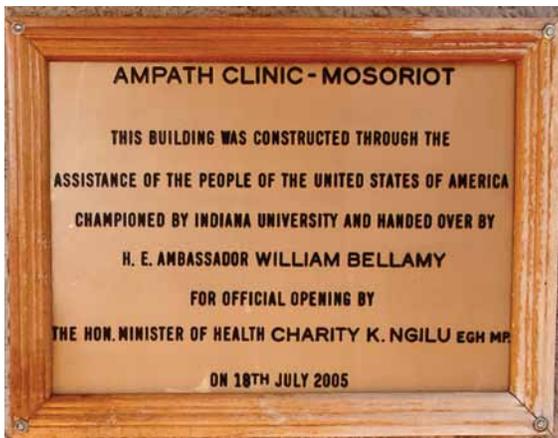
In partnership with the Kenyan government, AMPATH is making a transition to expand its services to primary and chronic disease care. In recent years, additional AMPATH projects have included the Riley Mother & Baby Hospital, the Orphans and Vulnerable Children program, and an agricultural program that provides clients of AMPATH with critical food support, including training and assistance in producing their own food.

**ABOVE** Joseph Mamlin, professor emeritus of medicine and field director of AMPATH, consults with a patient at a clinic in the Kenyan village of Mosoriot. **RIGHT** (Top) The Riley Mother & Baby Hospital in Eldoret, Kenya, opened in 2009. A major initiative of the IU-Kenya Partnership, the hospital is on the campus of Moi Teaching and Referral Hospital. Fundraising efforts by James Lemons, professor of clinical pediatrics at the School of Medicine, helped raise \$2.3 million to underwrite construction of the hospital. (Bottom) Robert Einterz, director of Indiana University's new Center for Global Health.

Building on the successes of the Indiana-Kenya Partnership, Indiana University has established a Center for Global Health, directed by **Robert Einterz**. Einterz is associate dean for global health and professor of clinical medicine at the IU School of Medicine and also co-founder of IU's partnership with Moi University and the AMPATH program. The new IU Center for Global Health will serve as a unifying infrastructure for all of IU's global health initiatives, which include partnerships with institutions in Botswana, China, the Dominican Republic, Honduras, Japan, Liberia, Mexico, and Thailand.

Housed at the IU School of Medicine, the center will encourage individuals from multiple campuses, disciplines, and schools within the IU system to work collaboratively toward developing sustainable programs that address the many dimensions of global health and health-care delivery, such as access to clean water and nutritious food, income security, and gender equity.

"Millions of lives around the world are cut short because of preventable diseases, and too many families suffer needlessly," says Einterz. "At IU's Center for Global Health, our mission is to provide care, training, and research to ensure that all people have access to basic health care, regardless of where they live."



“By any measure, Indiana University is one of America’s leading international universities. We could count ... the breadth and depth of international research and scholarship, the level and variety of international engagement, or the number of Title VI area studies centers: all of these point to that fact.”

—IU President Michael McRobbie, *State of the University Speech*, September 2010

# Global Outreach

## International partnerships

Partnerships between Indiana University and universities around the world create important opportunities for joint research efforts. By 2010, IU had primary partnerships with 42 universities including O.P. Jindal Global University in India, Chulalongkorn University in Thailand, the University of Zagreb in Croatia, and the University of Freiburg and Free University of Berlin in Germany.

IU President Michael A. McRobbie signed a memorandum of understanding with the Free University of Berlin in late 2010, renewing a half-century of relations with that city's largest research university and expanding the partnership into new areas of cooperation including faculty exchanges, joint workshops, and enhanced academic collaborations.

McRobbie also signed a memorandum with the University of Freiburg, one of Germany's oldest and most prestigious universities, founded in 1457. The agreement formalizes IU's academic and research collaborations with Freiburg, which has been home to some of the world's greatest thinkers and numerous Nobel laureates. The agreements with both institutions will open up opportunities in areas ranging from medical sciences to the study of music.

