Cancer Center at Illinois

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
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Pathways is a Cancer Center at Illinois (CCIL) publication that highlights the interdisciplinary and translational work of CCIL faculty, staff, students, and external partners.

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As we enter a new decade, I want to take time to reflect on the progress the Cancer Center at Illinois has made. Our members and staff are a powerful force, still propelling the Cancer Center at Illinois at a rapid growth pace.

Collaboration has flourished with the keen participation of all our members. 2019 recorded the highest research funding and collaborative activities of our Center ever. Our activities, including the annual retreat, continue apace, and student programs are growing and evolving. Our partnership with Carle now includes dedicated CCIL lab space in their Biomedical Research Center. We’re moving forward on construction of the Tumor Engineering and Phenotyping (TEP) lab – a resource that will serve both our members and the scientific community on campus – funded by an NIH grant that received more than $3.2 million of support for construction.

Our other three shared resources continue to make progress in bringing new cancer research capabilities to Illinois. I am grateful to the leaders and staff of Beckman, IGB, Carle, and our shared lab resources. To keep our momentum going, the CCIL is continuing our Seed Grant Program and has launched cooperative efforts with other campus units to support interdisciplinary, cancer-focused research projects. Funding seed projects are a special priority for the Center, and for me personally, as they offer an opportunity to work with colleagues and expand the impact of the CCIL’s many scientific disciplines and foci on our campus.

Not only are we growing in collaboration and research, but in administrative staff. The second half of 2019 brought three new administrative staff – Jordan Goebig, Communications Coordinator, Amber Lannert, Senior Director of Advancement, and Hui Xu, Research Coordinator for TEP Shared Resource.

Exciting times are ahead as we develop our infrastructure, sharpen our focus, and mature as a research institute. We are, as always, thankful for your continued support and interest.
CCIL Program leader, Brian Cunningham, Electrical and Computer Engineering Professor, led a team of Illinois researchers who developed a method to capture and count cancer-associated microRNAs, which are tiny bits of messenger molecules that are exuded from cells and can be detected in blood or serum. The group developed a technique named Photonic Resonator Absorption Microscopy (PRAM) that was sensitive enough to detect small amounts of known prostate cancer markers in a patient’s serum.

“Cancer cells contain gene mutations that enable them to proliferate out of control and to evade the immune system, and some of those mutations turn up in microRNAs,” said Cunningham.

“There are specific microRNA molecules whose presence and concentration are known to be related to the presence and aggressiveness of specific types of cancer, so they serve as biomarkers that can be the target molecule for a diagnostic test,” he said.

The PRAM approach could be adapted to different microRNAs or other biomarkers, the researchers say, and is compatible with existing microscope platforms.

FOR MORE: go.illinois.edu/CancerMarkers

Story by Liz Ahlberg Touchstone, photo by L. Brian Stauffer

“This approach makes the idea of performing a ‘liquid biopsy’ for low-concentration cancer-related molecules a step closer to reality. The results of the test might tell a physician whether a regimen of chemotherapy is working, whether a person’s cancer is developing a new mutation that would make it resistant to a drug, or whether a person who had been previously treated for cancer might be having a remission. — Brian Cunningham
An Illinois research team including C*STAR research fellow Sylvia Crowder, found that patients who eat foods high in antioxidants and other micronutrients prior to their head or neck cancer diagnosis were less likely to develop chronic nutrition impact symptoms. Cancer patients frequently develop physical symptoms that impact their ability or desire to eat. Patients who ate healthier at diagnosis reported fewer problems with chewing, swallowing and mucositis one year after treatment, the scientists found.

