



IUPUI
OFFICE OF THE
VICE CHANCELLOR
FOR RESEARCH

RESEARCH &
CREATIVE ACTIVITY
MATTERS @ IUPUI

2012
RESEARCH
REPORT



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FROM INNOVATION TO IMPACT

Message from the Vice Chancellor for Research

I am delighted to present the IUPUI Annual Research Report for Fiscal Year 2012. This has been yet another remarkable year for research at IUPUI. Research expenditures reached an all-time high of \$288 million, significantly impacting such diverse areas as the arts and humanities, energy, and human health. This achievement has been supported by a strategic research roadmap, which was developed by campus stakeholders and launched in 2008, as the guidepost to aid IUPUI to reach its full potential in research and scholarly activity. The main goal of the roadmap has been for IUPUI to be a top urban research university, conducting research that has great socioeconomic impact. This goal is getting realized through the development and expansion of innovative research programs that align with the institutional mission and strategic plan, address important national and global needs, and through technology transfer and commercialization, noticeably support the economic development of Indiana and the nation.

In Fiscal Year 2012, the IUPUI research enterprise has continued its robust advancement, with significant achievements in many areas. This report highlights the broad range of research and creative activity carried out by IUPUI investigators during this period. It is organized around key campus-wide strategic initiatives, including the IUPUI Center for Translating Research into Practice, the Signature Centers Initiative, Medical and Life Sciences initiatives, the IUPUI Arts and Humanities Institute, the Integrated Nanosystems Development Institute, the STEM Education Research Institute, and the IUPUI Imaging Research Initiative. The report also has sections on innovative programs exposing undergraduate students to the research experience, and on effective community engagement projects. Moreover, it highlights how, through technology transfer and commercialization, IUPUI research outcomes are having an impact on economic development and social well-being.

To learn more about the innovative research conducted at IUPUI, I invite you to visit our research webpage at research.iupui.edu, or contact us at OVCR@iupui.edu.

Kody Varahramyan, Ph.D.
Vice Chancellor for Research



TRANSLATING RESEARCH INTO PRACTICE (TRIP)

New Center Improves Quality of Life

Chancellor Charles R. Bantz and Dr. Sandra Petronio

IUPUI is increasingly known for success in translational research, research that bridges the gap between generating new knowledge and using that knowledge to solve everyday problems and improve people's lives. The projects are as varied as the human story, yet all of them share an intrinsic connection to the community. Understanding the importance of that link led Chancellor Charles R. Bantz to



Stephan Viehweg

establish the Center for Translating Research Into Practice. Dr. Petronio is a nationally recognized translational researcher in the field of communication and serves as the Center's Founding Director. The Center is directed by Stephan Viehweg, who is assisted by the strategy team of Sandra Petronio (TRIP Project Leader), Dennis Fortenberry (TRIP Faculty Fellow), and Teresa Bennett (IUPUI Solution Center Director). "The faculty at IUPUI has a long history of partnership with the community as well as engaging students in research efforts that matter," observes Bantz. The Center hosts the annual *IUPUI TRIP Showcase*



Dr. Patricia Scott



Dr. Tamara Leech

as well as an annual *TRIP Keynote Address* to encourage faculty, students, and the community to engage in dialogues that result in additional translational research efforts.

In a personal effort to promote the growth of translational research on campus, Chancellor Bantz and Dr. Petronio have established the *Bantz-Petronio Translating Research Scholarship Into Practice Award*. The "TRIP Award" recognizes outstanding work in translational research by IUPUI faculty and includes a monetary award. The inaugural award will be announced in spring 2013 followed



by the recipient presenting their research at the 2013 *TRIP Showcase*.

TRIP SCHOLARS SHOWCASE

Dr. Tamara Leech (Liberal Arts) discovered that Mapleton-Fall Creek community members were more likely to draw on informal, rather than formal, sources of support to fulfill the needs related to the well-being of teen mothers and fathers, and their children. Her findings support the efficacy of extending the *Women's Information and Support Exchange* (WISE) program in specific, low-income neighborhoods. Dr. Patricia Scott (Health and Rehabilitation Sciences) used personal experience to explore strategies to support successful life experiences after liver transplants. Finding very little research in this area, Dr. Scott has engaged in a three-phase research project that explores the best interventions to support individuals struggling to resume meaningful, post-transplant lives.



IUPUI SIGNATURE
CENTERS
INITIATIVE

Not a Solo, but a Chorus

Dr. Flora Hammond



Since its 2007 launch, this initiative has become a cornerstone of the IUPUI research enterprise, playing an important role in enhancing research and scholarly activity while fostering the development of research centers that are improving IUPUI's national and international reputations. The following are examples of centers currently funded under the Signature Centers Initiative.

CENTER FOR PANCREATIC CANCER RESEARCH:

The mission of the Center is five-fold: 1) to promote a better understanding of the critical pathways and molecular mechanisms involved in pancreatic tumor development, 2) to stimulate the consistent and productive exchange of ideas between clinicians and basic scientists, 3) to facilitate external funding for its members, 4) to disseminate information across the Indiana medical and research communities, and 5) improve pancreatic cancer patient outcomes. The Center, comprised of basic, translational, and clinical researchers, represents the continuum of disease research from biological and molecular investigation to clinical trials. The Center is directed by Dr. Murray Korc.

CENTER FOR BRAIN REHABILITATION, ADVANCED IMAGING, AND NEUROSCIENCE:

The research mission of the Center is to integrate and further develop neuroimaging and behavioral measurement technologies to provide integrated, and interdisciplinary methods for examining the natural evolution, individual differences, and responses to rehabilitative interventions in acquired brain injuries. The Center brings together an interdisciplinary team of clinical researchers in order to: 1) advance basic science and clinical knowledge to the next level of integration, 2) translate the knowledge gained directly into clinical care for improved patient outcomes, and 3) use the newly integrated knowledge to drive the leading edge of future research. The Center is directed by Dr. Flora Hammond.

THREE-DIMENSIONAL IMAGING OF THE CRANIOFACIALDENTAL COMPLEX CENTER:

The primary mission of the Center is to develop long-term intellectual and financial support for strong, interdisciplinary imaging studies related to a better understanding and quantification of 3-dimensional normal and abnormal growth, development, function, esthetics, and treatment of the hard and soft tissues of the craniofacialdental complex. The secondary mission of the Center is to assess the airways of patients with sleep disorder breathing and the responses to therapies. The tertiary mission is to become the regional and national point of information and service for patients and health professionals involved with orthodontic orthopedic tooth movement, facial esthetics, functions, airways, and imaging. The Center is directed by Dr. Katherine Kula.



From Top to Bottom: Dr. Murray Korc; Dr. Katherine Kula

NEW RECORD FOR SCHOOL OF MEDICINE

In the highly competitive arena of medical research and extramural funding, the School of Medicine posted a record \$267 million in research grants and contracts in fiscal 2012, which according to Dean D. Craig Brater, M.D., “is a testament to the skill, persistence, and creativity of our scientists.”

Other exciting developments came from a variety of fields: aging, schizophrenia, and global health. 2012 also saw Indy’s Super Cure, a Super Bowl tie-in with the IU Simon Cancer Center to collect healthy tissue donations from more than 700 women for the Komen Tissue Bank, the world’s only bio-bank of healthy breast tissue samples. As Dr. Brater says, “Strong research programs enable us to develop therapies to help tomorrow’s patients, and enable us to teach young physicians to practice tomorrow’s medicine.”

BREAKING GROUND ON GROUNDBREAKING CENTER — NEUROSCIENCE GETS NEW HOME


In August, just weeks after the new Ambulatory Care and Imaging building opened, ground was broken for the IU Neurosciences Research Building, which will provide School of Medicine scientists (including researchers from the Institute of Psychiatric Research and the Stark Neurosciences Research Institute) state-of-the-art facilities in which to conduct a broad range of research projects in fields such as neurotrauma, dementia, addiction, epilepsy, and pain.