Also in 2010, Indiana University initiated an academic partnership with Bogazici University, described as Turkey's most selective institution of higher education. Bogazici President Kadri Ozcaldiran

visited Indiana in early 2010, meeting with faculty and administrative leaders to discuss ways IU will work with Bogazici to establish linkages in anthropology, Turkish Studies, history, business, education, and philanthropic studies. The philanthropic studies program would be the first of its kind in Turkey. Through the new agreement, IU and Bogazici will work toward identifying support for faculty exchanges, scholarships, and research programs.

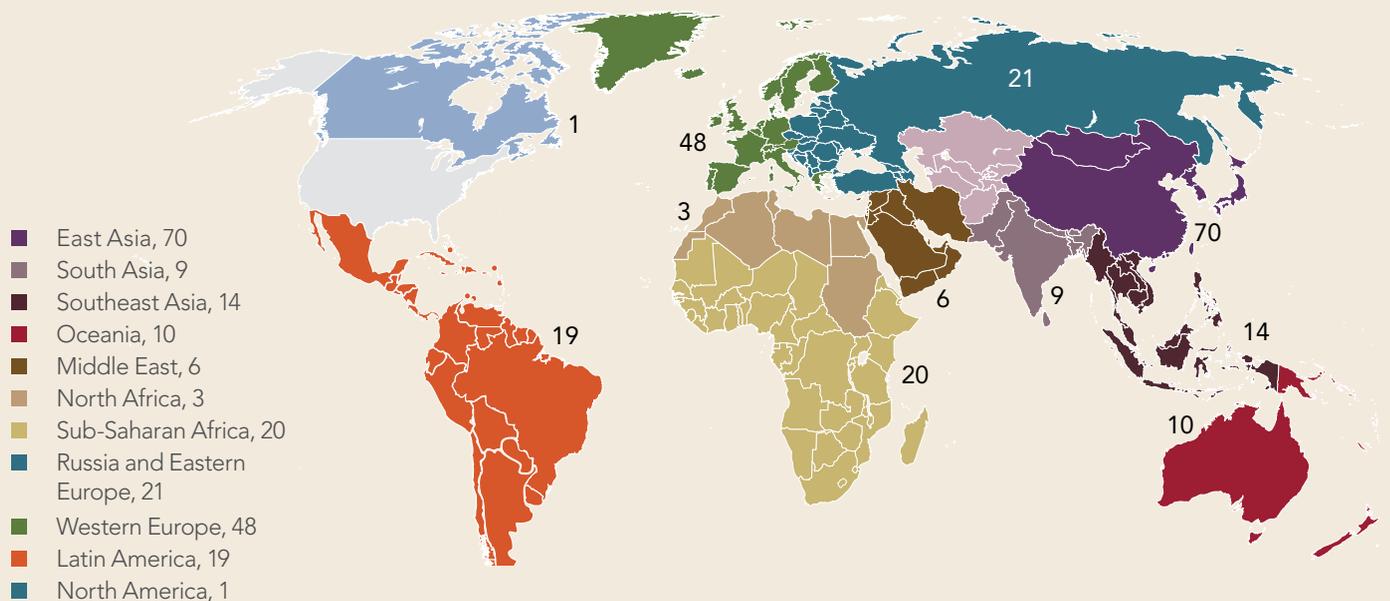
## Sustaining international business

In mid-2010, the Center for International Business Education and Research (CIBER) at Indiana University's Kelley School of Business in Bloomington was awarded a \$1.55 million from the U.S. Department of Education to focus on long-term sustainable approaches to international business practice and economic development. CIBER received its grant as part of \$17.6 million, awarded over four years to 10 international programs at IU, through the Department of Education's Title VI program.

The IU center, a part of the Kelley School since 1992, is a member of the national CIBER network of 33 centers. With its renewed Title VI funding, the IU CIBER will move its strategic focus toward promoting sustainable business practices internationally, especially through social entrepreneurship. New initiatives resulting from the grant include CIBER Share, an online portal for multimedia instructional materials that will benefit faculty at U.S. colleges and

## University Partnerships 2010

In addition to 42 primary university-wide partnership agreements, Indiana University has nearly 200 other international partnerships in place, including academic unit-to-unit agreements and formal cooperative relationships between IU and institutions other than universities.



