A new camera mimics the mantis shrimp’s eye and could improve early cancer detection
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**PATHWAYS**

is a publication of the Cancer Center at Illinois, University of Illinois at Urbana-Champaign. Each issue highlights the interdisciplinary and translational work of Cancer Center faculty, staff, students and external partners.

**ON THE COVER**

Members of Viktor Gruev’s research team set out in a boat to test the mantis shrimp-inspired camera at the Great Barrier Reef.

**ILLINOIS**

Cancer Center
Greetings! Since our last issue of Pathways, there have been some big changes. First, our Cancer Community at Illinois officially became the Cancer Center of the University of Illinois at Urbana-Champaign! Kudos to all our faculty, staff and students who have worked so hard to realize what was merely a concept just a few years ago.

In this issue, we highlight many of the scientific leaders of our Cancer Center. I would especially like to recognize the service of our Steering Committee (below) and especially our Chair, Prof. Gaskins, in guiding and forming this center. A big thank you to our former steering committee members Profs. Milan Bagchi, Benita Katzenellenbogen, William O’Brien and Edward Roy.

We also gratefully acknowledge the support provided by the Interdisciplinary Health Sciences Institute at Illinois and Director Neal Cohen, the Beckman Institute and Director Jeff Moore, the College of Engineering and Dean Andreas Cangellaris, and the Department of Bioengineering, with heads Profs. Michael Insana and Rashid Bashir. And we applaud our Deputy Director, Dean King Li of the College of Medicine, for his visionary leadership of the college, as well as contributions to establishing the Cancer Center. The Cancer Center is truly a result of the entire campus contributing its efforts.

With our cover featuring Prof. Gruev’s research in bringing lessons from the natural world to cancer imaging, we are truly meeting a goal of navigating new waters. Building on Illinois’ strengths in cancer research, we seek to become a unique NCI-designated “basic science” cancer center focusing on technology and translation of scientific innovations. Toward this goal, our campus solicited the assistance of a panel of national leaders in cancer research. They visited in October as our inaugural External Advisory Committee. I am grateful to Chancellor Robert Jones, Vice Chancellor Susan Martinis, and over 100 of our faculty, staff and students who worked to make this visit a success. This issue highlights our committee, and we are delighted to have such a distinguished panel and look forward to building our center with their advice.

We also highlight the successes of our faculty and students within the past few months. Several distinguished faculty have joined the University and Cancer Center, and new students have brought new energy to our campus. The University continues to power ahead with its contributions towards eliminating the burden of cancer with impactful research and innovative educational programs. The past few months have seen progress not only in our center but also in our shared vision of Illinois’ strides in nutrition, behavioral sciences, basic sciences and engineering being used to serve local, national, and global audiences.

From the Director
Cancer Center at Illinois: Navigating new waters

Steering Committee
Researchers at the University of Illinois at Urbana-Champaign have a long history of innovation and discovery in the life sciences, engineering, supercomputing and imaging. Now they have launched a new center of interdisciplinary collaboration — the Cancer Center at Illinois — to make a greater impact in the fight against the second leading cause of death in Illinois and the United States.

The Cancer Center at Illinois brings together more than 70 faculty members from across campus and numerous graduate students and postdoctoral researchers to pursue cancer-related research.

Illinois has exceptional research programs, shared research facilities, novel educational programs, and the strategic partnerships to address this challenge. The Cancer Center is working to advance knowledge in fundamental science and engineering so that it can be translated into interventions that address cancer throughout a patient’s journey.

“Today we applaud Founding Director Rohit Bhargava’s leadership in forming a community of like-minded researchers, creating innovative educational opportunities in cancer research, and connecting with clinical partners. Now the Cancer Center at Illinois is poised to make significant impact in how this university transforms cancer research,” said IHSI Director Neal Cohen.

Bhargava, Founder Professor of Engineering at Illinois, is deeply involved in cancer research and education efforts. With a primary appointment in the Department of Bioengineering and affiliations with the departments of Chemistry, Electrical and Computer Engineering, Mechanical Science and Engineering, and Chemical and Biomolecular Engineering, and the Beckman Institute for Advanced Science and Technology, he pioneered the field of digital molecular pathology, using spectroscopic imaging to study cells. He also leads the National Institutes of Health (NIH)-supported Tissue Microenvironment Training Program for graduate students and the undergraduate Cancer Scholars Program.

“Now the Cancer Center at Illinois is poised to make significant impact in how this university transforms cancer research.”

“The Cancer Center builds upon our work over the last several years to support the outstanding investigators, scientific resources, and highly collaborative environment we have at Illinois,” Bhargava said. “I am deeply grateful to our faculty and staff, the cancer community steering committee and University leaders for their enthusiasm, support, and hard work that has led to this moment.”

Along with the IHSI, the creation of the Cancer Center also has the support of the Beckman Institute, the College of Engineering and the Department of Bioengineering. The new Carle Illinois College of Medicine’s inaugural dean, Dr. King Li, serves as Deputy Director of the Center, while the steering committee for the Cancer Community at Illinois, headed by Professor H. Rex Gaskins, continues to guide the Cancer Center.

One goal is to become a National Cancer Institute (NCI) Designated Cancer Center in the near future, making the Cancer Center at Illinois a unique contributor of next-generation technologies and interventions to address cancer across the lifespan.

“Given the urgent need in our society for better healthcare at lower costs, we are excited that Illinois’ research strengths are focused through this Center to serve the community, state and nation. We are looking forward to exciting advances against cancer for many years to come,” said Bhargava.
Jeffrey Moore, the Murchison-Mallory Professor of Chemistry, a professor of Materials Science and Engineering, and a longtime Beckman faculty member, was named director of the Beckman Institute for Advanced Science and Technology in July 2017.

“Jeff’s research expertise, administrative experience, and dedication to Illinois make him the perfect person to lead the Beckman Institute,” said Peter Schiffer, vice chancellor for research at the University of Illinois at Urbana-Champaign.

A Beckman faculty member since 1994, Moore has served as co-chair of Beckman’s Molecular and Electronic Nanostructures theme and is a member of the Autonomous Materials Systems Group. Moore recently was named a member of the National Academy of Sciences and, in 2014, was named a Howard Hughes Medical Institute Professor. He is also lead primary investigator for the Joint Center for Energy Storage Research, a multi-institution research hub funded by the Department of Energy. Moore oversees the hub’s thrust on “Non-Aqueous Redox Flow Batteries.”

“Having served as interim director for the past year, I’m excited by the wide-ranging research that occurs in the Beckman Institute. Our researchers pursue problems with a team-minded spirit, free from the constraints of traditional academic boundaries,” Moore said. “You see so many examples of mutually beneficial interactions between science and technology here — a powerful way to solve important problems and drive new discoveries.”

The establishment of the Cancer Center at Illinois, based at the Beckman Institute, occurred early in Moore’s tenure as director.

“The Cancer Center is a perfect fit for the Beckman Institute,” said Moore. “The center’s research will build on our past accomplishments in multimodal cancer imaging and benefit from Beckman’s shared instrumentation and service facilities. The proximity of the Beckman Institute to local healthcare providers will facilitate relationships between our clinical collaborators at Carle and OSF Healthcare. Headquartering the Cancer Center at Beckman is one example of how the campus is uniting to stand up a first-rate, engineering-based College of Medicine.”

The Beckman Institute, home to more than 600 researchers and staff and more than $18 million in external research funding to date in FY16, pursues interdisciplinary research in the physical sciences, computation, biomedical imaging, materials science, biology, behavior, cognition, language and neuroscience.

Moore has published over 400 articles covering topics from technology in the classroom to self-healing polymers, mechanoresponsive materials, and shape-persistent macrocycles. He is a Fellow of the American Academy of Arts and Sciences, the American Chemical Society and the Royal Society of Chemistry, and has received numerous awards for his contributions to teaching and research.

He received his BS in Chemistry in 1984 and his PhD in Materials Science in 1989 from Illinois. He was an assistant professor at the University of Michigan before joining the Illinois faculty in 1993.

“Since 1989, Beckman has been a pioneering example of an academic entity that encouraged faculty to cut across traditional boundaries to address important research problems. The Institute’s success, in great part, has paved the way for the global rise of interdisciplinary research environments,” Moore said. “As today’s scientific challenges grow in complexity, and as technology moves at ever-faster rates, we must become even more agile and find new ways to foster partnerships with a wider cross-section of the talent on our campus.”