A key element in research productivity is proximity. The connected buildings are “just down the hall from each other,” allowing researchers to easily consult with



MEDICAL AND LIFE SCIENCES IMPACT

Year of Firsts at School of Medicine



Dr. Gerry Oxford



Dr. D. Craig Brater



IU Health Neuroscience Center



Dr. David S. Wilkes

faculty physicians in neurological surgery, psychiatry, and neurology. According to Gerry Oxford, Ph.D., director of the Stark Neurosciences Research Institute, the combined facility will give researchers and clinicians “unprecedented ability to collaborate in order to speed research findings to clinicians. This will ensure that our patients and their physicians will have access to the latest discoveries and top experts in a range of specialties.” The IU Health Neuroscience Center is located on 16th Street, across from Methodist Hospital.

2 PARTNERS, 5 YEARS, \$150 MILLION SRI SPARKS NEW ERA OF RESEARCH

A simple discussion more than a year ago concluded when campus research and clinical leaders signed the Strategic Research Initiative. The School of Medicine and IU Health will invest \$150 million in a 5-year collaboration to boost translational as well as basic research in cardiovascular disease, cancer, and the neurosciences.

“It is our goal to fund transformative proposals that will fundamentally change our understanding of these diseases and lead to important new therapies for patients,” said David S. Wilkes, M.D., Executive Associate Dean for Research Affairs at the School of Medicine.

The School was evaluating new strategies of confronting the combined trend of increased difficulty landing large NIH grants (historically, about half of incoming research dollars) and more targeted research initiatives, such as team science. Meanwhile, IU Health was intent on leveraging outcomes from the School Medicine in order to strengthen patient care.



INDIANA CTSI RESEARCH FOR THE COMMUNITY

Problem Solving on a Grand Scale



Dr. Jacob Kean



During its fourth year, the Indiana Clinical and Translational Sciences Institute saw strategic investments in innovative people and ideas yield big rewards. This includes two fellows whose work towards new drug therapies and improved clinical care earned support from the National Institutes of Health (NIH) and Department of Veterans Affairs, and a research team whose results attracted an outside company to bring a new, more effective test for chest cancer to the health care market. Led by Anantha Shekhar, M.D., Ph.D., the Indiana CTSI includes IU, Purdue, and Notre Dame, as well as public and private partners, and aims to accelerate the progress of ideas from the lab to clinical practice. It is supported by a five-year, \$25 million grant from the NIH, and nearly \$60 million from its three member universities, the state of Indiana, and public and private groups.

USING TELEHEALTH TO ASSIST WOUNDED VETERANS

About 180,000 recent war veterans suffer from mild to moderate traumatic brain injury (TBI), but the Veteran Health Administration's telehealth system—one of the most effective tools to manage conditions over long distances—is not always used to serve these wounded warriors.

“Traditionally, telemedicine collects primarily objective measures,” said Jacob Kean, Ph.D., Assistant Research Professor of Physical Medicine and Rehabilitation at the School of Medicine and scientist at the Richard L. Roudebush VA Medical Center, in regard to the VHA's advanced network of technologies for the long-distance monitoring of disease. “TBI requires measuring cognitive and emotional symptoms.”

A former Indiana Clinical and Translational Sciences Institute fellow whose work has also been supported by a grant from the institute's project development program, Dr. Kean recently received more than \$900,000 from the Department of Veterans Affairs Rehabilitation Research and Development Service to leverage the VA's telehealth system to assist veterans with TBI. The first 18 months of the project aim to create a framework to measure self-management in veterans. This will include interviewing returning soldiers about their health experiences.

The data will create a computerized assessment that measures self-management skills, giving physicians the information they need to steer patients toward the right care for their conditions, such as a support group or individual therapy.

From Left to Right: Dr. Sunil S. Badve; Dr. Melissa Kacena

The system will be a pilot at five hospitals that serve veterans and active duty soldiers, including the Walter Reed National Military Medical Center in Bethesda and the Roudebush VA Medical Center in Indianapolis.

A NEW RISK FACTOR TEST FOR RARE CHEST CANCERS

Research supported by the Indiana CTSI and the IU Melvin and Bren Simon Cancer Center has resulted in a new test to predict the risk of recurrence for thymoma, a rare tumor of the upper chest.

Castle Biosciences, a Texas-based molecular diagnostics company, has licensed the rights to a genetic test for thymoma marketed under the name DecisionDx-Thymoma. The test is based on research conducted by Sunil Badve, MBBS, M.D., Professor of Pathology and Laboratory Medicine; Patrick Loehrer Sr., M.D., Director of the IU Melvin and Bren Simon Cancer Center, and Yesim Gökmen-Polar, Ph.D., Assistant Research Professor of Pathology and Laboratory Medicine.

Thymomas, while rare, are one of the most common cancers of the upper chest. Treatment involves surgical removal, often followed by radiation or chemotherapy. While physicians can generally diagnose a tumor's severity, they cannot easily predict whether the cancer will return. An accurate assessment of recurrence risk reduces the need for painful treatments following tumor removal by sparing patients with low risk for redeveloping tumors.

"This whole effort has been the perfect combination of



a research scientist, clinician, and pathologist working together," Dr. Badve said. "Everyone played complementary roles to bring about a real change in cancer treatment for patients with thymoma."

EXPLORING NEW DRUG TO SAFELY HEAL BONE DEFECTS

About a half million people suffer fractures each year as a result of tumor removal, infections, car crashes or war wounds that require surgical intervention to repair. These unhealed breaks are extremely painful and debilitating.

Current bone healing treatments often regrow too much bone, which can pinch nerves, inflame surrounding tissue, or inhibit motion, and may require additional surgeries.

With support from the Indiana CTSI, Melissa Kacena, Ph.D., Assistant Professor of Orthopaedic Surgery at the School of Medicine, is studying a compound that research suggests has potential to re-grow bone with fewer side effects. The drug, currently used to treat blood disorders, is unique in its ability to stimulate both osteoblasts, which create bone, and osteoclasts, which destroy bone, reducing



unregulated bone growth. In early 2012, she received more than \$3.4 million from the National Institute of Arthritis and Musculoskeletal and Skin Diseases to support this research.

"What we're tackling here are the most challenging bone healing problems," Dr. Kacena said. "This work has high potential to move very quickly into clinical study."

In addition to a fellowship from the Indiana CTSI, Dr. Kacena has received about \$100,000 from the institute to create a genetically altered mouse model and conduct the pilot studies needed to advance this research towards human clinical trials. Dr. Kacena has also received an additional \$100,000 from the Indiana CTSI to advance other research efforts.

Dr. Kacena is co-inventor on two patents filed by the IU Research and Technology Corp. related to the mouse model and application of the drug in bone healing. The Indiana CTSI provided about \$20,000 to the project, which enabled the team to conduct polymerase chain reaction testing and other analyses that strengthened the research validity, attracting the interest of outside investors.

The IUPUI Arts and Humanities Institute (IAHI) consists of a partnership between the Office of the Vice Chancellor for Research and participating campus units, including the Schools of Liberal Arts, Herron School of Art and Design, Informatics, Engineering and Technology, Medicine, and the University Library. Its mission is to support individual faculty, groups, and interdisciplinary teams in research and creative activities in arts and humanities, including interdisciplinary initiatives; serve as a portal for the promotion of innovative inquiry-based arts and humanities educational experiences in academic curricula across campus; and act as a liaison between IUPUI and the community in the development of arts and humanities endeavors.