Courtesy IU International Fact Book

universities as well as K–12 teachers, business managers, and government officials; a short-term international faculty development program focusing on sustainable business practices in Latin America and the Caribbean; and expansion of the Kelley School’s Global Business and Social Entrepreneurship consulting program for entrepreneurs and small-business owners in emerging economies. Active in Peru the last two years, the program will expand to India and Ghana.

## Speaking the world’s languages

Offering courses on more than 80 languages, Indiana University’s world language disciplines are well established and widely known. In 2010, the College of Arts and Sciences at IU Bloomington added a new undergraduate Swahili Flagship program, led by **Alwiya Omar**, clinical associate professor in the Department of Linguistics and an expert in the field of Swahili language pedagogy.

The program is part of the Language Flagship, a federally funded initiative that is a component of the National Security Education Program at the U.S. Department of Defense. With a three-year grant of \$600,000, the Swahili Flagship is IU’s third such advanced language program, joining undergraduate and graduate Chinese Flagship programs led by Jennifer Liu, professor in the Department of East Asian Languages and Culture. Swahili is the language of more than 70 million people in Kenya, Uganda, and Tanzania, as well as in parts of Somalia, Democratic Republic of Congo, Rwanda, Burundi, and the Comoro Islands.

In 2010, IU also participated in the Second Lieutenant Afghan Language Program, offered through the Indiana Complex Operations Partnership (InCOP), a growing collaboration between IU and the Indiana National Guard. InCOP offers highly specialized training to prepare military service personnel from across the country for international deployments.

The Afghan language program tapped the expertise of IU’s Title VI Center for Languages of the Central Asian Region. Instruction in Pashto and Dari, the official languages of Afghanistan, emphasized cultural awareness and everyday use of the language. The Muscatatuck Urban Training Complex in southeastern Indiana, designed to simulate a city in crisis, provided numerous opportunities for practicing the languages in a realistic setting. For student Josh Guerra, a second lieutenant and class leader, learning the cultural meaning behind the words was the biggest challenge.

“Like any language, not only do you have to learn what the word means on the face of it, but in what situations it would be used,” he says. “Wrapping one’s mind around that is something quite difficult.”

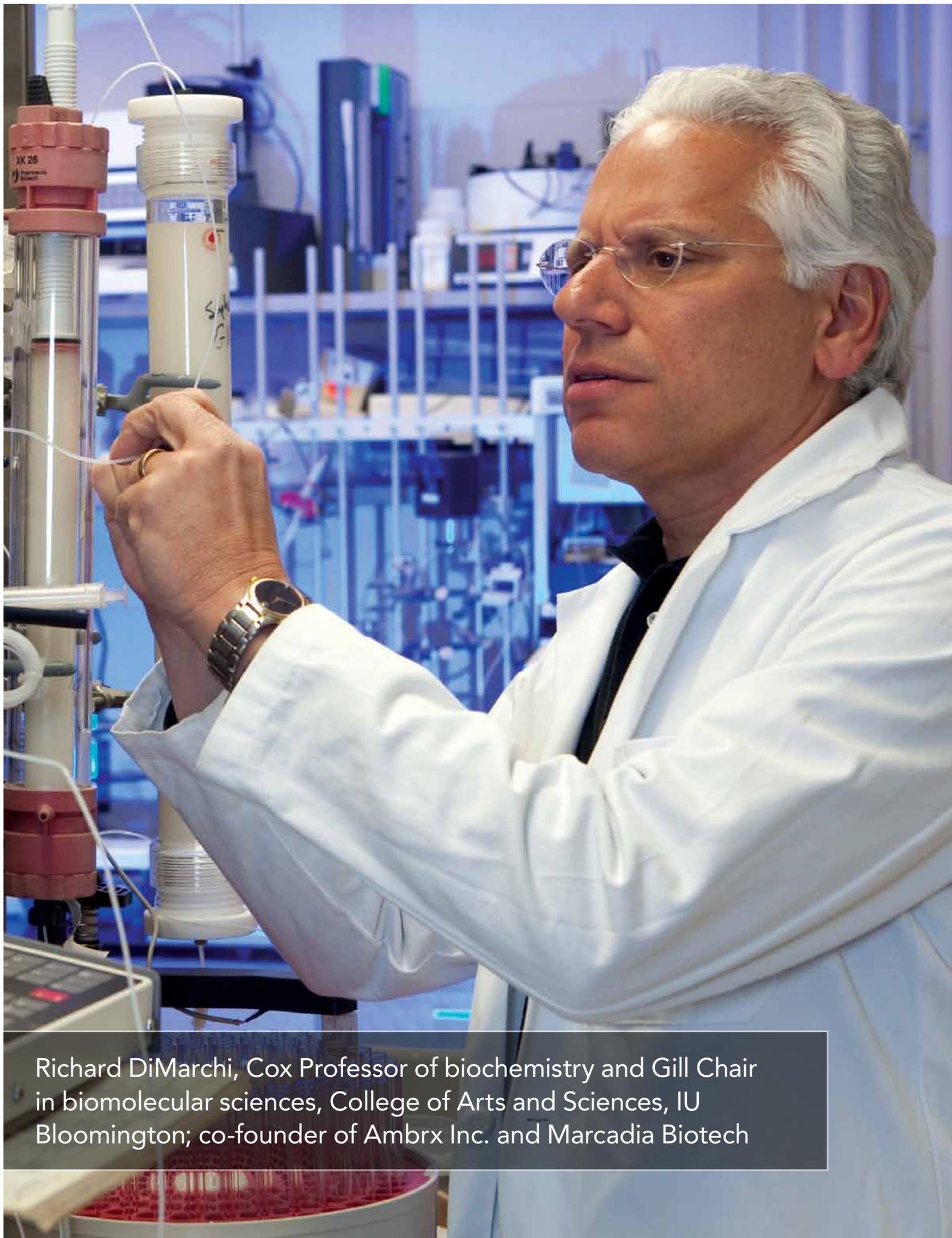
InCOP leaders are now exploring the possibility of offering similar courses involving other languages and cultural activities considered critical to international efforts. Potential partners could include federal agencies such as the State Department and Homeland Security, ROTC programs from other branches of service, and nongovernmental organizations.



