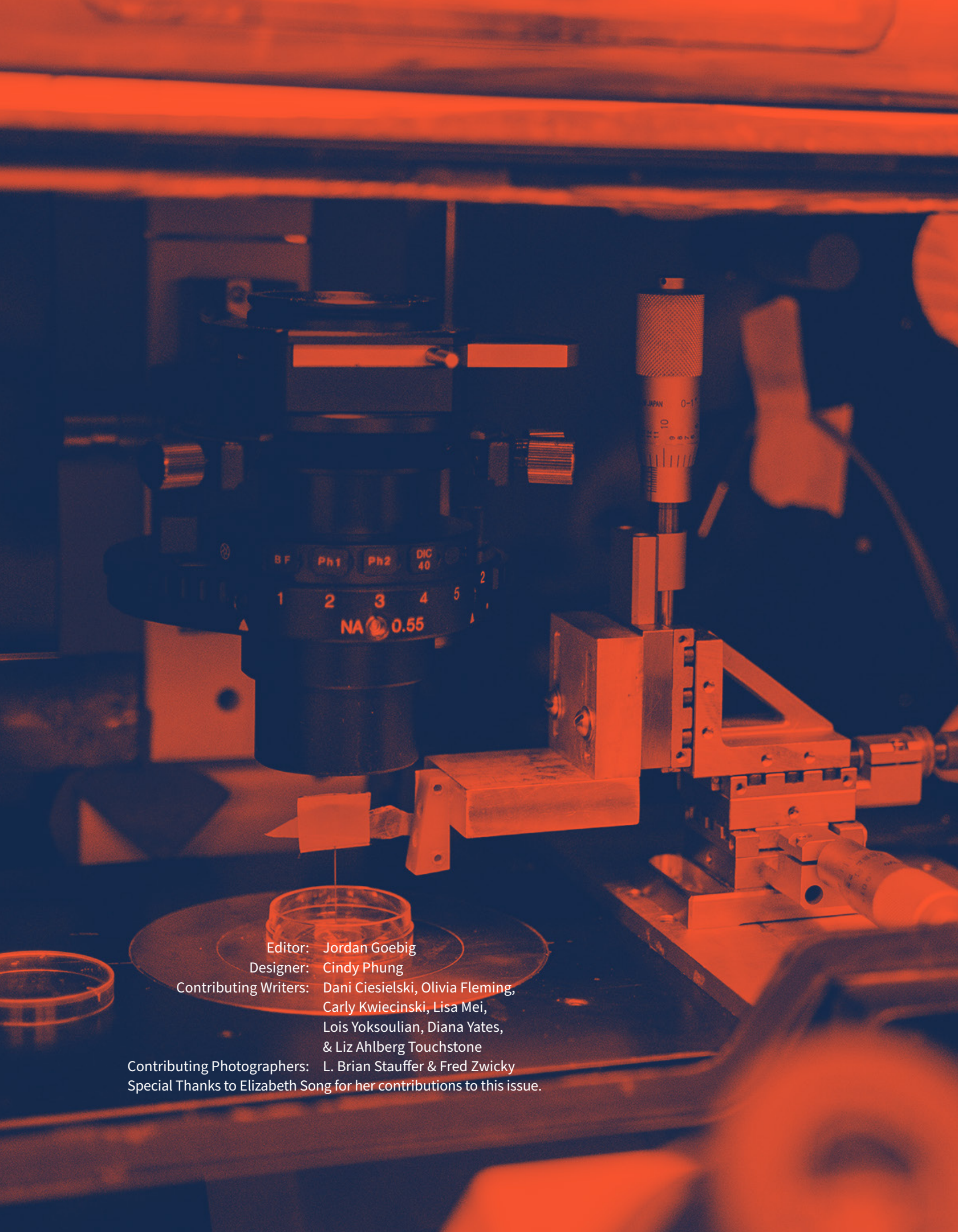
2020 Annual Report

Cancer Center at Illinois

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

WHERE CANCER RESEARCH *INSPIRES*



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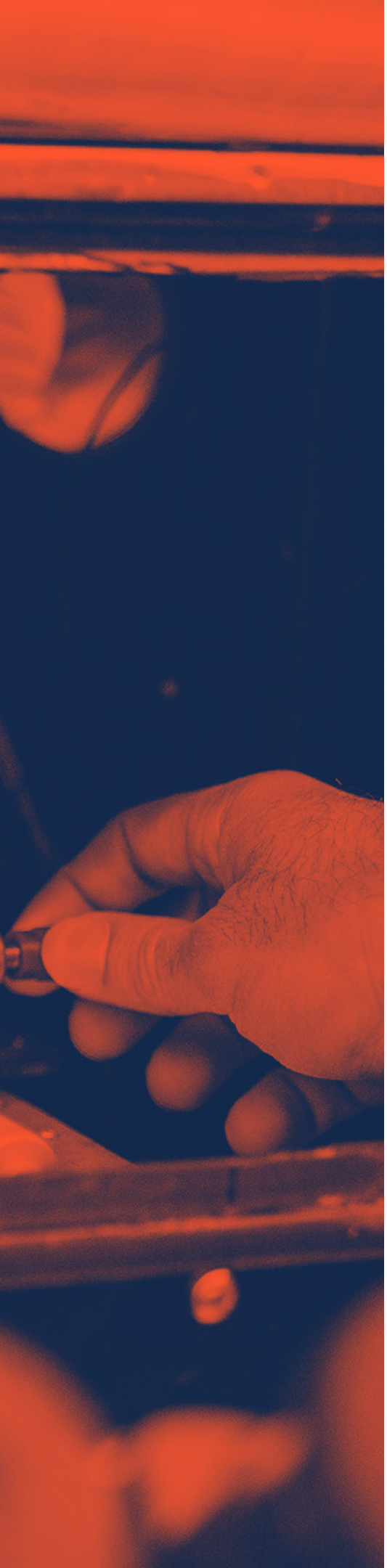
Special Thanks to Elizabeth Song for her contributions to this issue.



CONTENTS

DIRECTOR'S MESSAGE

When I sat down to write the Director's Message for the Annual Report, my mind whirred with the possible words – chaotic, unprecedented, challenging – one could use to describe all that we all have been through over the past year. However, as I reflected on how we were able to transition an entire cancer center to remote work – successfully, efficiently, productively – those thoughts were quickly overshadowed by my appreciation of being able to contribute to our mission of enhancing cancer research alongside the Cancer Center at Illinois (CCIL) members, administration, scientists, and students.

When you ask someone at the CCIL "why cancer research," part of their response always emphasizes that they wanted to help people, to save lives. This ethos to aid the world does not just apply to cancer. When COVID-19 struck the world, it did not stop us. CCIL scientists asked themselves how they could help, and they did, pivoting laboratory research to develop technologies and solutions to address COVID. The University of Illinois Urbana-Champaign was able to contain infection rates and functionally operate thanks to its development of the SHIELD testing program, led by CCIL members. Not only did they innovate and implement a robust COVID testing system that has been adapted by universities, school systems, private companies, and government entities around the U.S., but they efficiently returned their focus to cancer research and are using what they have learned from their COVID discoveries and applying it to improve cancer diagnostics.

The exceptional contributions that CCIL members make are apparent in other ways too. In the past year, we have continued to see increases in our research and education programming, faculty and student numbers, grants awarded, and articles published– with individuals across campus jumping in to get involved in cancer research, more than ever. While we are not able to feature every major contribution over the past year, this 2020 Annual Report is a testament to the efforts of each one of our members and the dedication of our staff that aids this work.