IUPUI HOSTS NORTH AMERICAN PREMIERE AT THE COLUMBIA CLUB

Tim Hardy, a faculty member of the Royal Academy of Dramatic Art in London, was the IAHI's first Artist-in-Residence in September 2012. Hardy has decades of experience as both actor and director, having performed across Europe and North America. He has also performed with the Royal Shakespeare Academy and the Opera Music Theatre London.

During his residency, Hardy guest-lectured in English and History where he discussed the nature of acting as well as how the performing arts can help interpret historical events. In his lecture, "From Shakespeare to Sondheim to Shaw," he explored the profound impact that acting can have on worldviews.

The culmination of his visit was the American premiere of *The Ancient Mariner*, a dramatic music production inspired by Coleridge's *Rime of the Ancient Mariner*. Written by London-based composer Geoff Paige, the piece is a sequence of songs and musical scenes sung as solos with piano accompaniment.

EXPLORING HERRON'S ROOTS — CLASSICAL ART IN MODERN AMERICA

Jennifer Lee, Associate Professor of Art History and Associate Dean of Student Services at the Herron School, has been coordinating a Herron-IAHI collaboration to study the history of Herron and its place in the evolution of American art schools. Specifically, she is looking at Herron's museum, which formed the core of the Indianapolis Museum of Art. Like many art schools of its age (1902), Herron proudly owned a collection of plaster casts of ancient Greek works of art (also referred to as "the Parthenon sculptures") that represented "the classical tradition." Lee's research examines the fundamental role of these classical sculptures in the formation of early 20th century American aesthetics and how they influenced the training of generations of Herron students. Sadly, the only remaining pieces of the collection were a handful of casts from the Parthenon Frieze. As part of the project, Herron undergraduate Benjamin Sunderlin (BFA 2012) was commissioned to create new casts. The result



IUPUI ARTS AND HUMANITIES INSTITUTE

Advancing the Human Condition
Through Creative Activities





was a set of pristine plaster casts of this famous relief sculpture and a greater understanding of the role of the Parthenon frieze and its many copies in shaping public taste as well as training artists.

GLOBAL ACCESS TO AN AMERICAN PHILOSOPHER

In addition to being a philosopher, Charles S. Peirce (pronounced “purse”) was a scientist, logician, and mathematician. Often referred to as “the father of pragmatism,” he was an extremely prolific writer whose papers reside in multiple locations (the bulk at Harvard) and are largely unorganized. The Peirce Project is a collaborative effort to catalogue, date, and organize his extensive writings. IU Press has published six of the estimated 30 volumes required to cover the body of Peirce’s work. *The Peirce Edition Project* seeks to reinvent what scholarly editions of great thinkers ought to be when posted online.

David Pfeifer, Director of the Institute for American Thought (IAT), and André De Tienne, Professor of Philosophy and Director of the Peirce Edition Project in the IAT, received



Page 10 from Top to Bottom: Dr. Andre De Tienne; Dr. David Pfeifer
Page 11 from Left to Right: Dr. Jennifer Lee; Tim Hardy; Dr. Jack McKivigan

NEH and IAHI grants to spearhead an ambitious initiative. In collaboration with the Human-Computer Interaction Program at the School of Informatics, Pfeifer and De Tienne have been developing two revolutionary, open-sourced platforms. One is STEP (Scholarly Text Editing Platform): an online, web-based XML production platform that provides all the tools needed to create a scholarly edition from manuscript organization and transcription to editing and final layout. The second is CORPUS (Collaborative Online Research Platform for Users of Scholarly editions): a powerful dissemination environment that will redefine how the general public will browse the great texts in open access environments, and how scholars will contribute original work to the editions.

SYMPOSIUM DRAWS INTERNATIONAL SCHOLARS

Jack McKivigan, Mary O’Brien Gibson Professor of History and Editor for the Frederick Douglass Papers, received IAHI funding to support the symposium, “Rediscovering the *Life and Times of Frederick Douglass*.” Douglass, a former slave turned abolitionist was one of the most influential writers during the Civil War and Reconstruction. The two-day event celebrated the publication of the first scholarly edition of his third and final autobiography, *Life and Times of Frederick Douglass*, which examines abolition, civil and women’s rights, and public education. McKivigan edited the



volume that is one of five editorial projects in the Institute for American Thought in the School of Liberal Arts.

Utilizing the new edition of *Life and Times*, nine internationally recognized scholars in history, literature, political science, law, and Africana Studies presented original research on Douglass. Symposium organizer, John Kaufman-McKivigan, will edit the presented papers as an upcoming special issue of the *Journal of African American History*. The symposium and the upcoming journal issue are valuable new additions to the expanding scholarship on Frederick Douglass’s central role in the 19th century African American experience. Jack McKivigan has also co-edited (with Heather L. Kaufman), *In the Words of Frederick Douglass: Quotations from Liberty’s Champion and Selected Speeches of Frederick Douglass*, to be published by Yale University Press in 2014.

Support came from the IAHI, Office of Diversity, Equity and Inclusion, Liberal Arts, and a special grant from Indiana Humanities.

SUCCESS BEGETS SUCCESS

The Indiana Center for Biological Microscopy recently received a second, 5-year renewal of its NIH P-30 grant, now entering its 11th year. The NIH renewal was also accompanied by funds from the Department of Medicine, the School of Medicine, and the IUPUI Imaging Research Initiative to help maintain the cutting-edge facility. The Center offers investigators unique opportunities to simultaneously view multiple dynamic biological processes in four dimensions (3D plus time) at the cellular and subcellular levels within living animals by using 2-photon microscopy. Developed within the Division of Nephrology and directed by Dr. Bruce Molitoris, the Center is utilized by 70 campus faculty as well as investigators from around the world. In the previous academic year alone, the facility contributed to 68 unique publications. In addition, Indiana CTSI Core funds are available to investigators to cover the costs associated with facility use. Educational courses are offered every other year, allowing researchers to have hands-on experience in obtaining and processing imaging data.

Perhaps the most important aspect of the 2-photon facility relates to translation of basic science discovery into clinical understanding and therapeutics. The ability to directly collect mechanistic data and observe therapeutic responses allows investigators to answer specific questions not possible with other techniques at organ, cellular, or subcellular levels. This approach has also resulted in FAST BioMedical, a spin-off company that has licensed an IU patent to develop a technique to quantify plasma volume and kidney function at the bedside.

Page 12 from Top to Bottom: Dr. Gary Hutchins; Dr. Bruce Molitoris

Page 13 from Top to Bottom: Dr. Eliza Y. Du; Dr. Paul Salama

Imaging is a key area of strength at IUPUI, and the IUPUI Imaging Research Initiative has been created to develop and coordinate major imaging research efforts. The initiative is guided by the IUPUI Imaging Research Council, with representatives from the Schools of Medicine, Science, Engineering and Technology, Liberal Arts, and Informatics.

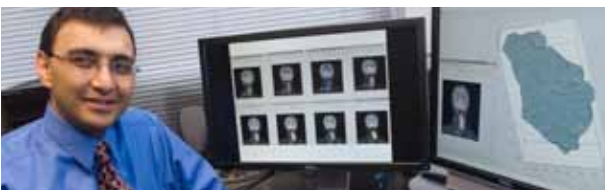
IUPUI IMAGING RESEARCH INITIATIVE

Strengthening Research Collaboration



PICTURES WORTH MORE THAN 1,000 WORDS

Paul Salama, Associate Professor in Electrical and Computer Engineering and Director of the Visual Communications Laboratory, is one of the reasons that imaging research is such a strong suit at IUPUI. His research interests are many: 2D/3D Image analysis techniques (including registration and segmentation) for medical imaging, image fusion, image/video compression, error resilient/secure transmission of compressed video, and statistical signal processing. He is particularly interested in the development and application of novel image analysis techniques that can be used for varied medical applications. In collaboration with his colleagues in the Division of Nephrology, the School of Medicine, and Purdue, Dr. Salama has developed non-rigid registration techniques for the microscopic imaging of live animals. These methods are currently being utilized to correct the effects of respiratory motion and heartbeats, consequently enhancing imaging studies of visceral organs. Dr. Salama and his graduate students have developed 3D segmentation techniques for detecting NF1 tumors in MRI brain images. In addition to all that, he has collaborated with Biomedical Engineering colleagues to develop a plan to de-noise neural signals recorded from electrodes implanted in the peripheral nervous system.



cooperative iris recognition system, which was funded by the Office of Naval Research and National Institute of Justice. Du collaborated with Dr. Darrel WuDunn, Professor of Ophthalmology at the School of Medicine, to propose the sclera recognition concept and design a sclera recognition method. She and her team then designed the first fully automatic sclera recognition method. They then combined the strengths of iris and sclera recognition and created multimodal eye recognition, which can perform more accurate, non-intrusive and non-cooperative human identification. These novel designs have resulted in several patent applications, some of which have been licensed for commercialization.