Beckman, which celebrated its 25th anniversary in 2014, works to transcend the limitations inherent in traditional university organizations and structures. The Institute was founded on the premise that reducing the barriers between traditional scientific and technological disciplines can yield research advances that more conventional approaches cannot. Researchers from departments as far-ranging as psychology, computer science, electrical engineering, physics, chemistry, and bioengineering make up Beckman Institute groups.
Cancer Center establishes scientific

NCI-Designated Cancer Centers

The National Cancer Institute’s Cancer Centers Program is one of the anchors of the nation’s cancer research effort. There are currently 69 NCI-Designated Cancer Centers, located in 35 states and the District of Columbia, that form the backbone of NCI’s programs for studying and controlling cancer. At any given time, hundreds of research studies are under way at the cancer centers, ranging from basic laboratory research to clinical assessments of new treatments. Many of these studies are collaborative and may involve several cancer centers, as well as other partners in industry and the community. The NCI-Designated Cancer Centers are recognized for their scientific leadership, resources, and the depth and breadth of their research in basic, clinical, and/or population science. There are 13 Cancer Centers, 49 Comprehensive Cancer Centers, and 7 Basic Laboratory Cancer Centers. Comprehensive Cancer Centers must demonstrate expertise in each of the following three areas: laboratory, clinical, and behavioral and population-based research. Comprehensive Cancer Centers are expected to initiate and conduct early phase, innovative clinical trials and to participate in the NCI’s cooperative groups by providing leadership and recruiting patients for trials. Cancer Centers conduct a combination of basic, population sciences, and clinical research, and are encouraged to stimulate collaborative research involving more than one field of study. Basic Laboratory Cancer Centers conduct only laboratory research and do not provide patient treatment. The Urbana-Champaign campus will be seeking Basic Laboratory Cancer Center status.

The NCI grant funding to the cancer centers supports shared research resources, provides developmental funds to advance scientific goals, and fosters cancer programs that draw investigators from different disciplines together. In addition, individual cancer center investigators are highly successful at obtaining research funding from NCI and other funding agencies and organizations. The cancer centers develop and translate scientific knowledge from promising laboratory discoveries into new treatments for cancer patients. Many cancer centers are located in communities with special needs and specific populations. As a result, these centers not only disseminate evidence-based findings into communities that can benefit from these findings, but the centers can also, through the experience of working with those patients, help inform national research and treatment priorities.

Source: www.cancer.gov

Cancer Center at Illinois: Scientific External Advisory Committee

A panel of national leaders with expertise in cancer center development have agreed to serve as external advisors to the Cancer Center at Illinois.

Dr. Otis Brawley, MD, currently serves as professor of hematology, oncology, medicine and epidemiology at Emory University. From April 2001 to November 2007, he was medical director of the Georgia Cancer Center for Excellence at the Grady Memorial Hospital in Atlanta and deputy director for cancer control at Winship Cancer Institute at Emory University. He filled a variety of capacities at the National Cancer Institute (NCI), most recently serving as assistant director.

Dr. Steven Clinton, MD, PhD, is a physician-scientist who divides his effort between clinical care and research. He serves as director of genitourinary oncology for The Ohio State University Comprehensive Cancer Center - Arthur
G. James Cancer Hospital and Richard J. Solove Research Institute and manages the renowned Prostate Cancer Multidisciplinary Clinic there. His team is a national leader in accrual to therapeutic trials in genitourinary cancer. Dr. Clinton also has an active laboratory research program that focuses primarily on understanding the development of prostate cancer, as well as its prevention and treatment.

Dr. Robert Diasio, MD, is the director of the Mayo Clinic Cancer Center. His research focuses on understanding how genetic factors can affect the efficacy of anti-cancer agents and can also be potential predictors of individuals at risk of severe, and potentially life-threatening, adverse drug toxicities. Dr. Diasio’s primary research focus is on the chemotherapy agent 5-fluorouracil (5-FU), which is prescribed to nearly 300,000 patients annually in the U.S. for the management of colorectal and other cancers. His lab has been instrumental in demonstrating that dihydropyrimidine dehydrogenase (DPD, encoded by the DPYD gene) has a critical role in converting approximately 85 percent of administered 5-FU to inactive metabolites.

Dr. Richard Levenson, MD, FCAP, is professor and Vice Chair for Strategic Technologies in the Department of Pathology and Laboratory Medicine, UC Davis. He trained in medicine at University of Michigan and pathology at Washington University, and is Board-certified in Anatomic Pathology. A faculty position at Duke was followed by an appointment at Carnegie Mellon University where he helped to become VP of Research, and served as principal investigator on federally funded research to develop multispectral microscopy systems and software for molecular pathology and diagnostics, three-dimensional small-animal imaging, optical dynamic contrast techniques, and birefringence microscopy.

Dr. Edison Liu, MD, is the committee chair and is the president and CEO of The Jackson Laboratory. Previously, he was the founding executive director of the Genome Institute of Singapore (2001-2011), and was the president of the Human Genome Organization (HUGO) from 2007-2013. From 1997-2001, he was the scientific director of the National Cancer Institute’s Division of Clinical Sciences in Bethesda, Md., where he was in charge of the intramural clinical translational science programs. Dr. Liu’s own scientific research has focused on the functional genomics of human cancers, particularly breast cancer, uncovering new oncogenes and deciphering on a genomic scale the dynamics of gene regulation that modulate cancer biology.

Dr. Milan Mrksich, PhD, is the Henry Wade Professor of Biomedical Engineering at Northwestern University. His interests overlap chemistry, biology and engineering, with an emphasis on the design and synthesis of materials that are biologically active and in applications of the materials to relevant problems in the biological and medical sciences. His lab has pioneered the design of “dynamic substrates”...

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that present ligands whose activities can be switched on and off in response to electrical or optical signals, particularly for studies that address the responses of adherent cells to changes in the extracellular matrix.

Dr. Timothy Ratliff, PhD, is a distinguished professor in comparative pathobiology and the Robert Wallace Miller Director of the Purdue University Center for Cancer Research. He received his BS from the University of Texas, his MS from Texas A&M, and his PhD from the University of Arkansas. The Purdue University Center for Cancer Research has a fundamental approach to discover new information about cancer that will lead to new ways to detect and treat the disease.

Dr. Bruce Tromberg, PhD, is the director of the Beckman Laser Institute and Medical Clinic (BLI) at the University of California, Irvine (UCI), and principal investigator of the Laser Microbeam and Medical Program (LAMMP), an NIH P41 National Biomedical Technology Center in the BLI. He is a professor with joint appointments in the departments of Biomedical Engineering and Surgery, co-leads the Onco-imaging and Biotechnology Program in UCI’s NCI Chao Family Comprehensive Cancer Center, and has been a member of the UCI faculty since 1990. Dr. Tromberg’s research spans the interdisciplinary fields of Biophotonics and Biomedical Optics with particular emphasis on the development of new technologies for medical imaging and therapy.

Dr. Donald L. (Skip) Trump, MD, FACP, is CEO and executive director of the Inova Schar Cancer Institute. Dr. Trump assumed his executive role in 2015, bringing more than two decades of leadership experience with prestigious cancer care, cancer research and cancer education programs.

With a strong clinical and research interest in genitourinary oncology, he has focused on the development of new approaches in the treatment of genitourinary cancer, especially prostate cancer. He has led institutional and cooperative group trials in new treatment approaches to GU malignancies.

Dr. Denis Wirtz, PhD, has joint appointments in the Department of Materials Science and Engineering at the Whiting School of Engineering, as well as the departments of Oncology and Pathology at the Johns Hopkins School of Medicine. He is also the Theophilus H. Smoot Professor of Chemical and Biomolecular Engineering in the Whiting School. He directs the Johns Hopkins Physical Sciences-Oncology Center and co-directs the Cancer Nanotechnology Training Center, both National Cancer Institute-funded entities. He also serves as associate director of the Johns Hopkins Institute for NanoBioTechnology and has served as vice provost for research since February 2014.

Dr. K. Dane Wittrup, PhD, is the Associate Director for Engineering at the Koch Institute for Integrative Cancer Research.
at the Massachusetts Institute of Technology. He is also the Carbon P. Dubbs Professor in Chemical Engineering and Biological Engineering. Dr. Wittrup attended the University of New Mexico as an undergraduate, graduating Summa Cum Laude with a bachelor’s in Chemical Engineering in June 1984. He went on to attend the California Institute of Technology in Pasadena, where he worked with Prof. James Bailey on flow cytometry and segregated modeling of recombinant populations of Saccharomyces cerevisiae.

UI Chancellor Robert Jones greeted the EAC members at the opening dinner, saying, “Our plans and goals for the Cancer Center are ambitious in both scale and timeline. This is one of the leading priorities of our campus in the health area. Along with the Carle Illinois College of Medicine, the Cancer Center is part of our medical and health focus. We’ve been laying the foundation for years, bringing together dozens of faculty members, hundreds of students, and years of research infrastructure investments across campus. For most of us, when we hear the word ‘cancer,’ our first thought is one of despair. We truly believe that the discoveries and innovations that come from this center at Illinois have the potential to change the definition to one of hope.”
The establishment of the Cancer Center brings together a cadre of skilled administrators and researchers to think about and address cancer research using different models of discovery, engagement and learning. Strategically focused within an agile model of change, a diverse campus-wide interdisciplinary team has come together to build and nurture a transformative ecosystem where individuals collaborate, innovation takes place, students and faculty engage in transformative activities, and achievements across the spectrum are celebrated.