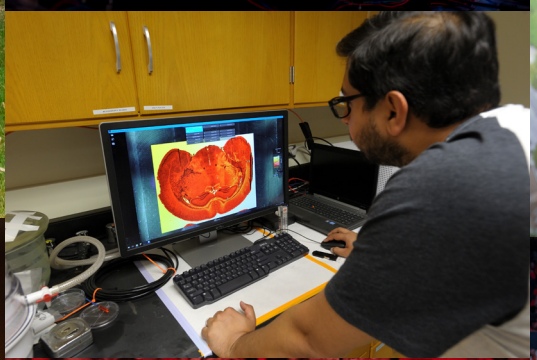
I hope that as you read through this issue, you will be excited to learn about how many universities and medical centers are partnering with CCIL members, and appreciate how our scientific expertise is not just making an impact locally, but also nationally. The CCIL's research programs are leading the way in engineering, technology, and the basic sciences, and crossing disciplines to make the world a healthier place. In 2020, CCIL members launched advanced imaging techniques that will improve diagnosis wait times and help clinicians make more informed, and precise, decisions for cancer treatment. Our chemists and biologists worked together to create ErSO, a cancer therapeutic that eradicated ER+ breast cancer in over 90% of mouse models with late-stage and metastatic cancers. The proven scientific success of this treatment fast-tracked the drug to licensing and soon, clinical trials with humans.

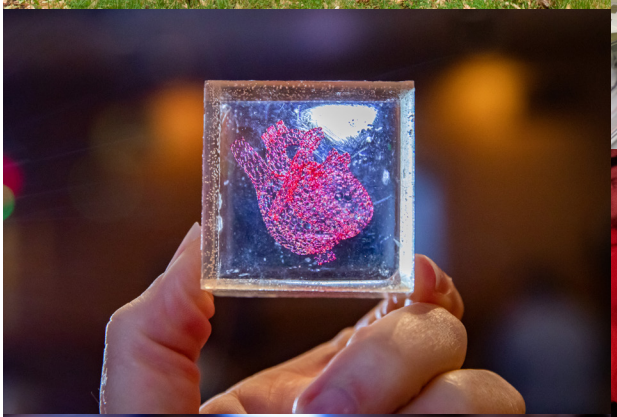
In 2020, we launched the CCIL's five-year strategic plan. This plan delineates a multitude of ways in which our entire CCIL community will further support and enhance our Center's efforts toward our mission to harness the power of technology and engineering to transform cancer care. The CCIL's Seed Grant program, for example, has launched innovative, multidisciplinary cancer research projects. Since its inception in 2019, this program has evolved to launch over 25 proposals into advanced, self-sustaining projects, and, thanks to generous individuals, the CCIL was able to fund its largest cohort of cancer researchers this past year. Together, I hope Cancer Center at Illinois scientists can transform the cancer research landscape — uncovering information and discoveries that will have long-term, impactful outcomes.

Rohit Bhargava
CCIL Director


FIGHTING ILLINI
FIGHTING CANCER

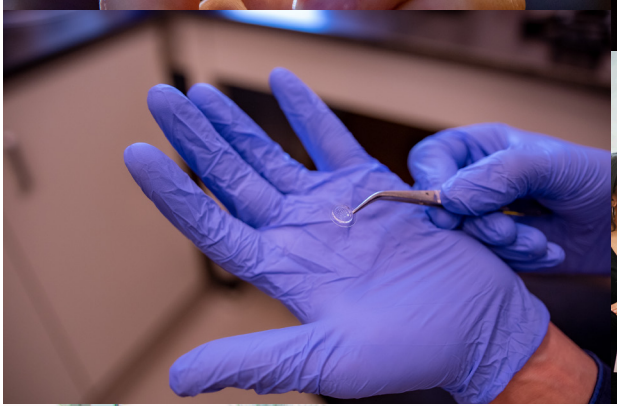

FUTURE HOME OF
CCIL
KRUSH
CANCER






KRUSH
CANCER
Cancer Center
at Illinois


KRUSH
CANCER



STRATEGIC PLAN

MISSION

The mission of the Cancer Center at Illinois is to initiate and harness the combined power of engineering and basic sciences to transform cancer research, detection, and treatment.

VISION

Our vision is to be a national hub for cancer science, engineering, and technology by transdisciplinary collaboration and coordination for research and education.