Currently, Du is collaborating with Xukai Zou, Associate Professor of Computer Science, in designing a new kind of biometric method for improved cybersecurity. When a user is accessing their account remotely, there could be security breaches or network attacks. Their biometric data may be compromised and as a result, their identity may be stolen. With funding from the Center for Applied Cybersecurity Research, her research team has created the BioCapsule concept to help accurately identify people

while ensuring identity security. Their goal is to make sure that user identities would be 100% safe in the face of severe security breaches or even a series of system attacks.

MEDICAL IMAGING VISUALIZES BIOLOGICAL AND BIOCHEMICAL ALTERATIONS IN HUMAN DISEASE

Modern medical imaging provides windows into the human body, revealing biological and biochemical alterations that are the hallmarks of disease. These advanced imaging methods, commonly referred to as “functional and molecular imaging,” are being used to establish the specific manifestation or phenotype of disease in individual patients. These imaging tools can also be applied to monitor the efficacy of experimental therapies. Dr. Gary D. Hutchins, John W. Beeler Professor of Radiology, Director of Imaging Sciences Section, and Vice Chair of Research in the School of Medicine, supports the development, validation, and application of advanced medical imaging technologies through a multifaceted approach, which includes research, service, and education. As a scientist Dr. Hutchins has developed novel imaging technology and data analysis methodology, enabling the quantitative assessment of organ and tissue biochemistry and molecular biology. The tools developed through his research have broad application in neurological and cardiovascular disorders as well as in cancer. Dr. Hutchins has made these imaging technologies available to the Indiana academic and industrial biomedical communities through the Indiana Institute for Biomedical Imaging Sciences. In turn, knowledge gained through his research, and the research performed by his many colleagues, is transferred to the next generation of imaging scientists through the Indiana-Purdue Joint Medical Physics.

IUPUI AT FOREFRONT OF CYBERSECURITY AND ACCESS CONTROL

Eliza Y. Du, Associate Professor of Electrical and Computer Engineering and Founding Director of the Biometrics and Pattern Recognition Lab, leads her research team in designing accurate and secure human identification approaches for homeland security, cybersecurity, and access control. She and her team designed the first non-



From Left to Right: Dr. Andrew D. Gavrin, Dr. Charles Feldhaus, and Dr. Jomo Mutegi (SERI Leadership Team)

STEM INITIATIVES IMPACT

INNOVATIONS LOCALLY
AND GLOBALLY



Building on the existing campus strengths in STEM education and research, the STEM Education Research Institute (SERI) has been created to promote and coordinate STEM education research initiatives pursued through the institute and in collaboration with its external partners. SERI consists of a partnership between the Office of the Vice Chancellor for Research and participating campus units, consisting of the School of Engineering and Technology, School of Science, and School of Education.

IUPUI RESPONDS TO NATIONAL NEED — STEM PIPELINE A CAMPUS PRIORITY

The U.S. Department of Labor projects 6 million openings for positions requiring technical degrees by the end of this decade. A \$2 million project funded by the NSF, the Central Indiana STEM Talent Expansion Program (STEP) has hit its mark in each of its first three years: increasing STEM graduates at IUPUI by 10%. The goal is to add close to 300 STEM diplomas to the workforce by the end of 2014. Jeffrey Watt leads the dedicated team of professors that includes Charlie Feldhaus, Kathy Marrs, Stephen Hundley, Andrew Gavrin, Mariah Judd, and Howard Mzumara. Together, they are reshaping an important element of campus culture. STEP focuses on four areas: career services, student-centered pedagogy, articulation with IVY Tech, and student success.

Career Services: foster student success after graduation through services such as the School of Science Career Development Center and exciting new internships.

Student-Centered Pedagogy: internal grants awarded to faculty for designing and implementing new instructional

Nathan Mott with Indy Learning Centers student tutors

ideas into their courses have helped lower Drop/Fail/Withdraw rates in STEM classes and increased student retention.

Articulation with IVY Tech: IUPUI and IVY Tech have aligned the content and standards in a variety of STEM courses, providing a seamless transition for students who want to transfer to an IUPUI program.

Student Success: programs such as the STEM Summer Bridge or Honors Seminar empower students with self-confidence. Students who are fully engaged in learning succeed.

IUPUI RESEARCHERS ADAPT WINNING INSTRUCTIONAL MODEL TO CYBERSPACE

Peer-Led Team Learning (PLTL) is effective. It promotes deep learning. It also improves performance and course retention, develops communication and team skills, raises motivation and course satisfaction, and increases interest in pursuing further studies in science. PLTL has been successfully introduced in college STEM courses across the country.

Since 2009, Dr. Pratibha Varma-Nelson's team has worked to adapt the PLTL model to a cyber environment (cPLTL). Their work represents a new direction for education research, expanding the knowledgebase on teaching STEM concepts as well as utilizing technology in education. With funding from the NSF and Next Generation Learning Challenges (NGLC), Varma-Nelson's team has studied cPLTL's impact on student achievement, deep learning, and the development of 21st century workplace skills. Analysis shows cPLTL's positive impact on student performance

and development. Its efficacy is further highlighted by its designation as an Effective Practice in Online and Blended Education by the Sloan Consortium, a leadership group dedicated to quality in online education.

The project has further confirmed that cPLTL holds great promise for influencing college completion efforts nationally. According to Andy Calkins, NGLC Deputy Director, it is one of four projects whose influence “will extend far beyond their own institution and the students they serve directly.” The Varma-Nelson team and IUPUI are making an important contribution in moving post-secondary education towards a more personal and digitally-supported learning experience.



Dr. Pratibha Varma-Nelson (Far-left); Dr. Annela Teemant and research team (Top); Dr. Jeffrey Watt (Left)

INNOVATIONS IN UNITY — IUPUI HELPS NEXT GENERATION

Indy Learning Centers partners with central Indiana schools to provide tutoring and academic support for grades 2-12. It all began in 2007 with four elementary schools and a handful of eager college students wanting to share their enthusiasm for STEM. Under the direction of Nathan Mott, the program has secured more than \$1.8 million in funding and grown to 50 students per semester who serve 28 elementary, middle, and high schools.

The tutoring services have grown and expanded, branching out from strictly STEM to also include not only language and arts, but on demand (web-based) tutoring as well. Whether it's working one-to-one or supporting programs such as After School Achievers or directed study halls, the staff of Indy Learning Centers invests their energies in the local community to improve the educational outlook of hundreds of potential collegians.

ESL, STEM, AND INCLUSION

Indiana has experienced over 400% growth in its English Language Learner (ELL) population, dramatically increasing the need for certified ESL teachers (English as a Second Language). Under the umbrella of the Urban Center for the Advancement of STEM Education (UCASE), Dr. Annela Teemant received \$1.9 million dollars from the U.S. Department of Education to prepare teachers, especially secondary science and math teachers, to teach ELLs well.