**King Li**, MD, MBA, is the center’s deputy director. He is the inaugural Dean of the Carle Illinois College of Medicine (COM) and Chief Academic Officer for the Carle Health System. He provides critical guidance and advice to the Director, acting on behalf of the Director to represent the cancer center as needed. He will be especially engaged in faculty recruitment and retention and, in particular, of those with clinical duties. Li also oversees the Shared Resources (SRs) of the center by working closely with SR directors, the center’s administrative team and members to ensure that the shared resources provide critical services. He conducts the annual review of the SRs, meeting SR directors to evaluate critical needs; develop plans to address these needs; and advise SRs on strategy, service, funding and service fees. He also leads the first engineering-based college of medicine built at the intersection of engineering and medicine, a partnership between the University of Illinois at Urbana-Champaign and Carle Health System, Urbana, Ill.. With a clear vision of redefining medical education to re-engineer healthcare delivery, Li actively leads all facets of the Carle Illinois COM development, particularly its engineering-based foundation and public-private structure. He is a highly regarded scholar who commands respect in his discipline and in the medical profession. Equally important, Li enthusiastically engages faculty, disciplines and colleges across campus as well as physician colleagues at Carle and beyond in establishing the revolutionary college. Li is a renowned researcher, educator, inventor and clinician in molecular imaging and radiology. Holding 16 patents, with another six pending, and four new invention disclosures since joining the Carle Illinois COM, he has a long record of accomplishment in developing and commercializing intellectual property, as well as setting up and administering large clinical and translational research programs.

**Rex Gaskins**, PhD, is the chair of the cancer center’s Steering Committee. The Steering Committee is the primary means for the administrative team to interact with the representative membership of the center. Drs. Bhargava and Gaskins work together to gather input from the steering committee on important matters and activities. Gaskins presides over meetings, organizes advisory comments, and acts as a powerful “bottom-up” advocate for cancer-related topics across campus. Dr. Gaskins’ laboratory focuses on host-intestinal microbe interactions relevant to colorectal cancer (CRC), with a specific interest in microbial sulfur and hydrogen metabolism. He and his team were the first to show that the human colon is persistently colonized by bacteria capable of using both inorganic and organic sources of sulfur to generate hydrogen sulfide, a reductive gas that they also were first to demonstrate activates pro-inflammatory pathways and leads to genomic instability — two hallmarks of CRC.

**Margaret Browne Huntt**, PhD, serves as the Associate Director for Administration. She plays a vital role in the development and execution of the center’s activities and has proven administrative and facilitative skills enabling the integration of vision, decision-making, and resource allocation. She has held several administrative and leadership positions and is the site administrator for several of the center’s education programs, working directly with various leaders and strategic organizing committees. Performing in the dual positions of Senior Research
**Scientific Leaders**

**Thenkurussi Kesavadas**, PhD, Professor, Dept. of Industrial & Enterprise Systems Engineering; and Director, Health Care Engineering Systems Center, College of Engineering

Dr. Kesavadas has been researching Virtual Reality (VR) and its applications since 1990 when he pioneered a new VR interface to control robots to carry out complex operations as part of his doctoral dissertation. Before moving to the University of Illinois, he was a faculty member at the University of Buffalo, where he started the VR lab in 1996.

**Saurabh Sinha**, PhD, Professor and Willett Faculty Scholar, Dept. of Computer Science; and Director, NIH BD2K Center of Excellence: KnowEnG, a Scalable Knowledge Engine for Large-Scale Genomic Data

Dr. Sinha’s research falls into the area of regulatory genomics and big data genomics. Beginning with his post-doctoral experience at the Rockefeller University (with Eric Siggia), for the last 13 years he has focused on metazoan gene regulation. He has developed a suite of computational methods for ab initio discovery of enhancers in these genomes using sequence and expression data as well as cross-species comparison. In the last six years, he has been involved in research on quantitative modeling of enhancers, with the goal of predicting expression levels from DNA sequence.

**Brendan A. Harley**, ScD, Schaefer Family Scholar and Associate Professor, Dept. of Chemical & Biomolecular Engineering; and Theme Leader (Regenerative Biology & Tissue Engineering), Carl R. Woese Institute for Genomic Biology

Dr. Harley’s research interests during the last 15 years have focused on developing biomaterials that present microenvironmental (biophysical and biomolecular) signals to dynamically regulate cell behavior for applications in musculoskeletal regeneration, hematopoietic stem cell biofacturing, and models of invasive brain cancer.

**Paul Hergenrother**, PhD, Kenneth Rinehart Jr. Endowed Chair in Natural Products, Dept. of Chemistry; and Theme Leader (Anticancer Discovery from Pets to People), Carl R. Woese Institute for Genomic Biology

Dr. Hergenrother is a chemical biologist and medicinal chemist with substantial experience and expertise in cancer biology and anticancer drug discovery. The major goals of his laboratory are the identification of novel compounds and novel biological targets that can be exploited for selective anticancer therapy. He uses the compounds discovered to validate novel anticancer...
targets *in vivo*, with the objective of moving experimental therapeutics into human clinical trials.

**Stephen A. Boppart**, MD, PhD, Abel Bliss Professor of Engineering, Dept. of Electrical & Computer Engineering, Dept. of Bioengineering, and Dept. of Internal Medicine; Director, Glaxo Smith Kline Center for Optical Molecular Imaging; and Theme Leader, Integrative Imaging, Beckman Institute

Dr. Boppart has established a record for leading and participating in large and small federally funded research projects, leading and managing large groups of investigators, and initiating and leading major interdisciplinary efforts among academic institutions, clinical institutions, and industry. He has co-founded three companies based on biomedical imaging technologies and devices.

**Brian Cunningham**, PhD, Donald Biggar Willett Professor, Dept. of Electrical & Computer Engineering, Dept. of Bioengineering; Director, Micro and Nanotechnology Laboratory; and Theme Leader (Omics Nanotechnology Cancer Precision Medicine), Carl R. Woese Institute for Genomic Biology

Dr. Cunningham’s research looks at the development of simple, inexpensive, and compact detection platforms that are capable of digital-resolution sensing of protein or nucleic acid biomarkers from complex media to enable such assays to be routinely conducted for applications in biological research or *in vitro* diagnostics. The underlying physical principle pursued in his work is the coupling of electromagnetic energy from an external illumination source (such as a laser or LED) to a nanostructured optically resonant surface (a photonic crystal), which in turn efficiently couples energy into surface-attached plasmonically active nanoparticles that are resonantly matched to the photonic crystal.

**Barbara Fiese**, PhD, Pampered Chef, Ltd., Endowed Chair and Professor, Dept. of Human Development & Family Studies; and Director, The Family Resiliency Center

Dr. Fiese’s program of research focuses on family-level factors that promote health and wellbeing. Specifically, she has identified patterns of family interaction and routine practices that are associated with children’s physical and emotional health, including obesity and quality of life.

**Hillary Klonoff-Cohen**, PhD, Saul J. Morse and Anne B. Morgan Professor in Applied Health Sciences, Dept. of Kinesiology and Community Health

Dr. Klonoff-Cohen serves as the Director of the MPH, MS, and PhD programs in Community Health and the Associate Head for the Department of Kinesiology and Community Health at the University of Illinois at Urbana-Champaign. She has mentored students for the past 23 years, chairing 200 medical, doctoral and post-doctoral students’ committees, and taught and conducted clinical research at the University of California, San Diego. Previously she served as the Director for the Post-Doctoral Program in Cancer Disparities and the Director for the Core Epidemiology course for medical students.
The Carle Illinois College of Medicine, the first engineering-based medical school, has received preliminary accreditation from the Liaison Committee on Medical Education and is recruiting students for its first class. The first cohort of 32 students, who will begin classes in July 2018, will receive full four-year scholarships funded by donors and friends of the college.

“We believe that engineering and technology will revolutionize the way we deliver health care,” said Dr. King Li, the dean of the Carle Illinois College of Medicine. “We want to increase quality and accessibility while decreasing costs. We aim to produce physician-innovators and physician-leaders who can leverage engineering and technology in their medical practices to facilitate this change in healthcare delivery.”

The college is a partnership between the University of Illinois at Urbana-Champaign and the Carle Health System, based in Urbana, Ill. The case-driven, problem-based, active-learning curriculum will integrate engineering principles with medical education and clinical experience from day one.

To encourage curiosity and creativity, the college will require students to develop ideas for innovation in each of their clinical rotations. Students will expand upon one of their ideas for a capstone project. To translate their innovations to market, students will have access to campus entrepreneurial and intellectual property resources.

The faculty include distinguished researchers and educators from across the campus and skilled physicians at Carle Health System. The breadth of expertise will allow students and researchers to innovate many aspects of healthcare delivery — design, economics and communication, for example — alongside technology and medicine.

“Illinois has a culture of collaboration. We have many institutes and centers that are set up to encourage that,” Dr. Li said. “But the entire Carle Illinois College of Medicine is designed to be the catalyst for health science research at the University of Illinois to improve health for all.”

Admissions information and materials for the M.D. program are available online.

The Carle Illinois College of Medicine hosted two open houses on the Urbana campus in October and November for anyone interested in learning about the college.

The LCME is the U.S. Department of Education-recognized accrediting body for programs leading to the M.D. degree in the United States and Canada. The Carle Illinois College of Medicine is seeking approval from the Higher Learning Commission to offer the Doctor of Medicine degree. Approval from the HLC is pending and not guaranteed.