FOR MORE: go.illinois.edu/HealthyDiets

Story by Liz Aihberg Touchstone, photo by L. Brian Stauffer
CCIL LEADERS EARN NAI DESIGNATION

Stephen Boppart, CCIL Program Leader, and David Kranz, CCIL Deputy Director, were elected as 2019 National Academy of Inventors (NAI) Fellows. NAI Fellows are recognized for their outstanding inventions that make a tangible impact on human lives, economic development, and/or the welfare of society. Boppart has co-founded three companies (including PhotoniCare and Diagnostics Photonics) and his research focuses on biophotonics. Kranz and his lab team research proteins of immunological interest with a primary focus on T-cell receptors (TCR).

HERGENROTHER NAMED AAAS FELLOW

Paul Hergenrother, CCIL Program Leader, is one of eight professors at the University of Illinois at Urbana-Champaign honored as a 2019 American Association for the Advancement of Science (AAAS) Fellow. Hergenrother has made advances in the way new medicines are discovered and developed, using readily available natural products as the starting point for complex molecule synthesis. His discoveries impact not only basic scientific research but also the lives of cancer patients.

GASKINS HONORED WITH ACES INVESTITURE

H. Rex Gaskins, CCIL Associate Director for Education and professor of animal sciences and nutritional sciences in the College of Agricultural, Consumer and Environmental Sciences (ACES), was honored as the Keith W. and Sara M. Kelley Endowed Professor of Immunophysiology. The focus of Gaskins’ studies is the biological basis of the increased risk of colorectal cancer associated with consuming a diet high in saturated fat, as well as the role of mitochondria in tumor cell migration in patients with brain cancer.
CCIL member, Shuming Nie, was one of eight University of Illinois academics named Highly Cited Researchers of 2019, comprised of the top 1% of cited scientists in the world. The data to determine this recognition is collected by Web of Science. Nie is the Grainger Distinguished Chair in Bioengineering and a professor of chemistry, materials science, and electrical and computer engineering. Nie’s research is focused in nanotechnology and cancer molecular imaging, molecular profiling, pharmacogenomics, and targeted therapy.

CCIL member Catherine Murphy was named the recipient of the 2019 Materials Research Society Medal. The honor acknowledges her outstanding accomplishments over the previous ten years in materials research and is awarded for a major advance or a group of closely related advances in any materials-related field of research. Murphy is receiving the Medal “for pioneering the controlled synthesis of anisotropic metal nanostructures in transition metal nanoparticles and investigation of nanoparticle effects on and toxicity in biological systems.”

The need to improve imaging techniques, specifically to detect cancer, is the focus of a four-year National Institutes of Health grant titled, “Advanced image reconstruction for accurate and high-resolution breast ultrasound tomography,” awarded to CCIL member Mark Anastasio, the Donald Biggar Willett Professor in Engineering and the head of the Department of Bioengineering at Illinois and co-PI Neb Duric, an internationally acclaimed leader in ultrasound imaging research from Wayne State.
In the spirit of collaboration and thematic research support, the CCIL launched its first Seed Grant Program in 2019. In the initial cycle, 19 applications were carefully reviewed and four 2-year projects were ultimately selected. Due to the success of the first round, the CCIL opened up a second round of Seed Grant Funding in January 2020. Applications are due in March 2, 2020 with the possibility of up to $250,000 in funding.

"CCIL members have the knowledge and abilities to change the world. These seed project funds are a special priority for the Center," said CCIL Director Rohit Bhargava. "This year, we are especially encouraging those ideas that may catalyze NCI and other NIH cancer-focused proposals and large multi-investigator efforts."

The Seed Grant Program is designed to foster collaborations that reach across the engineering and biology continuum and leverage research team results for submitting external multi-PI grants in cancer research.