The award supports a collaborative university-public school partnership: faculty from the schools of Education and Science are working with Indianapolis Public Schools (IPS) and the Metropolitan School District of Pike Township to articulate a shared and institutionalized vision of high-quality STEM instruction that engages and develops all learners. The partnership will result in a multi-year professional development initiative that uses intensive summer workshops and ongoing classroom-based instructional coaching

of teachers to build capacity across school districts. IUPUI faculty will also redesign university courses to further institutionalize the pedagogy of engagement and differentiation for diverse learners. The project's effectiveness will be measured by teacher growth and improved student achievement.

A total of 175 educators will benefit from professional development activities during the five-year grant. More than 50 IUPUI faculty will participate in the workshops, 80 IPS teachers will participate in two years of instructional coaching, and 45 teachers (30 of whom will be secondary STEM educators) will receive 21-credit ESL tuition scholarships. Together these funded activities ensure systematic and collaborative improvement in several areas: IUPUI methods courses, clinical placements for student teaching, and the professional development offered veteran teachers. This grant will contribute to defining what it means to effectively teach ELLs in regular classrooms whether those classrooms are at a university or a neighborhood school.



INTEGRATED NANOSYSTEMS DEVELOPMENT INSTITUTE

Advancing Nanotechnology
Research and Education

INDI Leadership Team from Left to Right: Dr. Maher Rizkalla, Dr. Hazim El-Mounayri, Dr. Christoph Naumann, Dr. Mangilal Agarwal, Dr. Frank Witzmann, and Dr. Ricardo Decca



SMALLER THAN MICROSCOPIC LOOMS LARGE DISCOVERIES GROUNDED IN COLLABORATION

The Integrated Nanosystems Development Institute (INDI) is a partnership between the Office of the Vice Chancellor for Research and campus units interested in advancing nanotechnology research and education. With the realization that progress within the field of nanotechnology results from multidisciplinary collaborations, INDI is comprised of 30+ faculty in Engineering & Technology, Science, Medicine, and Dentistry.

INDI facilitates collaborations in this diverse group of researchers in order to develop nanotechnology-based systems that address major societal needs. Building on campus strengths including the Lugar Center for Renewable Energy and the School of Medicine, the Institute focuses on nanotechnology and bionanotechnology. INDI is also actively engaged in educational and outreach activities such as nanotechnology summer camps for high school students and teachers.

The INDI leadership team:

Mangilal Agarwal, Director, *Electrical and Computer Engineering*

Christoph Naumann, *Chemistry and Chemical Biology*

Hazim El-Mounayri, *Mechanical Engineering*

Ricardo Decca, *Physics*

Frank Witzmann, *Cellular & Integrative Physiology*

Maher Rizkalla, *Electrical and Computer Engineering*

EXAMPLES OF BIONANOTECHNOLOGY AND NANOENERGY PROJECTS

Designing Biomembrane-Mimicking Substrates

Christoph Naumann, *Chemistry and Chemical Biology*

With the ability to feel and respond to their surroundings, cells plated on traditional glass or plastic substrates display features less predominant in native tissue environments. While previously developed elastic gel substrates better replicate tissue and have provided insight into the role of substrate elasticity on mechanotransduction, a lack of a suitable dynamic substrates has inhibited the assessment of substrate viscosity and its role. Novel biomembrane-mimicking substrates are being developed and characterized as tools for regulating substrate viscoelasticity and exploring its impact on cellular response. Preliminary results show profound changes in phenotype, cytoskeletal organization, and motility in response to changes in viscoelasticity.

Assessing Nanoparticle Toxicity

Frank Witzmann, *Cellular & Integrative Physiology*

Silver nanoparticles (AgNPs) are increasingly used in food packaging and dietary supplements due to their antibacterial qualities, yet their impact on health once ingested remains unclear. As a result, concerns regarding AgNP exposure are on the rise. Understanding biological interactions between engineered nanomaterials and the gastrointestinal tract is vital to assess potential risks and to develop safe, nanomaterial-based products. This research aims to develop an

From Left to Right: High School Students at Nanotechnology Camp; Nanoscale Laboratory Instrumentation; High School Teachers at Nanotechnology Camp

innovative analytical platform capable of accurately characterizing and assessing AgNP toxicity, dosage, exposure, and fate in the gastro-intestinal tract using a well-characterized *in vitro* platform that mimics the intestinal mucosa.

Fabrication and Characterization of Nanoparticle-Based Solar Cells

Mangilal Agarwal, *Electrical and Computer Engineering*

Copper Indium Gallium Selenide (CIGS) nanoparticle-based solar cells show promise in creating a viable and sustainable energy source. CIGS have been widely studied for high efficiency solar cell applications, yet in order to see widespread use, cost effective manufacturing must be developed. Utilizing a nanofabrication process known as Layer-by-Layer (LbL) nanoassembly, CIGS films can be fabricated in a cost effective method. Aside from providing reduced manufacturing costs, LbL nanoassembly allows the fabrication of solar cells on flexible and non-uniform substrates. Preliminary data shows potential in CIGS-based solar cells as commercially viable renewable energy sources for the future.

The Center for Research and Learning (CRL) exists to promote, create, and coordinate the implementation of innovative inquiry-based learning programs that integrate research and education to provide students effective pathways for lifelong active learning and professional development. This highlights a few Center for Research and Learning supported projects.

BUILDING BRIDGES

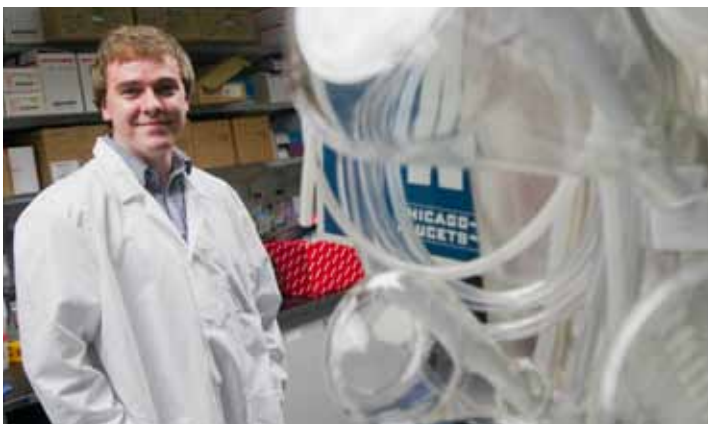
The bridge that Robinah Maasa crossed to realize her educational goals has literally spanned an ocean and two continents. Robinah received an education BS from Makerere University, Uganda's largest and second-oldest university. She then taught high school biology for five years, inspiring her pupils to love the essence of learning. Her thirst for knowledge and professional development led her, in 2006, to immigrate to Indiana.

She first earned certification as a Qualified Medication Aide, which piqued her interest in pharmaceutical studies. Robinah then participated in the *Bridges to the Baccalaureate Program*, an IUPUI-Ivy Tech partnership. The Bridges program afforded her the opportunity to work with Jill Reiter, Assistant Professor of Obstetrics and Gynecology, and Director of the OB/GYN Perinatal Epigenetics Research Laboratory. Dr. Reiter observes, "Robinah is a non-traditional student. She brings an insight and maturity to her academic and scholarly work that is evident to everyone." Currently, Robinah is an undergraduate majoring in biology. She is also an active member in the IUPUI Biology Club, serves as Student Ambassador for the Center for Research and Learning, and is a participant in the Diversity Scholars Research Program. She also delivered the student keynote speech at the 2013 IU Undergraduate



STUDENT RESEARCH MATTERS

Fostering a Culture of Inquiry



Research Conference. Unwilling to rest on her laurels, Robinah plans to pursue a doctoral degree in medicine or pharmacology following her 2014 graduation.