Additional information about the HLC can be found at www.hlcommission.org, and specific questions should be directed to admissions@medicine.illinois.edu.
“Physical space is an important component of creating connections. Arnold Beckman knew it when he conceived of the Beckman Institute. Today, we continue to build on that uniqueness, taking into account the importance of eliminating physical separations and barriers. That’s why we’re reinventing the institute’s collaborative spaces. Our goal is to create an even more dynamic environment—one where people meet by accident, where conversations are spontaneous, and where there’s a buzz of activity and energy of engagement.”

— Jeff Moore, Director, Beckman Institute

As part of the Beckman Institute’s process of re-envisioning its space, Dr. Deana McDonagh and her industrial design team are working with different neighborhoods or groups within the Beckman Institute.

One of those neighborhoods is the Cancer Center. In trying to meet the needs of the Cancer Center of the future, McDonagh’s team has met with the center’s leadership to discuss what the space could look and feel like. Words often heard during the discussions include: open, collaborative, inviting, energetic, vibrant, and dynamic.

The Cancer Center’s work is geared toward designing technologies and interventions that lead to better prevention, detection, diagnosis, and treatment, resulting in a better quality of life.

Part of the discussion is centered on creating a space that encourages teamwork, new ideas, efficiency and productivity.

The design team recently shared their thoughts on the process of designing the Cancer Center space.

Why is the concept of space, particularly collaborative space, so important

Collaboration generates a synergy that builds upon the libraries of knowledge, experience and skills we all bring to the table. The workspace ideally encourages and provides a supporting environment for all to contribute to.

How does space build bridges?

Traditional workspaces are fast disappearing. Wherever your laptop tends to be is your mobile office and work space. Teams tend to be interdisciplinary, especially at the Beckman Institute, and designing spaces that encourage interaction amongst them helps to generate a culture of trust. When trust is created, individuals tend to be more willing to share their thoughts, their work and their time with each other. This space will be calming and at the same time dynamic. It is the people that build bridges. The space we provide will merely give people the tools.

In the potential design of the Cancer Center space, what, if anything, is unique?

This space needs to be emotionally uplifting, reflective, and symbolize hopefulness. As much as the team envisions a new tomorrow, we need to reflect and remember those we have lost. The memorial wall will display names of lost love ones to cancer., for they provide the impetus that drives the work within this center.

How does your work and research inform the process of designing the space?

Design can empower, enable and enhance the quality of lives. Employing an empathic design research approach provides the opportunity to generate a user experience that is positive and engaging. Empathic design relies upon all the necessary functional requirements being met, while also seeking to satisfy emotional needs (e.g., cultural, social, emotional) to ensure a more balanced environment.
discussions help shape collaboration, office space

ABOUT THE DESIGN TEAM

Dr. Deana McDonagh is a professor of Industrial Design in the School of Art + Design at the University of Illinois at Urbana-Champaign and is a faculty member and designer-in-residence at the Beckman Institute of Advanced Science and Technology. Her research concentrates on emotional user-product relationships and how empathy can bring the designer closer to users’ authentic needs, ensuring both functional and emotional needs are met by products. She is a research fellow at Coventry University (UK), adjunct professor at Northwestern University, and Director of Research and Insight for Herbst Produkt design consultancy (USA). She is the designer entrepreneur-in-residence (startup incubator) at the UI Research Park.

Amanda Henderson is a design researcher with a background in industrial, scenic and exhibit design. After completing her undergraduate degree in Industrial Design at Carnegie Mellon University with a minor in Photography, she spent five years in the exhibit design industry. This experience inspired a curiosity to pursue her research focus: how designed forms change human perception of a spatial environment, with the ultimate goal of creating spaces that allow people to feel comfortable and knowledgeable interacting with their surroundings. She is pursuing her MFA in Industrial Design at Illinois, where she is an instructor of record at the School of Art + Design and designer-in-residence at the Beckman Institute for Advanced Science and Technology.
The Tumor Engineering and Phenotyping (TEP) resource supports and advances cancer research by enabling analyses on materials from cells to engineered tissues to animal models. The primary function of the TEP is to support the studies of cancer investigators, especially those who are engaged in basic science or technology development. It also seeks to become a unique resource nationally by acting as a repository and "maker lab" for development of novel tumor models for mimicking and improving our understanding of the structure, function and dynamics of the tumors and their microenvironment. There are three broad functions of the TEP: (a) to maintain and offer state-of-the-art facilities and shared resources for in vitro and in vivo tumor models to the cancer center, (b) collaborate with the microscopy SR and offer specialized facilities to integrate state-of-the-art pre-clinical imaging resources as needed, and (c) aid in the development of novel pre-clinical in vitro and in vivo tumor models as well as their assessment and evaluation.

The Biological Imaging Shared Resource (BISR) unites the cancer related Core Facilities at the Carl R. Woese Institute for Genomic Biology (IGB) and the Imaging Technology Group (ITG) at the Beckman Institute for Advanced Science and Technology. The two components of ITG are the Microscopy Suite and the Visualization Laboratory (Vis Lab). The IGB and ITG have been working together in a coordinated manner since the founding of the IGB in 2007. For the past 25 years, ITG has provided microscopes/microscopy-related instrumentation, image-processing/analysis programs, and the necessary expertise to make use of those tools to the U of I research community. The directors of each core have worked together for 20 years, first as coworkers at ITG and then separately for the past 10 years positioning the two cores to provide non-overlapping instrumentation and imaging expertise to the Illinois campus. In general, the IGB Core Facilities provide high-end light microscopy instrumentation (fluorescence, confocal, Airy scan, structured illumination microscopy [SIM], light-sheet microscopy), cell-counting, and serial block-face scanning electron microscopy; the ITG Vis Lab provides a wide range of sophisticated image-processing software packages on fast computers that can handle large data sets, as well as staff to guide researchers in their utilization of those packages; a studio with macrophotography, a StackShot automatic focus stacking rail system, 3D scanning capability on macro and nano scales, a 2-million-fps video color camera and a Graphics group that specializes in custom journal covers and figures; and the ITG Microscopy Suite provides a large number of electron microscopy, scanned probe microscopy, fluorescence microscopy/spectroscopy, and micro- and nano-x-ray computed tomography instruments, as well as other pieces of analytical and preparation equipment.

The BISR provides the cancer research community access to state-of-the-art imaging through the
acquisition of state-of-the-art instrumentation, efficient operation of the equipment, thorough training of researchers in their use of the equipment, and guidance in experimental protocols. Both ITG and IGG have used this strategy since their respective inceptions. The cores work with faculty to determine instrument needs and funding strategies. After purchase, the instrumentation is generally maintained on service contracts supported by user fees. Both facilities have staff assigned to train users on each instrument or software package. The creation of the single Biological Imaging Core for Cancer Imaging will result in additional instrumentation and training capabilities specifically useful for cancer research.

The University of Illinois Roy J. Carver Biotechnology Center (CBC) offers its core facilities to provide functional genomics, library services, high throughput sequencing, genotyping, fragment analysis, oligonucleotide synthesis, proteomics, transgenic, and metabolomic services. These form critical capabilities needed for researchers, in all the programs of the center. The CBC has a foundation of instrumentation and trained scientists dedicated to offering comprehensive support to medical research. All facilities are open access and actively involved in a wide variety of large to small projects. The CBC has ample throughput capacity to accommodate all existing and emerging projects from researchers and therefore will directly contribute to the successful operation.

The Micro + Nanotechnology Shared Resource (MSR) seeks to provide high quality micro and nanofabrication capabilities that include the most modern methods as well as state of the art nanobiotechnology facilities for cancer research. The MSR is managed and includes parts of the facilities of the Micro and Nanotechnology laboratory (MNTL), which is the foremost laboratory for micro and nanotechnology research at the University of Illinois.

The Micro and Nanotechnology Laboratory (MNTL) is a state-of-the-art multidisciplinary research facility in the College of Engineering at the University of Illinois at Urbana-Champaign. MNTL is one of the nation’s largest and most sophisticated university-based facilities for semiconductor, nanotechnology, and biotechnology research. The MNTL is part of a campus-wide set of resources open to all faculty and it provides equal access to all university Cancer Center investigators. Part of the MNTL’s facilities relevant for cancer research are organized under this umbrella as a CCIL shared resource that will be managed by the MNTL. The mission of the MNTL is to create, support, and sustain an environment to facilitate advanced research in photonics, microelectronics, biotechnology and nanotechnology for the benefit of the University community, the State of Illinois, and society as a whole.
Beckman Institute Vision and Spirit Award recognizes Bhargava

In honor of the sesquicentennial of the University of Illinois, the Beckman Institute Vision and Spirit award, in the amount of $150,000, recognizes a researcher at the Beckman Institute for Advanced Science and Technology who exemplifies founder Arnold Beckman’s vision in establishing the institute and who has fostered collaboration in order to mount a bold and risky experiment that meets not only short-term research goals but inspires future long-term work, contributing significantly to the institute’s mission.

“A visionary researcher, Bhargava’s ideas have resulted in the development of infrared spectroscopic imaging. And instruments developed in his laboratory have provided new means to characterize and define cancer using chemical imaging methods that are leading to the emergence of the field of digital molecular pathology,” said Jeff Moore, director of the Beckman Institute, who presented the award to Bhargava in April 2017. “With relentless spirit, he has championed the creation of the Cancer Community at Illinois, a University-wide effort dedicated to advancing cancer-related research and scholarship at Illinois, positioning us to become a cancer center based on fundamental science and technology.”