## 2019 SEED GRANT PROJECTS

### CANCER IMMUNOTHERAPIES FOR PRECISION MEDICINE IN THE STATE OF OBESITY

**PI:** Andrew Smith, Bioengineering  
**RESEARCH TEAM:** Erik Nelson, Molecular and Integrative Physiology | Wawrzyniec Dobrucki, Bioengineering

### CHARACTERIZATION OF ONCOGENIC NONCODING RNAS IN BREAST CANCER PROGRESSION AND METASTASIS

**PI:** Kannanganattu Prasanth, Cell and Developmental Biology  
**RESEARCH TEAM:** Auinash Kalsotra, Biochemistry | Erik Nelson, Molecular and Integrative Physiology  
Wawrzyniec Dobrucki, Bioengineering

### DEEP MUTATIONAL SCANNING OF RECEPTOR TYROSINE KINASES INVOLVED IN CANCER USING TRANSFER LEARNING APPROACHES

**PI:** Diwakar Shukla, Chemical and Biomolecular Engineering  
**RESEARCH TEAM:** Erik Procko, Biochemistry and Biophysics and Quantitative Biology

### NEXT GENERATION CANCER IMAGING USING SUPER-RESOLUTION ULTRASOUND MICROSCOPY COMBINED WITH PHOTOACOUSTIC TOMOGRAPHY

**PI:** Pengfei Song, Electrical and Computer Engineering  
**RESEARCH TEAM:** Yi Lu, Professor of Chemistry | Liang Gao, Electrical and Computer Engineering  
Timothy Fan, Veterinary Clinical Medicine
Over fifty CCIL members, faculty, and staff joined together to discuss Cancer Center programs and initiatives, as well as the current and future University of Illinois-driven cancer research at Carle’s Biomedical Research Center (BRC) – an over 12,000 sq. ft. laboratory space open to CCIL researchers.

CCIL Director, Rohit Bhargava, opened the retreat with an update on the Center’s growth and the many accomplishments of its members. The CCIL currently has over 80 members spanning 18 units and serving more than 500 students. There is $25.7 million of funded cancer research being conducted through the Center, with new internal and external collaborations consistently developing.

Jennifer Eardley, Carle Foundation Hospital’s Vice President for Research, provided a summary on the multiple opportunities for CCIL members to partner with Carle physicians and clinical staff.

Following the retreat, CCIL members and Carle physicians attended an Open House of the BRC, hosted by Carle, and toured the lab space maintained and operated by CCIL staff and researchers.
CARLE FOUNDATION HOSPITAL

In 2019, the CCIL’s collaboration with Carle grew to include physical space at Carle’s Biomedical Research Center. CCIL members now have over 12,000 sq. ft. of dedicated lab space, enabling frequent interactions between investigators and physicians. Over 20 CCIL members have conducted more than 25 cancer-focused projects aided by Carle research coordinators. CCIL also manages funding for trainee programs, has implemented a formal mechanism for release time for Carle physicians to perform research, streamlined prioritization of projects, and enabled systematic access to clinical material and data monitoring of patients, post-therapy.

MAYO CLINIC

Mayo Clinic and the CCIL members have worked together for over a decade on the development of new technologies and clinical tools and the design and implementation of novel education programs. Nanotechnology focused projects led by CCIL researchers, in collaboration with Mayo, have successfully studied and developed DNA sequencing, cancer drugs, and imaging. Additionally, CCIL programs, members, and students directly participate in collaborative research, conferences, and seminars.

CCIL members are eager to move forward on additional projects with Mayo Clinic in 2020. John Cheville, MD, Professor of and Consultant on Pathology at Mayo Clinic, will visit with a Mayo team in Spring 2020 to discuss collaboration opportunities.

Pengfei Song
Assistant Professor
Electrical & Computer Engineering

Song is leading a team of researchers to develop next-generation cancer imaging methods for early detection, diagnosis, and treatment. Cancer imaging plays a central role in cancer research and medical care, as it can help researchers and doctors better understand cancer initiation, progression, and metastasis in order to find effective measures for early diagnostics and therapeutics. An accurate and sensitive cancer therapy monitoring tool would not only allow for the expedient identification and stratification of patients who are benefiting or not benefitting from certain treatments, but also guide the timely institution of alternative precision medicine strategies.