NOT A MOMENT WASTED

Tómas Meijome exemplifies hard work, and it is definitely paying off. Early in his undergraduate career, he was given the opportunity to research with Dr. Melissa Kacena in the Department of Orthopaedic Surgery. It was a prophetic match, launching the young researcher on an impressive career arc. This faculty-student duo seeks to better understand the complex interactions that occur between bone and hematopoietic (blood forming) cells. Their goal is to translate their findings for the improved treatment of metabolic bone diseases and fracture healing.

As a result of his drive and Dr. Kacena's mentorship, Tómas has presented at multiple local and national conferences where his research has been recognized for its excellence. He was awarded 1st place for his scientific poster presentation at the 2010 Louis Stokes Alliance for Minority Participation Statewide Conference, and was most recently chosen as one of 15 students to receive an award for immunology research at the 2012 national meeting of the Annual Biomedical Research Conference for Minority Students. Locally, he won the 2012 Bowling-Jones-Russo Memorial Research Award.

Tómas currently serves as president of the Chemistry Club and upon graduation will have completed four years as a participant in the *Diversity Scholars Research Program*. Following graduation, Tómas plans to enroll in a dual M.D./Ph.D. degree program. His ultimate goal is to start his own translational research laboratory as a physician-scientist.

A QUEST TO EMPOWER STUDENTS

Tayana Dowdell left her home in Jamaica at age 16 to immigrate to the U.S. A year and a half later, she enlisted in the United States Marine Corps, becoming an Aviation Logistics Specialist. As her Marine Corps career drew to a close, she realized her passion for "helping students to attain the necessary skills and knowledge to promote their own social growth and success in life." Her first step was enrolling at Ivy Tech, and later transferring to IUPUI. Her major is Elementary Education with a concentration in reading. For Tayana, the promise of her talent as an educator is matched only by the potential of her students; their success is her success.

Tayana is currently a McNair Scholar. The *Ronald E. McNair Postbaccalaureate Achievement Program* afforded her the opportunity to work at the Center for Urban and Multicultural Education, under the mentorship of Dr. Crystal Hill Morton and Shanna Stuckey. Tayana assisted on the project "*Remedial Reading Intervention: Examination of the Impact of ReadUp in Increasing Reading Levels for At-Risk Learners*." In the fall of 2012, Tayana was selected to represent IUPUI at the Southern Regional Education Board Institute on Teaching and Mentoring in Tampa. Tayana plans on advancing to graduate school to obtain a Master's in instruction and curriculum planning and then ultimately a Ph.D.

MULTIDISCIPLINARY UNDERGRADUATE RESEARCH EXPERIENCE

Integrative Pathway Modeling for Pancreatic Cancer Drug
Principal Mentor: Jake Yue Chen, Ph.D.
Co-Mentor: Xiaogang Wu, Ph.D.
Graduate Mentor: Hui Huang

The objective of this project is to develop and validate a computational platform for screening potential pancreatic cancer drugs and apply this in-silico platform to assess the therapeutic efficacy of these drugs. With the help of three mentors, these five students (from biology, chemistry, math, and computer science) have posted significant research achievements.

Sara Ibrahim validated pathway-based drug evaluating algorithms by using pancreatic cancer related microarray datasets mapped onto pharmacological effect network (PEN) models.

Thanh Nguyen developed flow-based algorithms to evaluate therapeutic effects of candidate pancreatic cancer drugs from the PEN models by applying graph theory and matrix theory to calculating pharmacological effect on target (PET) score for each drug.

Selom Kubge built, compared and integrated drug-drug similarity networks from different data types; drug chemical structures, shared drug targets, drug side effects and drug ontology.

Bilal Jawed curated drug-protein directionality specific for pancreatic cancer based on PubMed and C-Maps (an online platform for computational connectivity maps).

Pragat Walge built an integrated pancreatic cancer specific pathway/network model by searching pancreatic cancer related pathways online and integrating them into a PEN model with directionality information.

Page 18 From Top to Bottom: Dr. Jake Chen & Research Team; Robinah Massa and Dr. Jill Reiter; CRL Staff Leadership Team: Wayne J. Hilson Jr., Elizabeth Rubens, Dr. Rick Ward (Executive Director), and Vicki Bonds; Tómas Meijome; Dr. Crystal Hill Morton and Tayana Dowdell



COMMERCIALIZATION AND ECONOMIC DEVELOPMENT

From Drawing Board to Market

The Office of the Vice Chancellor for Research, through its Research Commercialization Section, supports the invention culture on campus. This section serves as a ready source of support and information for faculty, staff, and students engaged in research with potential for commercial development. As part of this, multiple programs and services have been developed, as highlighted in this section.

Dr. Rajesh Khanna

PEPTIDES ENHANCE CANCER IMMUNOTHERAPY

Hua-Chen Chang, *Biology*

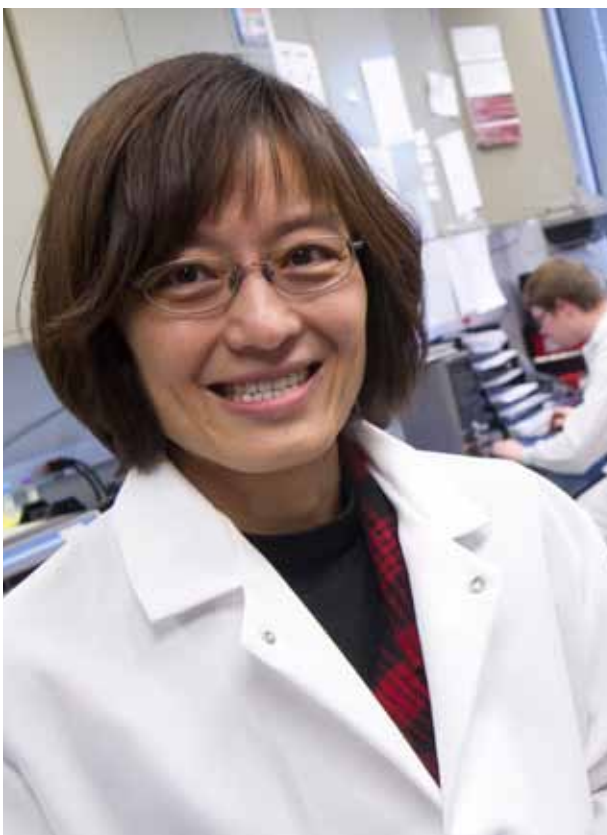
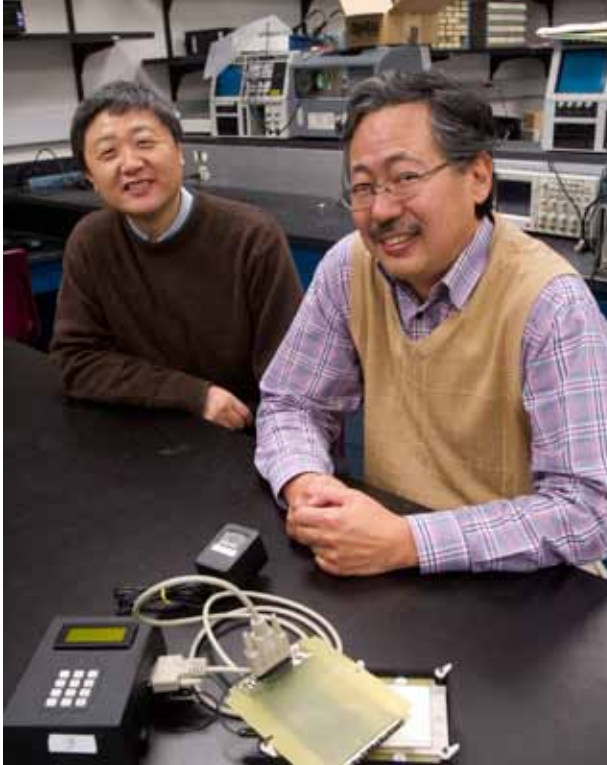
Professor Chang founded Immune Peptide Therapeutics LLC as a result of his research discoveries at IUPUI. Despite the effectiveness of chemotherapy to kill cancer cells, many patients eventually relapse or have other disease progressions. Dr. Chang's goal is to develop an effective immunotherapy that would circumvent chemotherapy induced immune deficiency while also harnessing anti-tumor immunity. Chang's team has discovered a novel class of synthetic peptides that modulate immune functions, which could be an alternative regimen for immunotherapy to improve clinical outcomes and limit tumor progression. In short, it may prolong the lives of cancer patients. This peptide-based immunotherapy harnesses the anti-tumor immunity by enhancing tumoricidal activity of innate immune cells such as natural killer (NK) cells. The synthetic peptides developed in Chang's laboratory have adjuvant effects on stimulating innate immune cells such as dendritic cells (DCs), which in turn will amplify the protective immune responses elicited by vaccination. These synthetic peptides could be used as adjuvants in therapeutic cancer vaccines for treatment as well as in vaccines for prevention.