Bhargava holds appointments in the departments of Bioengineering, Chemical and Biomolecular Engineering, Mechanical Science and Engineering, Electrical and Computer Engineering, and Chemistry. He also leads a National Institutes of Health-supported Tissue Microenvironment Training Program based at the Beckman Institute.

He received a dual B.Tech. degree in chemical engineering with a minor in Polymer Science and Engineering from the Indian Institute of Technology, New Delhi, and a doctoral degree from Case Western Reserve University.

“I am deeply honored and humbled by this award,” said Bhargava. “The Beckman Institute has not only helped me attract outstanding students, provided exceptional colleagues and access to world-class facilities but has provided the inspiration and environment to launch many of our ideas. The Beckman Institute is the ‘incubator of ideas’ for our campus, and I am deeply grateful to all our members in helping make those dreams a reality.”

Jeff Moore (left), director of the Beckman Institute, with Rohit Bhargava, Vision and Spirit Award recipient. PHOTO BY THOMPSON-MCCLELLAN

Bhargava (center) and several of his students. PHOTO BY THOMPSON-MCCLELLAN
Awards, Honors and Achievements

**Bashir to receive BMES 2018 Pritzker Distinguished Lecture award**
By Laura Schmitt, Bioengineering

Rashid Bashir, Grainger Distinguished Chair in Engineering, professor in Bioengineering, and executive associate dean of the new Carle Illinois College of Medicine, has been selected to receive the 2018 Robert A. Pritzker Distinguished Lecture Award, the Biomedical Engineering Society’s (BMES) premier recognition for outstanding achievements and leadership in the science and practice of biomedical engineering. Bashir will receive the award in 2018 in Atlanta.

Bashir’s research is focused on integrating engineering and technology with biology, from the molecular scale to tissues and systems. Among other innovations, his group has developed lab-on-a-chip technologies, miniature biological robots, and point-of-care diagnostic devices, leading to the creation of multiple startup companies.

**Kilian and Pan named Young Innovators of CMBE**
By Laura Schmitt, Bioengineering

Illinois Bioengineering faculty members Kristopher Kilian (pictured on the left) and Dipanjan Pan (at right) were named 2017 Young Innovators of Cellular and Molecular Bioengineering (CMBE). They presented their research at the 2017 Biomedical Engineering Society annual meeting in October.

Kilian and his team explore how both natural and synthetic materials influence the signaling that controls cell fate and function. His latest work, featured in CMBE’s journal, shows that matrix mechanics influences the phosphorylation state and cellular localization of histone deacetylase HDAC4. This work demonstrates how enzymes involved in the regulation of gene expression within cells are influenced by the surrounding environment, and may provide clues to how the properties of tissue directs normal and pathological processes.

A recognized expert in nanomedicine, molecular imaging, and drug delivery, Dipanjan Pan develops novel materials for biomedical applications and targeted therapies for stem-like cancer cell and phenotypically screened nanomedicine platforms. In his latest research, which appears in the October CMBE journal, Pan demonstrated the enhanced efficacy of a cocktail of agents delivered intracellularly from multi-compartment carbon nanoparticles as compared to the intracellular nanoparticle delivery of individual agents. This work can help quickly identify appropriate dosing regimens for various cancers and diseases.

**Klonoff-Cohen receives eminent scientist award**

In a ceremony at Huff Hall on October 10, Hillary Klonoff-Cohen (pictured at left) was recognized with the “Eminent Scientist of the Year 2017 and Millennium Golden International Award,” which was presented by the International Research Promotion Council (IRPC).
By mimicking the eye of the mantis shrimp, Illinois researchers have developed an ultra-sensitive camera capable of sensing both color and polarization. The bioinspired imager can potentially improve early cancer detection and help provide a new understanding of underwater phenomena, the researchers said. “The animal kingdom is full of creatures with much more sensitive and sophisticated eyes than our own,” said Viktor Gruev, a University of Illinois professor of Electrical and Computer Engineering and co-author of the new study. “These animals perceive natural phenomena that are invisible to humans.”

“Polarization of light — that is, the direction of oscillation of light as it propagates in space — is one such example,” Gruev said. While most of us are familiar with polarized sunglasses, which simply remove glare, many animals use polarized vision as a covert communication channel, to find food, or even to navigate by sensing polarization patterns in the sky.” The mantis shrimp, considered one of the best hunters in shallow waters, possesses one of the most sophisticated eyes in nature. Compared with human vision, which has three different types of color receptors, the mantis shrimp has 16 different types of color receptors and six polarization channels, Gruev said.

“These organs not only surpass the sensitivity of our own visual systems, they also capture more visual information — using less power and space — than today’s most sophisticated, state-of-the-art cameras,” he said.

Gruev and graduate student Missael Garcia led an effort to replicate the shrimp’s visual system using some basic physical concepts. They report their findings in the journal Optica.

“Nature has devised materials such that different colors of light penetrate at different depths,” said Gruev, who also directs the Biosensors Lab at Illinois. “If we shine a blue laser and a red laser on the tip of our finger, we can only observe the red light on the other side of the finger. This is because the red light can penetrate deeper in the tissue.”

“Nature has constructed the mantis shrimp eye in such a way that photosensitive elements are vertically stacked on top of each other,”
Gruev said. This stacking allows for absorption of shorter wavelengths, such as blue light, in the shallow photoreceptors and red light in the deeper receptors. The photoreceptors are organized “in a periodic fashion at the nanoscale that allows them to also ‘see’ the polarized properties of light,” he said.

“The same laws of physics that apply to the mantis visual system also apply to silicon materials, the material used to build our digital cameras,” Garcia said. “By stacking multiple photodiodes on top of each other in silicon, we can see color without the use of special filters. And by combining this technology with metallic nanowires, we effectively have replicated the portion of the mantis shrimp visual system that allows it to sense both color and polarization.”

This unique combination of silicon photodetectors and nanomaterials allowed the Illinois research team to create a point-and-shoot color-polarization camera. The applications for such cameras are wide-ranging, from early cancer detection to monitoring changes in the environment to decoding the covert communication channels that many underwater creatures appear to exploit, the researchers said.

In a previously published study by Gruev, a bioinspired polarization sensor fitted to a colonoscope could detect the disordered nature of cancerous cells in the human colon.

“By mimicking the mantis shrimp visual system, we have created a unique camera that can be used to improve the quality of our lives,” Gruev said. “The notion that we can detect early formation of cancer is what is driving this research forward. The cost of this technology is less than $100, which will enable quality health care in resource-limited places around the world.”

Gruev also is affiliated with the Beckman Institute for Advanced Science and Technology at the U. of I.

The National Science Foundation and the Air Force Office of Scientific Research supported this study.

Photo of a mantis shrimp taken by the researchers’ new camera: color image (top) and DoLP image in a false-color map (bottom), where red and blue indicate highly polarized and unpolarized lights, respectively.
Cholesterol byproduct hijacks immune cells, lets breast cancer spread

By Liz Ahlberg Touchstone, UI News Bureau

High cholesterol levels have been associated with breast cancer spreading to other sites in the body, but doctors and researchers don’t know the cause for the link. A new study by researchers at the University of Illinois at Urbana-Champaign found that the culprit is a byproduct of cholesterol metabolism that acts on specific immune cells so that they facilitate the cancer’s spread instead of stopping it.

The study, published in the journal Nature Communications, identifies new potential drug targets that could inhibit the creation or actions of the dangerous cholesterol byproduct, a molecule called 27HC.

"Breast cancer impacts roughly 1 in 8 women. We’ve developed fairly good strategies for the initial treatment of the disease," said Erik Nelson, a professor of Molecular and Integrative Physiology, who led the study, "but many women will experience metastatic breast cancer when the breast cancer has spread to other organs, and at that point we really don’t have effective therapies. We want to find what drives that process and whether we can target that with drugs."

Nelson’s group fed mice with breast cancer tumors a diet high in cholesterol. The researchers confirmed that high levels of cholesterol increased tumor growth and metastasis and that mice treated with cholesterol-lowering drugs called statins had less metastasis. Then they went further, specifically inhibiting the enzyme that makes 27HC during cholesterol metabolism.

"By inhibiting the enzyme that makes 27HC, we found a suppressor effect on breast cancer metastasis. This suggests that a drug treatment targeting this enzyme could be an effective therapeutic," said Amy Baek, a UI postdoctoral researcher and the first author of the paper.

The team also saw unusual activity in specific immune cells — certain types of neutrophils and T-cells — at metastatic sites high in 27HC.

"Normally your body’s immune system has the capacity to attack cancer," Nelson said, “but we found that 27HC works on immune cells to fool them into thinking the cancer is fine. It’s hijacking the immune system to help the cancer spread.” Nelson also describes the study in a YouTube video.

Because 27HC acts through the immune system, and not on the breast cancer itself, the researchers believe their findings have broad applicability for solid tumors. They performed experiments looking at colon cancer, lung cancer, melanoma and pancreatic cancer, and found that 27HC increased metastasis for all the tumor types, suggesting that a treatment targeting 27HC could be effective across multiple cancer types.