Andrew Smith
Assistant Professor
Bioengineering

Smith, working with CCIL Director Rohit Bhargava, developed stainless quantum-dot-enabled protocols for prostate pathology in association with clinicians at Mayo Clinic. These quantum dots, engineered nanoscale particles, developed provide a better understanding of how cancer cells transform and could be treated more effectively. Smith used the dots to develop a quantitative method for detecting diseased cells within a tissue sample. Smith has collaborated with a number of cancer center researchers to develop improved imaging technology.
The CCIL collaborates with OSF via the Jump Applied Research for Community Health through Engineering and Simulation (Jump ARCHES), led by CCIL member Thenkurussi “Kesh” Kesavadas, to develop new technologies and cyber-physical systems, enhance medical training and practice, and drive the training of health professionals. CCIL leadership and staff have engaged with OSF clinicians in strategic planning to identify the translation of CCIL science to OSF cancer patients. Both University of Illinois and OSF leadership continue to discuss potential areas and means to accelerate CCIL research and its adoption by OSF.

The CCIL and UIC Cancer Center have a long history of working together. UIC’s Cancer Center is focused on community health, delivering healthcare more effectively to underserved populations. The CCIL’s focus on technology is a powerful enabling tool for UIC and offers a unique opportunity with these underserved populations for technology to be developed and deployed. This relationship will continue to grow, fueled by Illinois technology, to serve the Chicago community, especially with the recently announced Discovery Partners Institute (DPI), an interdisciplinary public–private research institute located in Chicago and serving as a hub for the Illinois Innovation network.

Kesavadas is a pioneer in virtual reality, robots, and design advances in surgery. Kesavadas developed the world’s first Robotic Surgical Simulator, RoSS that is used to train residents and medical students. Kesavadas has developed several technologies to improve robotic surgery for treatment of cancer in Urology, Gynecology, and General Surgery including. Using computer vision algorithms, procedures such as prostatectomy and hysterectomy have been modeled and best procedure for tumor removal and lymph node dissection have been developed for which Kesavadas has been awarded two patents.

Gaskins, alongside UIC and other external scientists, investigated the biological basis of the increased risk for the development of colorectal cancer independently associated with being African American or consuming a diet high in red meat and saturated fat. The central hypothesis tested is that the bile salt taurocholic acid is a key diet-controlled metabolite whose metabolism by specific colonic bacteria yields both a carcinogen and a tumor-promoter. The key outcome will be novel understanding of a mechanistically targeted nutrient that can be used to develop effective cancer prevention interventions based simply on diet which may contribute to a reduction in the unequal colon cancer burden in African American men and women.
CCIL CONSTRUCTING TISSUE ENGINEERING LAB AS CCIL MEMBER RESOURCE

The University of Illinois at Urbana Champaign’s Beckman Institute for Advanced Science and Technology and Cancer Center at Illinois (CCIL) received $3.3 million from the National Institutes of Health (NIH) to create a dedicated cancer research laboratory.

The Tissue Engineering and Phenotyping (TEP) project includes the construction of a state-of-the-art facility for cell and tissue evaluation in the Beckman Institute. Its primary function will be to provide dedicated space for *in vitro* (inside living organisms) and *in vivo* (outside of living organisms) tumor modeling and studies. In addition to conducting experiments, TEP will be a training facility for future cancer scientists through the CCIL’s education programming.

The CCIL completed the schematic design in November 2019, and are currently working with the NIH to complete the development design in Spring 2020. Construction is expected to kick off in the summer of 2020 and completed in 2021.

“The Cancer Center at Illinois strives to be a one stop shop for advice, resources, and expertise for cancer-focused researchers at the University,” said Rohit Bhargava, CCIL Director. “Devoted lab space will enhance the groundbreaking work we’re doing, and it will provide scientists with access to specialized technologies and services.”