VALUES

Impact

We help translate our innovations to make significant contributions to the fight against cancer. We aim to provide meaningful and lasting impacts on society and benefits to the public good through scholarship, education, and service, in keeping with our University's land-grant heritage.

Excellence

We strive for excellence in everything we do. We foster cancer research, education, and translational efforts that are bold and creative, while always maintaining the highest rigor and integrity in our approach.

Innovation

We challenge existing modes of thinking, innovate in everything we do, and drive change for the next generation of cancer research.

Engagement

We engage locally, regionally, and globally to nurture people's interest in cancer science; foster the development of individuals at all levels to become successful cancer scientists, technologists, educators, and leaders; and expand the awareness and knowledge of cancer issues and approaches throughout society.

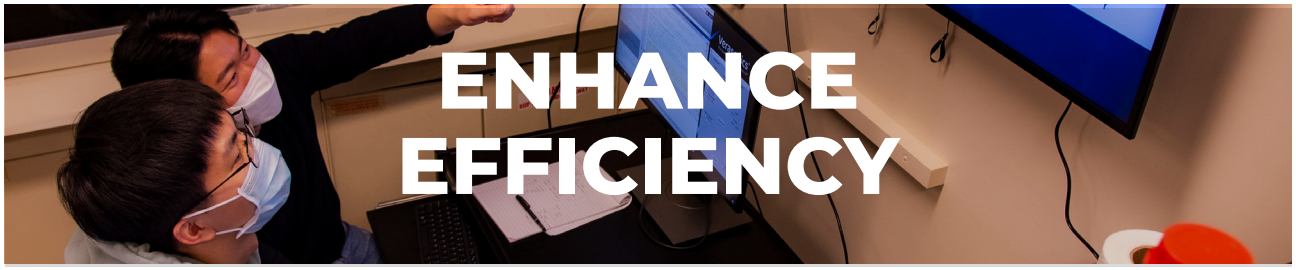
Empathy and Respect

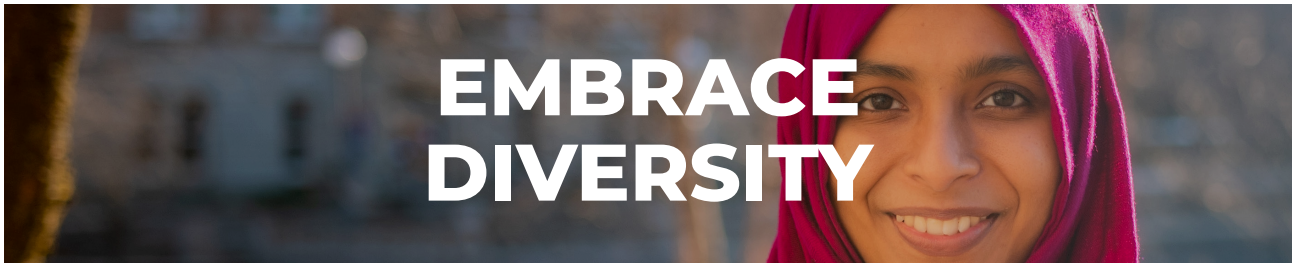
We empathize and respect those who are impacted by cancer, each other, and our partners in the pursuit of common goals. We embrace diversity, strive for equity and access, and prioritize inclusion.