The researchers are working to further understand the pathway by which 27HC affects the immune cells. With clinical partners at Carle Foundation Hospital in Urbana, Ill., the team is working to establish whether 27HC has the same pathway in human patients as in mice.

"We hope to develop small-molecule drugs to inhibit 27HC," Nelson said. “In the meantime, there are good cholesterol-lowering drugs available on the market: statins. Cancer patients at risk for high cholesterol might want to talk to their doctors about it.”

Nelson also is affiliated with the Cancer Center, the Division of Nutritional Sciences, and the Carl R. Woese Institute for Genomic Biology at Illinois.

The National Institutes of Health and the Susan G. Komen Foundation supported this work.
Following are Faculty Seminar Series and related symposium events held during the Fall 2017 semester. The Faculty Seminar Series is jointly sponsored by the Cancer Center at Illinois, the Health Care Engineering Systems Center, and the Interdisciplinary Health Sciences Institute.

UPCOMING SEMINAR

Thursday, December 7, 2017
3:00-4:30 p.m.
Health Care Engineering Systems Center
North Campus Parking Deck Building, Room 1232
1206 W. Clark Street, Urbana, Illinois

Shiva Abbaszadeh
Nuclear, Plasma, and Radiological Engineering
“Towards a High Spatial Resolution Dedicated Head and Neck PET System”

Princess Imoukhuede
Bioengineering
“Growth Factor Receptor Signaling and Cancer: New Mechanisms and Insights”

Laura Selmic
Veterinary Clinical Medicine
“Surgical Margin Imaging in Spontaneous Companion Animal Cancer”

RECENT SEMINARS & EVENTS

Held November 2, 2017
Beckman Institute for Advanced Science and Technology
Urbana, Illinois

Elvira de Mejia
Food Science and Human Nutrition
“Phytochemical Composition and Nutraceutical Properties of Flavonoids from Fruits and Vegetables: Role in Pancreatic Cancer”

Auinash Kalsotra
Biochemistry
“Unexpected Roles for RNA Splicing in Non-Alcoholic Fatty Liver Disease and Cancer”

Brendan Harley
Chemical and Biomolecular Engineering
“Engineering Tumor Microenvironments”

Held October 5, 2017
Health Care Engineering Systems Center
Urbana, Illinois

Anna Arthur
Food Science and Human Nutrition
“Diet as a Modifiable Factor for Cancer Outcomes”

Michael Oelze
Electrical and Computer Engineering
“Cancer Imaging and Therapy Using Ultrasound: What You Haven’t Heard”

David Kranz
Biochemistry
“Immunotherapy of Cancer”

The annual Carle Illinois Cancer Symposium was held on Friday, September 29, 2017, at the Forum at Carle, Urbana, Ill. Focusing on “Breakthroughs in Oncology,” the day-long symposium featured national leaders. Wendy Demark-Wahnefried, PhD, RD (University of Alabama - Birmingham) spoke on obesity and cancer. Christopher Comstock, MD, FACR (Memorial Sloan Kettering Cancer Center, New York) spoke on 3D versus 2D mammography for breast cancer screening. Additional speakers included Jamie Cairo, DNO, AOCNP (Aurora Cancer Center, Milwaukee); Everett Vokes, MD (University of Chicago Medicine and Biological Sciences); Blasé Polite, MD, MPP (University of Chicago Medicine); Barbara Conley, MD (National Cancer Institute); Sunandana Chandra, MD, MS (Northwestern University); and Timothy Fan, DVM, PhD, DACVIM, University of Illinois at Urbana-Champaign.

The Carle Foundation Hospital hosted the Clinical Advances in Neuro Oncology Symposium on October 4, 2017, which focused on cutting-edge imaging, diagnostics, and treatment for cancers of the brain. Dr. Jan Buckner and Dr. Bradley Erickson, both from Mayo Clinic in Rochester, Minnesota, were featured presenters, as well as Dr. Daniel Barnett from the Carle Cancer Center.
EDUCATION: researchHSStart student projects

By Margaret Browne Huntt, Cancer Center at Illinois

Students in researchHSStart visit the Escape Room at LabEscape, a new science-based puzzle activity at Lincoln Square in Urbana, Ill. Back row, left ot right: Elizabeth Breen, Jarron Roy, Joy Chen and Robert Forsyth. Front Row: Malaak Saadah, Aditi Mehta, Sarah Matatov and Yichen Yao

PHOTO BY Paloma Pearson

Elizabeth Breen
University of Illinois Laboratory High School
Mentors: Rex Gaskins, PhD; Jan Lumibao; Vladimir Kolossov, PhD
Title: GBMU87 and U87vIII CHCHD2 Localization and Redox Alterations with Live Cell Imaging

Glioblastoma (GBM) is the most common and aggressive form of brain cancer. Coiled-helix-coiled-coil-helix domain-containing protein 2 (CHCHD2) is a mitochondrial protein that aids in cellular respiration but is also suggested to act as a regulator of nuclear gene expression. GBM is a severely aggressive brain cancer that accounts for more than 40% of all primary malignant brain tumors. The disease is currently incurable, with median survival time usually only 12-15 months.

The mitochondrion, also known as the “powerhouse of the cell,” is the site of cellular respiration and where ATP, the cell’s primary energy source, is produced. CHCHD2 is a mitochondrial protein essential to the electron transport chain (ETC) and oxidative phosphorylation, where it operates as a transcriptional activator for cytochrome c oxidase (COX) subunit 4 isoform 2. In addition to the mitochondrion, CHCHD2 is also found in the nucleus, where it is presently known to stimulate transcription of a gene set that includes itself as well as several other genes.

In the mitochondria, CHCHD2 binds to COX and is necessary for optimal function of its respiration. Redox reactions can fully oxidize or fully reduce the amount of oxygen in a cell, depending on the reagent applied. We performed two experiments to investigate CHCHD2 and cellular redox in GBM cells. This project investigates whether cellular reduction with the reducing reagent dithiothreitol (DTT) causes migration of CHCHD2 to the nucleus of GBM cells and what is the role of CHCHD2 in the oxidation rate of GBM cells.

Joy Chen
University of Illinois Laboratory High School
Mentor: Erik Nelson, PhD
Title: 27-Hydroxycholesterol Promotes Breast Cancer Recurrence

Cancer metastasis is the spread of cancer cells from a primary tumor throughout the rest of the body to form new tumors. Studies have shown that individuals with high cholesterol have increased chances of breast cancer recurrence. A contributing factor to this phenomena is that a metabolite of cholesterol, 27-hydroxycholesterol (27HC), promotes tumor growth and metastasis. However, it is not quite understood the means by which 27HC functions. In this study, our goal is to recognize which receptors 27HC works through, as well as if the Notch signaling pathway is essential for its function. This will
— hands-on, mentored experiences

The team has concluded that 27-hydroxycholes-terol increases IL6 production and also likely requires the Notch signaling pathway as well as the estrogen receptor and liver X receptor. We also can see from our data that 27HC decreases the latency period of dormancy. Future research will seek to characterize 27HC induction of Notch, as well as evaluate the effects of 27HC in other models of cancer dormancy.

Robert Forsyth
Urbana High School
Mentors: Rohit Bhargava, PhD; Troy Comi, PhD
Title: Assessment of Octadecane Coating for Preparation of Aqueous Gels with Isomalt Scaffolds

Microfluidic devices are tools used to control and manipulate micro-scale volumes of fluid. Typically, microfluidic devices are manufactured through layer-by-layer printing, or soft lithography, with materials like polydimethylsiloxane. However, continuously curved structures and some complex geometries are difficult to produce with traditional fabrication methods. The Bhargava lab has developed a freeform 3D printer, which directly produces objects branch by branch, allowing it to create complex objects and continuously curved structures. The printer extrudes a sugar alcohol, called isomalt, which forms a stiff glass when cooled and dissolves in room temperature water. As such, isomalt can be used to fabricate complex structures and as sacrificial molds to form microfluidic devices. However, when these devices are fabricated in certain gels, the isomalt dissolves long before any useful channel has formed. This is a particular problem in collagen gels, which are a useful tissue mimic. Therefore, we need to coat isomalt so that it can resist dissolution and form channels inside of gels that would otherwise dissolve it.

The team will investigate other imaging techniques to acquire full cross-sectional images of C18-coated isomalt structures. Such data will allow the team to quantify coating uniformity and thickness to optimize coating parameters. Furthermore, they are designing an automatic C18 sprayer, which should reduce variability in coating by providing control over air pressure, flow rate, and the distance from the sprayer.

Aditi Mehta
Centennial High School
Mentors: Zeynep Madak-Erdogan, PhD;

Eylem Kulkoyluoglu
Title: Molecular Mechanisms of XPO1 and ERalpha Cotargeting in Breast Cancer

The majority of breast cancer-specific deaths occur due to recurrent and endocrine therapy resistant ER (+) tumors. Thus, there is a need to find a combination therapy that delays or prevents resistance. SXR is a specific inhibitor to XPO-1, a nuclear exporting protein. Our long-term objective is to determine what role XPO-1 plays in therapy resistance in ER (+) tumors. Specifically, in this project, the team studied the impact of a Selinexor (SXR) and Tamoxifen (4-OH Tam) combination on kinase signaling pathways. They used protein kinase arrays and western blotting together with GFP-specific fluorescence-based assays to identify the effect of this combination therapy on kinase activation and cell viability in T47D-GFP cells. In summary, the team identified various survival pathways as targets of ERα-XPO1 crosstalk. In future studies, they will validate these pathways and their importance in tamoxifen resistance.