## Title VI programs

Indiana University is in the top tier of universities maintaining federally funded Title VI international centers and programs in the United States. In 2010, the IU units with U.S. Department of Education Title VI funding were:

- African Studies Program
- Center for International Business Education and Research
- Center for the Languages of the Central Asian Region
- Center for Latin American and Caribbean Studies
- Center for the Study of Global Change
- Center for the Study of the Middle East
- East Asian Studies Center (with University of Illinois)
- Inner Asian and Uralic National Resource Center
- Islamic Studies Program
- Latin American Studies
- Russian and East European Institute



Richard DiMarchi, Cox Professor of biochemistry and Gill Chair in biomolecular sciences, College of Arts and Sciences, IU Bloomington; co-founder of Ambrx Inc. and Marcadia Biotech

Innovation



# IU Emerging Technologies Center

on the campus of Indiana University-Purdue University Indianapolis

## Bringing diabetes discoveries to patients

In 2010, Roche, the world's largest biotech company, acquired Marcadia Biotech for what could amount to more than \$500 million. Marcadia, founded in 2005, focuses on treatments for diabetes and obesity. Much of the company's success is based on the research of co-founder **Richard DiMarchi**, Cox Professor of biochemistry and Gill Chair in biomolecular sciences in the College of Arts and Sciences at Indiana University Bloomington.

The novel technologies developed in DiMarchi's lab have received sizable interest from leading pharmaceutical companies. Roche is providing \$287 million initially, with the potential for an additional \$250 million dependent on developmental milestones.

A former Group Vice President of biotechnology at Lilly Research Labs, DiMarchi's current research endeavors focus on developing peptides and proteins with enhanced therapeutic properties through an approach he has termed chemical-biotechnology.

DiMarchi is co-inventor on more than 100 patents. In addition to large sums of research funding from non-public sources that DiMarchi's lab attracts, the university receives licensing income arising from inventions that derive from his laboratory pertaining to Marcadia and from comparable agreements involving other research activities at IU.

“A person's life can be divided into three phases: learn, earn, return. I'm following that philosophy and living it to great fulfillment.”