NEW BLOTting DEVICE ADVANCES FIELD

Stanley Chien, *Electrical and Computer Engineering*

Hiroki Yokota, *Biomedical Engineering*

This duo formed an interdisciplinary research team for the development of bioelectric devices for protein analysis. One such product is a Multiblott Western Blotting Device. Western blotting is a common procedure for protein detection in many biomedical laboratories. The team has developed



a novel device that significantly reduces time and costs for blotting. Specifically, it enables a uniform transfer of proteins of various sizes onto 3-5 membranes from a single gel. An advantage of this device is the ability to generate multiple, high-quality membranes without being affected by variations among gels (US patent pending). A bioelectric company was established in 2012 for further development and commercialization of this device and others.

ANALGESIC THERAPEUTICS FOR AIDS-RELATED PAIN

Rajesh Khanna, *Pharmacology & Toxicology*

Chronic neuropathic pain is a huge problem in the U.S. to an increasingly aging population, one with estimates of 30-50% of this type of sufferer having become resistant to existing medications. Because of this, there is an imperative to increase knowledge of mechanisms of action of the key proteins in nociceptive pathways *in vitro* and to extend this knowledge to *in vivo* models of neuropathy to advance therapeutic development. N-type voltage-gated Ca^{2+} channels ($\text{CaV}2.2$) have emerged as potential novel targets for the treatment of chronic neuropathic pain. Funded in part by a FORCES grant, we have identified two novel derivatives of the parent 15 amino acid CBD3 peptide, derived from collapsin response mediator protein 2 (CRMP-2) that suppressed inflammatory and neuropathic hypersensitivity by inhibiting CRMP-2 binding to N-type voltage gated calcium channels ($\text{CaV}2.2$). Pharmacokinetic studies revealed nanogram levels of peptide in plasma of rats systemic administration consistent with relief of hypersensitivity.

From Top to Bottom: Dr. Stanley Chien and Dr. Hiroki Yokota;
Dr. Hua-Chen Chang

The IUPUI Solution Center serves Indiana as the “front door” to the community by connecting the university’s intellectual capital to the pressing needs of business, government, and the nonprofit sector. Drawing on the talent of IUPUI’s faculty and students, the Solution Center facilitates partnerships with Indiana’s business, nonprofit and government sectors that will build human capital, aid in economic growth, and transfer information, technologies, and methods that enhance innovation and practice.

HEALTHY SMILES FOR EMPLOYABILITY

Dentistry faculty and students aim to give Indianapolis residents in need more than one reason to smile. Under the direction of Dr. Karen Yoder, Director of Civic Engagement and Health Policy at IUPUI, and Dr. Timothy Carlson, Professor of Operative Dentistry, students working at Dentistry’s Student Outreach Clinic in the Near Eastside neighborhood are researching the link between dental health and economic development.

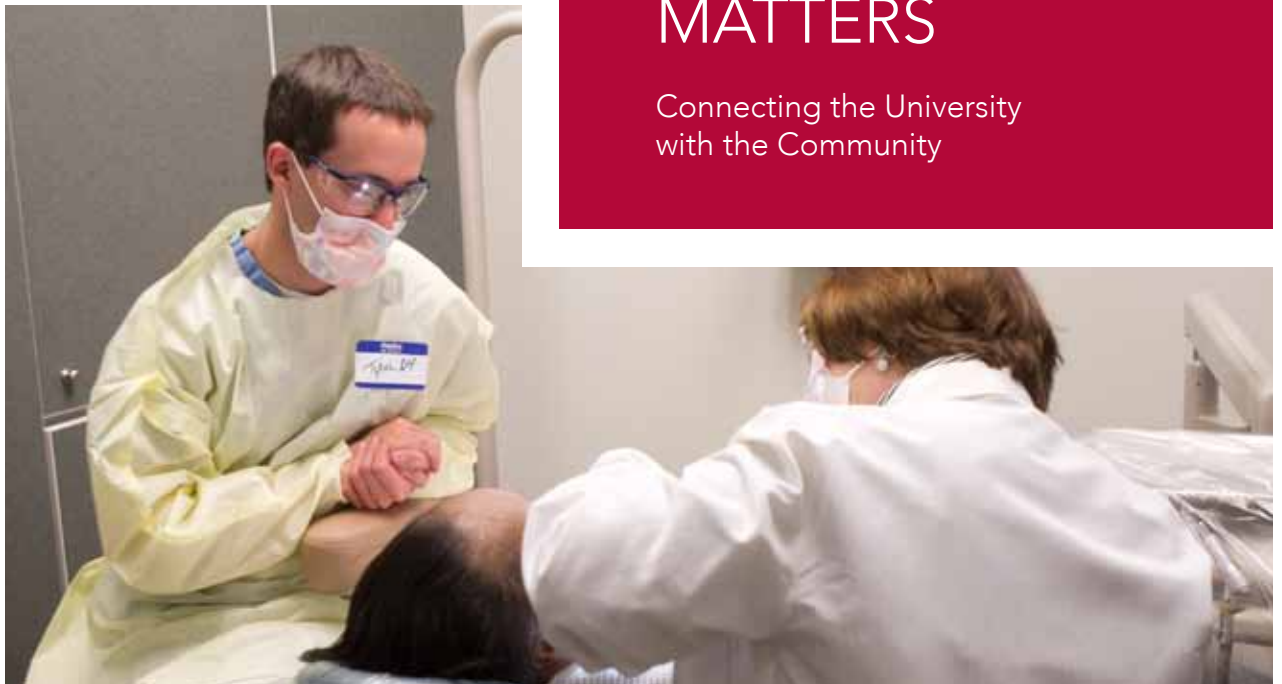
The project, “Healthy Smiles for Employability,” is supported through two funds at the IUPUI Solution Center: the Community Venture Fund and the JPMorgan Chase Near Eastside Legacy Initiative. The grant will cover the cost of student intern salaries at the clinic as well as oral surgery fees and dentures for up to 20 Near Eastside unemployed or underemployed residents.

From Top to Bottom: IUPUI graduate students from Herron School of Art and Design on a tour of Near Eastside neighborhood; Near Eastside community member receives free dental care at the School of Dentistry’s Student Outreach Clinic in Indianapolis



COMMUNITY PARTNERSHIP MATTERS

Connecting the University
with the Community





From Top to Bottom: IUPUI Solution Center staff members, including Teresa Bennett (Executive Director, second from left), and OVCRC colleagues; Professor Youngbok Hong



As part of the project, IUPUI students are interviewing Near Eastside employers to determine what role, if any, dental health plays in employer hiring decisions. Students are also connecting their dental patients to neighborhood job assistance programs. Their goal: discover how the combination of healthy teeth and a strong neighborhood support system affect a person's employment prospects.