Sarah Matatov
University of Illinois Laboratory High School
Mentors: Wawrzyniec Dobrucki, PhD; Christian Konopka
Title: in vitro and in vivo Evaluation of Doxorubicin-based Anti-cancer Treatment in Combination with the Herbal Medicine Black Cohosh in MCF-7

As a substitution for hormone replacement therapy, many breast cancer patients use herbal extracts of black cohosh (BC) in combination with doxorubicin-based (DOX) chemotherapy. Dobrucki’s lab has previously demonstrated that BC increases cytotoxicity of doxorubicin in EMT6 mouse mammary tumor cells due to changes in drug efflux. In this study, the team evaluated the synergistic effects of BC and DOX on in vitro viability. F-FDG revealed significant reduction in tumor metabolism after treatment with DOX (40%) and BC (20%) alone. However, they did not observe any synergistic effects on tumor metabolism when treated with DOX in combination with BC. Both DOX and BC treatments inhibited tumor growth by 20% and 12%, respectively. DOX treatment in combination with BC resulted in a substantial reduction in tumor size (57% versus control). Using various molecular biology and imaging techniques, they successfully demonstrated that BC exerts synergistic effects on DOX cytotoxicity, resulting in significant reduction in tumor size.
Continued from page 23:

in tumor size. Histological study of the tumors revealed that the presence of blood vessels is significantly reduced with the combined treatment of doxorubicin and black cohosh when compared to all other treatments.

Jarron Roy
Monticello High School
Mentors: Prasanth Kannanganattu, PhD; Qinyu Sun
Title: Establishing a dCas9 Tethering System to Recruit Splicing Factors to mRNA in Cancer Cells

The lncRNA MALAT1 has been shown to play a significant role in metastasis and tumorigenesis by regulating the splicing factor SRSF1 in order to modify BIM and BIN1, two oncogenes, via alternative splicing. These studies have been performed by inhibiting and/or overexpressing MALAT1 and SRSF1. In order to test this in a more refined manner, this project tethered a dCas9-SRSF1 fusion protein to exonic regions in BIM and BIN1 using sgRNAs in the absence of MALAT1. Then the team examined whether the local tethering of SRSF1 to BIM and BIN1 can rescue the phenotype from the knockdown of MALAT1. This will prove the proposed model of how MALAT1 and SRSF1 regulate BIM and BIN1 and provide a new technique for studies that need to recruit other splicing factors to other genes.

In summary, they have created both the dCas9-SRSF1 fusion protein and the sgRNA that will lead dCas9-SRSF1 to BIM and BIN1. To create the sgRNA construct, the team used an overlap extension PCR to insert the targeted sequence into the strand. Then they ligated it into a plasmid and cloned it in bacteria. After that, they transfected the plasmid into HEK293T cells to produce the virus that will be used to express the sgRNA in Hela cells.

Malaak Saadah
Champaign Central High School
Mentors: Roy Dar, PhD; Kathrin Bohn-Wippert, PhD; Yiyang Lu
Title: Proliferation and Viability of Cancer Cells and Bystander Cells Treated with Anticancer Drugs

Cancer therapy causes extreme side effects as a result of affecting off-target cell types and signaling pathways. This project investigates the proliferation and viability of leukemia T-cells compared to human embryonic kidney (HEK) bystander cells under anticancer drug treatments. Using cell counting and cell death stains, growth and viability measurements were obtained under drug treatments of 2-5 days. Here the team shows that anticancer drugs are more potent to the leukemia cells than the bystander cells. Population growth rates and lethality rates were correlated. The impact of drugs on healthy cells will continue to be of interest for biomedical research, and advanced quantifications like these will contribute to the pharmaceutical sciences.

Yichen Yao
University of Illinois Laboratory High School
Mentors: Viktor Gruev, PhD; Steven Blair
Title: Mixed Reality with Gear VR for Image Guided Surgery

The researchStart symposium was held on the Urbana campus in August 2017. Pictured here (l to r) celebrating researchStart and the campus’ 150th anniversary are Dr. King Li, Dean of the Carle Illinois College of Medicine; Dr. Rohit Bhargava, Director, Cancer Center at Illinois; and Debra and Ira Cohen, who helped develop and fund researchStart.

PHOTO BY MARGARET BROWNE HUNTT
Current intraoperative systems for tumor imaging provide useful information for oncologic surgery but face drawbacks or limitations, including the exposure of patients to ionizing radiation or the disruption of surgical workflows due to bulky hardware and remote displays. However, NIR fluorescence imaging aided by fluorescent contrast agents has proven a capable solution to these problems. The Gruev lab has developed an imaging system consisting of custom color and NIR imaging sensors wired to a computer for image processing and wearable virtual reality goggles for video display that provide real-time color and fluorescence information non-disruptively. This system has achieved 100% sensitivity in sentinel lymph node detection in human pilot studies, but it is an expensive custom-made system that relays information only given by the attached sensors, and it restricts the surgeon’s movement. For this project, Yao developed an economical alternative to these first-generation goggles with a smartphone-based mixed-reality system. When used with an appropriate imaging sensor and dye, her system offers an improved user interface, additional information, and freedom of movement to the surgeon.

Student thoughts about the researchHStart program

“I learned a lot, not only about cancer research itself, but a lot of new labwork techniques and skills that I can use throughout my researching career. The lab environment was super welcoming and the work was really fun, so I looked forward to going to lab every single day. The immense amount of lab-related work I learned how to do over the past summer just has been so amazing.” —Joy Chen

“I got to work in a real lab and was lucky enough to have entirely my own project that was mostly self led. I was mentored by a very cool prof, and the students in my lab were very nice and welcoming. I learned a lot about programming, and the real-world applications.” —Yichen Yao

“This opportunity gave me hands-on experience on how to carry out professional research and was a great starting point for my future career in the field.” —Elizabeth Breen

“I learned a lot about lab protocols and how to set up different experiments. I also learned a lot more about how to use Excel.” —Malaak Saadah

“I learned so much about current research fields, molecular biology, experimental techniques, and presentation skills.” —Jarron Roy

“The researchHStart program ... allowed me to form connections with faculty and staff at the university — connections that will probably last a long time. Also, I learned several new things about working in a lab with other people but also just several new techniques that I can put on my resume when I apply to work in labs as an undergraduate.” —Aditi Mehta

Thank you!

Each year, the researchHStart program continues to grow because of the time and commitment provided by the faculty mentors and their lab teams. The program hosts students in a variety of departments and colleges across campus for eight weeks during the summer.

Meet the Urbana-Champaign site team: Rohit Bhargava, Director, Cancer Center at Illinois; Margaret Browne Huntt, Associate Director, Cancer Center, and Senior Research Development Manager, Interdisciplinary Health Sciences Institute; Paloma Pearson, Program Manager; Marcia Pool, Director of Undergraduate Programs, Bioengineering; Cathy Tingley, Administrative Assistant, Interdisciplinary Health Sciences Institute.

Thank you also to the teams at the University of Chicago Cancer Center and University of Illinois at Chicago (UIC) Cancer Center.

The researchHStart program is administered at three locations: the University of Chicago, University of Illinois at Chicago, and the University of Illinois at Urbana-Champaign. The program is funded through philanthropic support from Debra and Ira Cohen, Kim Duchossois, and other generous donors.
EDUCATION: Cancer Scholars Program student spotlight

By Marcia Pool, Department of Bioengineering

Benjamin “Bear” Bissen

Bioimaging, cell culture and other biological techniques, computational models, etc. — these are the topics we imagine when we describe cancer research. Yet there is another realm in which the fight against cancer can be pursued, — public policy and lobbying.

Bear Bissen is a sophomore in the Cancer Scholars Program (CSP). He entered the program as an undergraduate in Computer Science but quickly became fascinated with public policy, and at the end of his freshman year, Bear changed his major to Political Science. Through his interest in public policy, Bissen is enlightening other CSP students about this aspect of the fight against cancer. In the CSP, a capstone project is required, which is typically a student’s senior design project in engineering. However, with Bissen changing his major, there is no such requirement for him, but Political Science offers a senior thesis.

As a potential senior thesis topic, Bissen identified the Childhood Cancer STAR (Survivorship, Treatment, Access, Research) Act (HR 820/S 292) congressional bill. According to the American Association for Cancer Research, Childhood Cancer STAR would expand opportunities for research in childhood cancers, including tracking those cases and identifying opportunities to improve the quality of life of patients and survivors. Currently, STAR has strong support, but more Senate support is needed, meaning that lobbying for passage could help get the bill passed.

While STAR is an ongoing interest for Bissen, he also is developing his skills working as an intern in Washington, DC, for Senator Dick Durbin from Illinois. Bear assists the senator’s staff in performing research and accomplishing day-to-day tasks. Bear has had the opportunity to use his research skills and draft communications for the legislative team on issues ranging from healthcare policy to appropriations.