The entire NIH award will cover a majority of the renovation costs. The CCIL is working with Beckman’s operations staff, Facility & Services, and the Reifsteck Reid Co. to complete the project. The TEP lab has a full-time research coordinator, Hui Xu, who is spearheading the renovation project. Assistant Director for Shared Resources, Timothy Fan, and Associate Director for Shared Resources, Joseph Irudayaraj will help manage the Shared Resource. The TEP Shared Resource will be available year-round for CCIL membership use, and members will receive priority access.
WHAT KIND OF RESEARCH ARE YOU FOCUSED ON?
My main project is to develop a quantum dot-based light source for infrared imaging. Quantum dots are semiconducting nanoparticles that emit light due to a property called quantum confinement. I can essentially control the color or type of light they emit by changing the material and size of the quantum dot. Constructing instruments with these quantum dot-based light sources would allow for discrete frequency infrared imaging which enables rapid data acquisitions of large areas. I am also developing technology for the generalized types of nanomaterials like gold nanoparticles using droplet fluidic devices.

WHY IS IT IMPORTANT TO IMPROVE IMAGING TECHNOLOGY?
This would help minimize the number of surgeries that would occur. It takes a large physical and psychological toll when patients are told they didn’t get all of the tumor the first time and have to go back for another round of surgery. It would allow us to detect cancer in a biopsy or a surgical margin while in the operating room based on chemical differences between normal and diseased tissue. This would provide more quantitative data.

HAS THE TiMe PROGRAM BEEN HELPFUL TO YOUR PROFESSIONAL DEVELOPMENT?
One major aspect is our journal club. We review each other’s papers and polish our writing and presentation skills. There are general career and professional development opportunities TiMe offers that expose us to a variety of topics that we wouldn’t learn about otherwise, whether it be in coursework or TiMe research. This helps us look at our own research from a different perspective and helps us develop new ideas.

WHAT ARE YOUR CAREER PLANS?
I am entertaining the idea of working in a government lab, maybe some kind of industrial or adjacent academics profession – not exactly academia but not exactly industry.

WHAT DO YOU DO IN YOUR FREE TIME?
I work with graduate students in an engineering outreach organization called Envision. We do a lot of science demonstrations throughout the year and have community events. The program’s goal is to get students interested in science. We show them how cool it can be and that it’s accessible. This is especially important to me as a minority student. It’s really important for me to show other students that you can do this too.
TARUN NAGARAJAN, BIOENGINEERING  
CANCER SCHOLARS

WHAT DREW YOU TO CANCER SCHOLARS?
I have immediate family members who have been affected by cancer which helped fuel my interest in cancer research. As an incoming freshman, I had the opportunity to be a part of this program and integrate my education with cancer research. As part of this program, I have had the privilege of listening to scholars in the area of cancer research, build on my knowledge, and participate in research.

WHAT DOES YOUR RESEARCH ENTAIL?
My research involves work in nanotechnology and biology in Dr. Andrew Smith's lab. I have worked on projects involving quantum dots, which are nanoparticles that emit fluorescent light. These particles are resistant to degradation and are very stable, making them useful as tags for components inside a cell that can be seen by imaging. The projects that I have been working on include single particle tracking by use of quantum dots as well as the quenching of quantum dots.

WHY IS THIS RESEARCH IMPORTANT?
The application of these quantum dots is widespread but the main focus of this research is to help understand the workings of cancer. By using these quantum dots, which can tag specific proteins inside the cell and bright enough to be seen by imaging, the processes of cancer can be better detected and understood.

HOW HAS THE CANCER SCHOLARS PROGRAM HELPED YOUR PROFESSIONAL GROWTH?
The biggest drive when I joined Cancer Scholars was to get involved in research toward the career path I want. The internship with Mayo Clinic is an extension of that. It’s a way to get broad exposure in multiple research areas. I was really interested in the internship because I’m interested in more than just basic science. I want to be in clinical translation, too, or at least the feasibility that my research could possibly go into the clinic at some point. The earlier you can get these experiences, the better, so I’m really happy to be a part of it.