A RISING TIDE LIFTS ALL BOATS

In an effort to overcome communication challenges in Indianapolis's Near Eastside neighborhood, IUPUI faculty and students collaborated on a foundational research project to understand methods of communication and information sharing in the underserved neighborhood. Beginning in fall 2011 and concluding one year later, students in class projects funded by the IUPUI Community Venture Fund and the Solution Center's JPMorgan Chase - IUPUI Near Eastside Legacy Initiative grant

program completed field work interviewing Near Eastside residents about how they communicate in their daily lives.

Although the project initially called for communication quick-fixes, such as websites, IUPUI faculty members found that the neighborhood's communication needs ran deeper than that and would need to be more closely examined if the university-community partnership was to have a real and lasting impact.

The project involved The project involved 13 Herron School of Art and Design students, 15 from Medicine's Department of Public Health, and 15 from Liberal Arts. Each group was faculty-led by Youngbok Hong, Associate Professor of Visual Communication; Kathryn Coe, Professor of Social and Behavioral Sciences; and Elizabeth Goering, Associate Professor of Communication Studies, respectively. After completing research separately in their respective fields, the interdisciplinary team came together to share their findings and create an overall communication strategy for the Near Eastside. Solutions included opening up more varied channels of communication to reflect the neighborhood's diverse population, providing more affordable transportation options to make it easier for community members to get together, and implementing incentives for business owners to help make the community a safer place to live and work.

The student/faculty research teams laid the foundation for future university-community partnerships by presenting their research to community partners. The Solution Center is currently using the research findings to develop future projects through the center's JPMorgan Chase grant that will further benefit the Near Eastside.

IUPUI: ROBUST AND GROWING

An institution's research capacity depends not only upon technology but also upon the human capital available to drive the enterprise. To build that human capital, IUPUI has launched two new schools and six new Ph.D. programs.

In alignment with the Life Sciences mission of IUPUI, three of the six new Ph.D. programs are in the newly chartered and newly named **Richard M. Fairbanks School of Public Health**.

Biostatistics — This degree engages faculty from Mathematics, Public Health, and Medicine to produce tools and data to improve medical decision making.

Epidemiology — This degree trains researchers who discover how diseases spread and how to best protect the public.

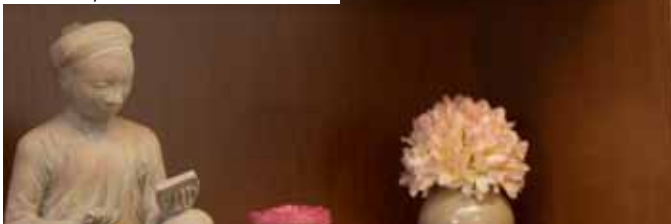
Health Policy & Management — This degree will train researchers to use data to drive a more efficient and effective health care system.

NEW PH.D.S, SCHOOLS OF LIBERAL ARTS, EDUCATION, HEALTH & REHABILITATION SCIENCES:

Economics — This degree focuses on medical economics, a vital component for a Life Sciences campus.

Health and Rehabilitation Sciences — This interdisciplinary degree focuses on research on how the body moves, contributing to improved health for Indiana citizens.

Dr. Sherry Queener
Associate Dean IU Graduate School
Director, IUPUI Graduate Office



NEW PH.D. PROGRAMS ON CAMPUS

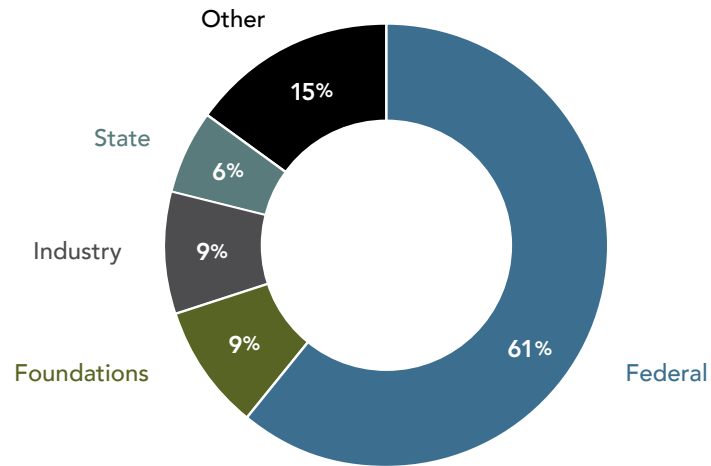
Capacity + Expertise = Innovation

Urban Education Studies — This degree focuses on developing best practices to meet urban educational needs.

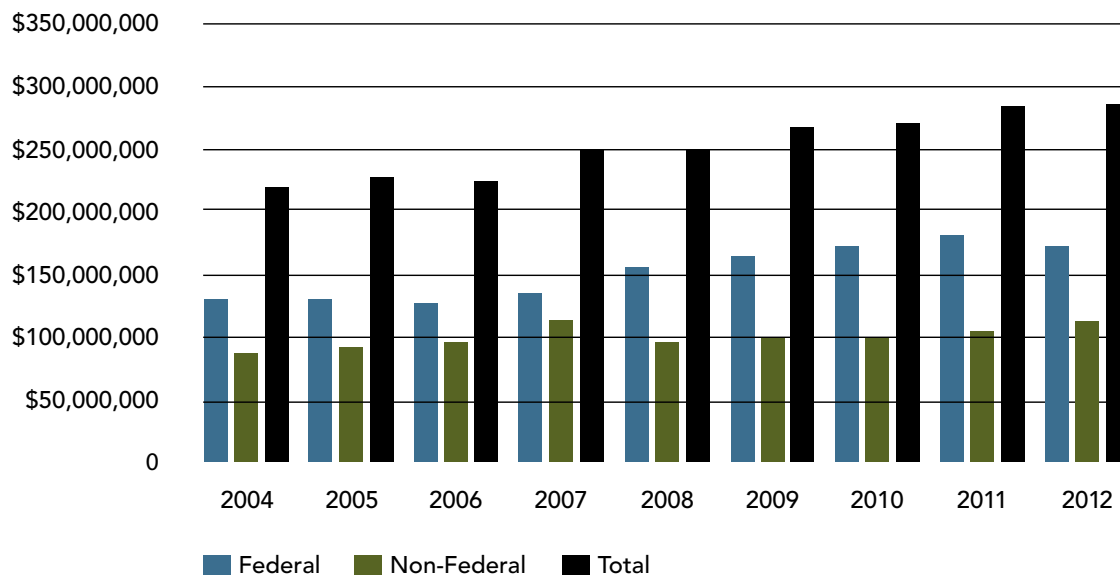
School of Philanthropic Studies — This school will be the new home of the Ph.D. in Philanthropic Studies, which was originally developed in the School of Liberal Arts. This Ph.D. program is developing researchers who are creating the new academic field focused on philanthropy.



IUPUI RESEARCH EXPENDITURES FOR FISCAL YEAR 2012
TOTAL: \$287,892,801



IUPUI TOTAL RESEARCH EXPENDITURES 2004–2012 FEDERAL VS NON-FEDERAL



IMPACT BY THE NUMBERS

IUPUI RESEARCH COMMERCIALIZATION METRICS

	FY 2011	FY 2012
Disclosures Received	134	173
Patent Applications Filed	158	212
Patents Issued	13	15
Start-Up Companies Formed*	7	10
Licenses Executed	27	30
License Income	\$4.2M	\$4.55M

* Company formation based on a license to an IUPUI technology.

IUPUI
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2012
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REPORT