—Richard DiMarchi, Cox Professor of biochemistry and Linda and Jack Gill Chair in biomolecular sciences, IU Bloomington

## Breakthrough basic research leads to new companies

The 2010 report *Sparking Economic Growth: How federally funded university research creates innovation, new companies and jobs* traced the origins of 100 companies to breakthrough research conducted at a university and sponsored by a federal agency. Compiled by the Science Coalition, a nonprofit organization of 45 leading public and private research universities, the report highlighted six Indiana University start-up companies.

Four companies were included among the report's 100 "success stories" fueled by federally funded research. The four IU-affiliated success stories are:

- **CS-Keys Inc.**, Indianapolis, a biotechnology company focusing on the discovery and development of third-generation cancer-associated biomarkers using proteomics.
- **FAST Diagnostics Inc.**, Indianapolis, a medical-technology company developing a reusable optical device and a single-use injectable fluorescent compound to provide cost-effective, rapid, and accurate measure of kidney function.
- **ImmuneWorks Inc.**, Indianapolis, a biotechnology company developing safe and effective immune tolerance treatments for autoimmune diseases, including idiopathic pulmonary fibrosis of the lung.
- **Therametric Technologies Inc.**, Noblesville, a dental technology company developing innovative devices and methodology to enhance detection and prevention of dental caries and other dental maladies.

Each of these four companies leveraged federal funding received from the National Institutes of Health and found the funding instrumental to the development of their core technologies.

The IU companies are highlighted alongside successful companies such as Google, Genentech, Cisco Systems, and iRobot.

## Innovate Indiana

The Innovate Indiana Fund is designed to invest in emerging-technology start-ups that propel Indiana University discoveries toward the marketplace and stimulate Indiana's economy. By the end of 2010, the fund had completed investments in its first three companies. The \$10 million fund, announced in December 2009 by IU President Michael McRobbie, is unique in that it invests in technologies and companies, not other funds.

The first three Indianapolis-based companies funded by Innovate Indiana are:

- **Aarden Pharmaceuticals**, located in IU's Emerging Technologies Center in Indianapolis, is a small molecule drug discovery and development company using technologies developed in the labs of IU School of Medicine researchers, including co-founder **Zhong-Yin Zhang**, the



Dennis



DiMarchi



Kelley



Zhang

Robert A. Harris professor and chair of the Department of Biochemistry and Molecular Biology at the School of Medicine. Its initial programs are focused on infectious disease, cancer, metabolic, and autoimmune conditions.

- **ApeX Therapeutics**, a joint start-up between cancer researchers at IU and Purdue University, is a biotechnology company focused on the discovery and development of novel pharmaceuticals for the treatment of pancreatic and brain cancers as well as age-related macular degeneration. ApeX's chief scientific founder is **Mark Kelley**, the Betty and Earl Herr Chair in pediatric oncology research and professor in the Department of Biochemistry and Molecular Biology and the Department of Pharmacology and Toxicology at the IU School of Medicine. Kelley is also associate director of the Herman B Wells Center for Pediatric Research and for basic science research at the IU Simon Cancer Center.
- **Courseload** was co-founded by **Alan R. Dennis**, professor and the John T. Chambers Chair of Internet systems in the IU Kelley School of Business in Bloomington. Located in the Emerging Technologies Center, this electronic media delivery company specializes in providing higher educational learning resources through collaborative web and stand-alone software platforms.

A photograph of the IU Innovation Center building, a modern structure with a large glass facade and a prominent overhanging roof. The building is set against a blue sky with scattered white clouds. The glass reflects the sky and surrounding greenery. The building's design is contemporary, with clean lines and a mix of materials including glass and light-colored panels.