As Bissen’s internship is in Washington, DC, he has been able to attend congressional hearings to see how the senators and field experts discuss the issues. In his own words, Bear described this internship experience as “a prime opportunity to learn more about the functions of our government, study the congressional job market, develop skills to perform legislative work, and network with (congressional) hill staff from across the nation.”
EDUCATION: TiMe training program prepares for final year

By Paloma Pearson, Department of Bioengineering

The University of Illinois Tissue and Micro-environment (TiMe) NIH T32 training grant has been very productive since its inauguration in Fall 2016. The eight scholars participated and led the first TiMe Day on May 15, 2017, during which they each presented a rapid-fire talk on their work and competed in a poster competition. Twenty-two people submitted posters, and approximately 70 attended to hear the scholars and the External Advisory Board, which consisted of Dr. David Beebe (University of Wisconsin-Madison), Dr. Peter So (MIT), and Dr. Bruce Wheeler (UCSD); and faculty preceptor Kris Kilian (Illinois).

Overall goals for the program are to:
(a) Create a campus-wide educational and research training program focused on the TiMe by designing a program curriculum with a set of common, mandatory courses and electives that extend trainees’ depth of knowledge in a collaborative, supportive environment beyond a single department or discipline.
(b) Develop short courses and workshops that prepare students for productive TiMe-focused research careers with integrated learning communities and responsible conduct awareness.
(c) Infuse a sense of research excellence and develop high-quality skills in trainees. The skills include critical thinking that integrates ideas from multiple areas, leadership qualities, communication skills, and the ability to work in teams. While each trainee will be expected to gain these skills, trainees will also gain practical skills in areas of their choice and interest, for example, in computational software or 3D printing.
(d) Effectively recruit and retain a diverse set of trainees actively involved in the program via a Trainee Leadership Council (TLC). Simultaneously, the program will emphasize faculty mentors’ engagement for a shared development of a highly synergistic program.
(e) Integrate assessment and evaluation, especially focusing on the differential value of TiMe training in student competence, research accomplishments, leadership ability, and employment outcomes.
(f) Communicate results, both scientific and training, to the campus biomedical community, as well as the broader bioengineering and imaging communities nationwide, to improve student education.

The scholars had the opportunity to hear from and interact with several esteemed guest speakers, including Ed Bartick (The George Washington University), Andre Balla (UIC), Kandice Tanner (NIH), Samira Azarin (University of Minnesota), Daniel Heller (Memorial Sloan Kettering), and Ed Moore (BioPhia Consulting, Inc.), who provided insights into the various opportunities for young doctoral scientists.

Scholars also participated in a grant-dissection workshop hosted by Dr. Rohit Bhargava to get a deeper understanding of the elements that make a higher reviewed submission. Dr. Rex Gaskins has been spearheading the focus on professional growth and career development through the use of the myIDP tool, which helped guide decisions on who to bring as speakers into the class.

Scholars are currently working on planning next spring’s TiMe Day, enlisting the next cohort of prospective students, and attending and presenting in various conferences.

For more about the work of the TiMe scholars, please visit time.illinois.edu.
Welcome, new physician and faculty!

CARLE PHYSICIAN
Georgina Cheng, MD, Gynecologist, Oncologist, Carle Health System
Dr. Cheng completed her undergraduate education at Cornell University focusing on microbiology and German studies. She earned her Ph.D. in Veterinary Pathobiology at the University of Illinois at Urbana-Champaign and her MD at the University of Illinois College of Medicine. Her career goal is to impact women’s health by practicing medicine, researching alternative treatment options, and teaching future generations of physicians. She looks forward in continuing her career path as a physician-scientist in gynecologic oncology.

U OF I FACULTY
Roy Dar, PhD, assistant professor, Bioengineering
Prof. Dar and his team are studying fluctuations in gene expression (or “noise”) due to the random timing and discrete nature of biochemical interactions occurring throughout gene expression processes. This noise can be used both as a probe to understand underlying gene circuit dynamics and regulation and to quantify biophysical parameters. Noise can be naturally exploited for decision making and distributing probabilities between genetic and cellular states in a cell population. Enhanced control of decision making at the single-cell level has importance for systems ranging from viruses and cancer to cellular reprogramming.

Liang Gao, PhD, assistant professor, Electrical and Computer Engineering
Prof. Gao’s primary research interests are microscopy — including super-resolution microscopy and photoacoustic microscopy, cost-effective high-performance optics for diagnostics, computational optical imaging, and multidimensional optical imaging. He earned a BS in Physics from Tsinghua University and a PhD in Applied Physics and Bioengineering from Rice University. Before joining Illinois, he was an advisory research scientist at Ricoh Innovations. Previous to that, as a postdoctoral research associate in Biomedical Engineering at Washington University in St. Louis, he invented the Compressed Ultrafast Photography passive imaging camera, which can capture dynamic scenes at 100 billion frames per second.

Viktor Gruev, PhD, associate professor, Electrical and Computer Engineering
Prof. Gruev earned his BS in Electrical Engineering with distinction from Southern Illinois University in Carbondale and completed his MS and PhD in Electrical Engineering from Johns Hopkins University. He was a postdoctoral researcher at the University of Pennsylvania before joining Washington University in St. Louis in 2008. Among the awards he has received is the 2016 IEEE Donald G. Fink Award for an outstanding scientific contribution. His current research focuses on bringing medical imaging technology to resource-limited hospitals and to the developing world.

Joseph Irudayaraj, PhD, Founder Professor in Bioengineering and associate head for graduate programs, Department of Bioengineering
Prof. Irudayaraj conducts bionanotechnology research, developing diagnostic tools to understand cellular mechanisms that could lead to targeted therapies or better prognoses for cancer or neurogenerative diseases. He spent more than a decade at Purdue University, where he made a significant breakthrough in utilizing gold nanorods and dark field plasmon imaging techniques, which made it possible to evaluate multiple different surface proteins and mRNA splicing at once in live cancer cells, with single-cell resolution. He earned an MS in Biosystems Engineering and an MS in Information and Computer Sciences from the University of Hawaii, Honolulu, and a PhD in Biological Engineering from Purdue University.

Shuming Nie, PhD, Grainger Distinguished Chair in Engineering, Bioengineering
Prof. Nie’s academic work is primarily in the areas of nanomedicine, molecular engineering, and image-guided, minimally invasive robotic surgery. His major academic achievements include the discovery of colloidal metal nanoparticles that are able to amplify the efficiencies of surface-enhanced Raman scattering (SERS) by 14-15 orders of magnitude, pioneering work on water-soluble semiconductor quantum dots for biomedical applications, and breakthrough work in developing multifunctional smart nanoparticles for targeted drug delivery and intraoperative cancer imaging.
The role of informed advocates in helping direct research and policy has become increasingly important. In addition to initiating foundations dedicated to funding research and lobbying governments for increased research spending, advocates are responsible for the clinical development of Herceptin for the treatment of Her2+ breast cancer, compassionate use of experimental drugs, and shifting FDA policy for the repurposing of drugs to treat “orphan diseases.”

The importance of research advocates has been recognized nationwide by funding agencies, including the Department of Defense and Susan G. Komen, both of which now include advocates in the research grant-application review process and require advocates to be actively involved in research teams selected for funding. With the newly established Office of Advocacy Relations, the National Institutes of Health (NIH) also is ensuring that the collective patient perspective is included in National Cancer Institute efforts to advance cancer research and improve patient outcomes.

Despite their clear impact, scientists have been reluctant to include advocates as active partners in their research teams, in part due to historic communication barriers between scientists and patients. Scientists have not been trained in how to engage an advocate, while advocates often do not appreciate the nuances of the research or clinical processes. So, to address an unmet need in our community and incorporate advocates into the cancer research process, the Cancer Center at Illinois established the Cancer Research Advocacy Group (CRAG) led by Dr. Zeynep Madak-Erdogan and Dr. Erik Nelson. A major goal is to establish a training program for advocates so they can effectively engage in research activities. These endeavors are currently supported by a Eugene Washington Patient-Centered Outcomes Research Institute (PCORI) Award.

Established at Illinois in the spring of 2016, CRAG includes survivors, scientists and clinicians. Collectively, CRAG supports fundamental, translational and clinical science at Illinois, helping to bridge the gap among these disciplines. CRAG’s mission is to promote interactions among cancer patient advocates, researchers and clinicians to ensure that the input from patient advocates can be incorporated throughout the entire research process and ongoing cancer research at Illinois is meaningful, trustworthy, patient-centered, innovative, evidence-based and accessible.

CRAG encourages participation from cancer survivors, immediate family members or friends of cancer survivors, community representatives, research scientists, and clinicians. Organizers believe that facilitating discussions among these groups will lead to better outcomes for all three groups. Survivor, advocate and clinician feedback can inform research, which in turn will produce new clinical trials, where more feedback from patients and clinicians can be produced to generate another iteration of the process. The “bench-to-bedside” and “bedside-to-bench” flow of information is what CRAG seeks to advance in the fight against cancer.

For more information . . .
If you would like to engage an advocate in your research program, or if you are interested in serving as an advocate, please contact Dr. Zeynep Madak-Erdogan or Dr. Erik Nelson at cancer-crag@illinois.edu.