WHAT ARE YOUR FUTURE PLANS?
I plan to work in industry for a year before eventually attending medical school where I hope to become an orthopedic surgeon with a focus in sports medicine.
The design of drugs with limited side effects is one of the main challenges in targeted drug design for cancer. These side effects originate from the interaction of the designed drug with proteins similar to the intended drug target. Shukla’s lab looks at a family of proteins called growth factor receptors which are involved in many types of cancers. Therapies developed to target these proteins have failed due to the numerous side effects originating from the interaction of the drugs with other growth factor receptors. The lab uses large-scale modification of the amino acids in protein and machine learning algorithms to understand how these modifications in the peptide drugs change their interactions with this family of proteins and identify drugs which interact with only one of these receptors.

In Madak Erdogan’s lab, they are identifying ways that a circulating cancer cell survives in stress conditions, such as when the patient is treated with drugs or when the cell reaches a new metastatic organ. This lab previously identified one such mechanism, activation of a protein, XPO1, as a way that breast cancer cells become resistant to treatments. Based on their current preclinical studies with a clinical trial group at MD Anderson Cancer Center, they will start a clinical trial testing whether combining inhibitors for XPO1 with endocrine agents might prevent or delay recurrence and metastasis. Preventing or delaying metastasis will prevent an estimated 120 deaths due to metastatic breast cancer per day.
**SPRING 2020 FACULTY SEMINAR SERIES**

Each seminar includes brief individual talks from CCIL faculty members, University of Illinois faculty members, and external cancer researchers followed by a Q&A period. These seminars provide CCIL members with an opportunity to learn more about the depth of cancer research happening at and with Illinois, and the potential for collaboration.

- **FEB. 18, 2020**
  - John Cheville, MD
  - Mayo Clinic

- **MARCH 24, 2020**
  - Gary Tearney
  - Massachusetts Institute of Technology

- **APRIL 21, 2020**
  - Erik Procko
  - Assistant Professor
  - Biochemistry
  - Kai Zhang
  - Assistant Professor
  - Biochemistry

**KRUSH KANCER AT ILLINOIS BASKETBALL**

On Feb. 24, the CCIL is partnering with Illinois’ Division of Intercollegiate Athletics (DIA) to highlight the Center and the ground-breaking research conducted by membership. The Orange Krush, Illinois’ student section, will wear t-shirts and wave rally towels to support both CCIL’s mission to “Krush Cancer.” CCIL messaging will be displayed across the arena screens and a CCIL donor and members of the Cancer Research Advocacy Group (CRAG) will be recognized.

**TIME SYMPOSIUM**

The annual Tissue Microenvironment Training Program (TiMe) Symposium features keynote speakers, plenary talks, student presentations, and a poster session.
In September, Amber Lannert joined the CCIL’s team as the new Senior Director of Advancement. Amber brings two decades of advancement experience to the CCIL. She received her BA in psychology from Eastern Illinois University and joined the University of Illinois in 2017 after 17 years as an executive in non-profit healthcare leadership and fundraising. Amber is developing the integrated strategic plan for all philanthropic priorities for the CCIL. Amber works with donors, volunteers, corporations, faculty, staff, and the overall cancer community to cultivate relationships that will provide opportunities and drive revenue for CCIL operations, programs, research funding, student, and faculty support.

Hui Xu, PhD, is the inaugural Research Coordinator for the CCIL Tumor Engineering and Phenotyping (TEP) Shared Resource. Xu received a doctoral degree in molecular biology and has helped set up a protein facility at Texas A&M University, as well as helped grow a commercial contract research organization in California over the past five years.

Before joining the Cancer Center, Jordan was a Communications Specialist at the Institute for Sustainability, Energy, and Environment at Illinois. Her previous experience includes working as an Assistant Director at the Illinois Property Assessment Institute and as a Program Coordinator for the American Lung Association. Jordan earned a bachelor’s degree in journalism and master’s degree in communication from Illinois State University. When Jordan isn’t at the university, she can be found hiking, cycling, or running with her husband, Adam, and their border collie, Emmy.