# IU Innovation Center

Home to the IU Research and Technology Corp., Pervasive Technology Institute, Center for Applied Cybersecurity and Research, Hoosier Hatchery, Persistent Systems Inc., and Department of Environmental Health

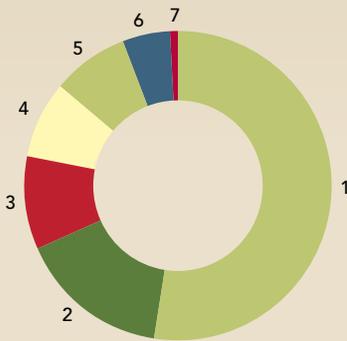
Growth

# Growth

## Awards by Direct Source

FY2010

|                           |                      |
|---------------------------|----------------------|
| 1. Federal, 52%           | \$318,458,264        |
| 2. Foundations, 16%       | \$95,279,593         |
| 3. Commercial, 10%        | \$57,900,090         |
| 4. Nonprofit, 8%          | \$48,823,502         |
| 5. State of Indiana, 8%   | \$49,163,574         |
| 6. Higher Education, 5%   | \$30,332,000         |
| 7. Other governmental, 1% | \$3,995,040          |
| <b>TOTAL</b>              | <b>\$603,952,063</b> |



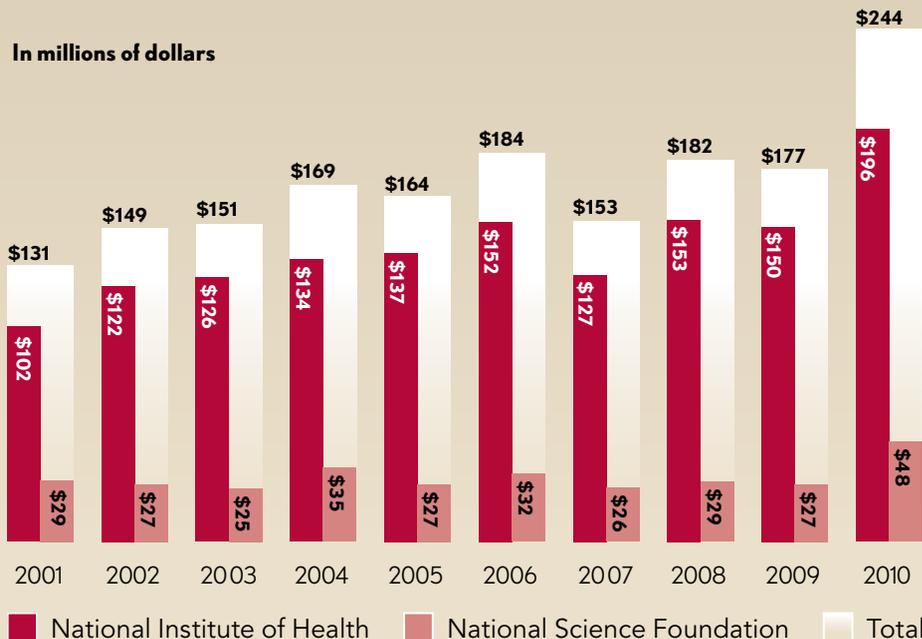
## Technology Commercialization

FY 2006-10

|  | FY06  | FY07  | FY08  | FY09  | FY10   |
|--|-------|-------|-------|-------|--------|
| Invention disclosures received                               | 257   | 216   | 144   | 131   | 154    |
| Licenses executed  | 65    | 70    | 35    | 34    | 27     |
| Patent applications filed                                    | 72    | 118   | 170   | 210   | 244    |
| Patents issued   | 19    | 24    | 16    | 8     | 15     |
| Royalties, fees, milestones<br><i>in millions of dollars</i> | \$6.7 | \$4.2 | \$4.9 | \$5.9 | \$14.1 |

## National Institutes of Health AND National Science Foundation Sponsored Program Activity

In millions of dollars

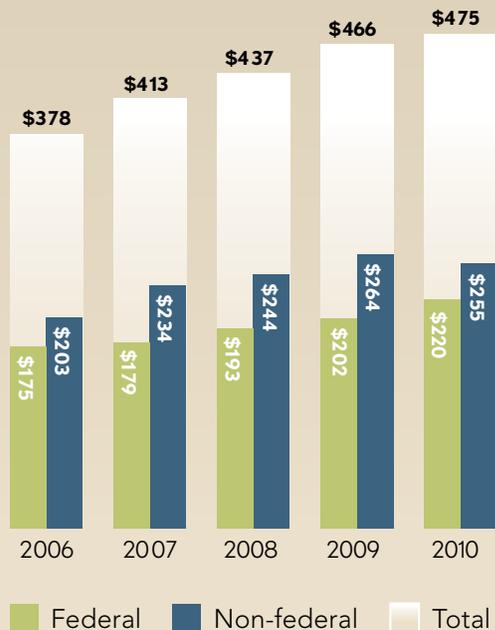


IU funding from the NIH and NSF in 2010 increased 37.8 percent over funding in 2009, largely due to the stimulus funding from the America Recovery and Reinvestment Act.

## Research Expenditures

FY 2006-10

In millions of dollars



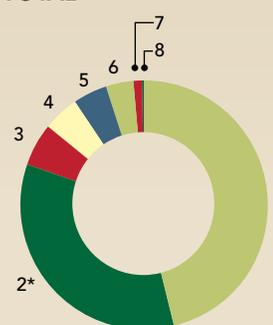
## Expenditures by Source

FY 2010

|                              |               |
|------------------------------|---------------|
| 1. Federal, 46%              | \$220,172,126 |
| 2. University Internal*, 34% | \$161,524,250 |
| 3. Foundations, 6%           | \$27,273,630  |
| 4. Commercial, 5%            | \$22,497,377  |
| 5. Higher Education, 4%      | \$20,308,354  |
| 6. Nonprofit, 4%             | \$18,145,414  |
| 7. State of Indiana, 1%      | \$4,609,260   |
| 8. Other governmental, <1%   | \$937,727     |

TOTAL

**\$475,468,138**



\* University Internal consists of direct costs on internally funded accounts as well as calculated indirect costs. It also includes cost share and unrecovered indirect costs on sponsored projects.

## Expenditures by Federal Agency

FY 2010

|   |                      |
|---|----------------------|
| 1. Department of Health and Human Services        | \$166,837,316        |
| 2. National Science Foundation                    | \$28,824,942         |
| 3. Department of Defense                          | \$14,304,273         |
| 4. US Department of Energy                        | \$4,302,755          |
| 5. US Department of Education                     | \$1,503,639          |
| 6. NASA   | \$1,351,360          |
| 7. US Environmental Protection Agency             | \$733,967            |
| 8. National Institute of Standards and Technology | \$553,522            |
| 9. US Department of Agriculture                   | \$542,301            |
| 10. All other federal agencies                    | \$1,218,052          |
| <b>TOTAL</b>                                      | <b>\$220,172,126</b> |

## Expenditures by Unit\*

FY 2010

|                             |               |
|-----------------------------|---------------|
| 1. Medicine                 | \$249,867,364 |
| 2. Arts & Sciences          | \$95,011,365  |
| 3. VP Research              | \$30,605,842  |
| 4. VP IT                    | \$14,459,912  |
| 5. Engineering & Technology | \$9,958,190   |
| 6. Education                | \$9,176,569   |
| 7. Science                  | \$8,927,716   |
| 8. Informatics              | \$7,965,366   |
| 9. Business                 | \$7,830,297   |
| 10. Nursing                 | \$7,096,745   |

\* Includes university internal funding. University Internal consists of direct costs on internally funded accounts as well as calculated indirect costs. It also includes cost share and unrecovered indirect costs on sponsored projects.



# INDIANA UNIVERSITY

## OFFICE OF THE VICE PRESIDENT FOR RESEARCH

Carmichael Center, Suite 202  
530 E. Kirkwood Ave.  
Bloomington, IN 47408

Change Service Requested

Nonprofit Organization  
U.S. Postage Paid  
Permit No 2  
Bloomington, IN 47401



## Bluebird Male, Female, and Young

Drawn from Nature by J.J. Audubon

Indiana University's Lilly Library owns a Double Elephant Folio of Audubon's 19th-century masterpiece, *Birds of America*. The Lilly's copy contains 435 meticulously detailed, hand-colored illustrations. Indiana University Bloomington Professor of English Christoph Irmscher, an Audubon expert, uses the Lilly's Audubon manuscript during his Picturing John James Audubon Institute for secondary teachers. The institute is made possible by a grant from the National Endowment for the Humanities Picturing America initiative.

From John James Audubon, *The Birds of America*, 1840-1844.  
Courtesy of the Lilly Library, Indiana University Bloomington