Transdisciplinary Collaboration

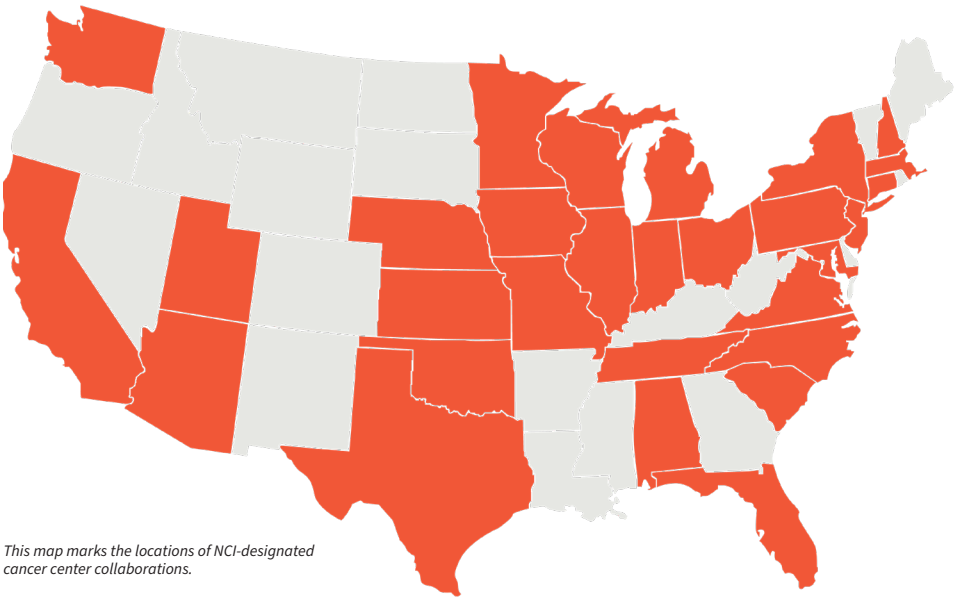
We create collaborations across disciplines to work together to defeat cancer. We embrace supportive colleagues and enable excellent mentors. We encourage openness, accessibility, trust, and respect in all our interactions.

STRATEGIC DIRECTIONS





BY THE NUMBERS



This map marks the locations of NCI-designated cancer center collaborations.

Alabama
- O'Neal Comprehensive Cancer Center

Arizona
- Arizona State University

California
- Chao Family Comprehensive Cancer Center
- City of Hope Comprehensive Cancer Center
- Jonsson Comprehensive Cancer Center
- Salk Institute Cancer Center
- Sanford Burnham Prebys Medical Discovery Institute
- Stanford Cancer Institute

Connecticut
- Yale Cancer Center

Florida
- Moffitt Cancer Center

Illinois
- Robert H. Lurie Comprehensive Cancer Center
- University of Chicago Comprehensive Cancer Center

Indiana
- Indiana State University Melvin & Bren Simon Comprehensive Cancer Center
- Purdue University Center for Cancer Research

Iowa
- Holden Comprehensive Cancer Center

Kansas
- University of Kansas Cancer Center

Maryland
- Sidney Kimmel Comprehensive Cancer Center
- University of Maryland Marlene and Stewart Greenebaum Comprehensive Cancer Center

Massachusetts
- Dana-Farber / Harvard Cancer Center
- David H. Koch Institute for Integrative Cancer Research at MIT

Michigan
- University of Michigan Comprehensive Cancer Center

Minnesota
- Masonic Cancer Center
- Mayo Clinic Cancer Center

Missouri
- Alvin J. Siteman Cancer Center

Nebraska
- Fred & Pamela Buffett Cancer Center

New Hampshire
- Norris Cotton Cancer Center

New Jersey
- Rutgers Cancer Institute of New Jersey

New York
- Albert Einstein Cancer Center
- Herbert Irving Comprehensive Cancer Center
- Laura and Isaac Perlmutter Cancer Center at NYU Langone
- Memorial Sloan-Kettering Cancer Center

North Carolina
- Duke Cancer Institute
- UNC Lineberger Comprehensive Cancer Center
- Wake Forest Baptist Comprehensive Cancer Center

Ohio
- Case Comprehensive Cancer Center
- The Ohio State University Comprehensive Cancer Center

Oklahoma
- Stephenson Cancer Center

Pennsylvania
- Sidney Kimmel Cancer Center at Thomas Jefferson University

South Carolina
- Hollings Cancer Center

Tennesee
- Vanderbilt-Ingram Cancer Center

Texas
- Dan L. Duncan Comprehensive Cancer Center
- Harold C. Simmons Comprehensive Cancer Center
- Mays Cancer Center at UT Health San Antonio
- University of Texas MD Anderson Cancer Center

Utah
- Huntsman Cancer Institute

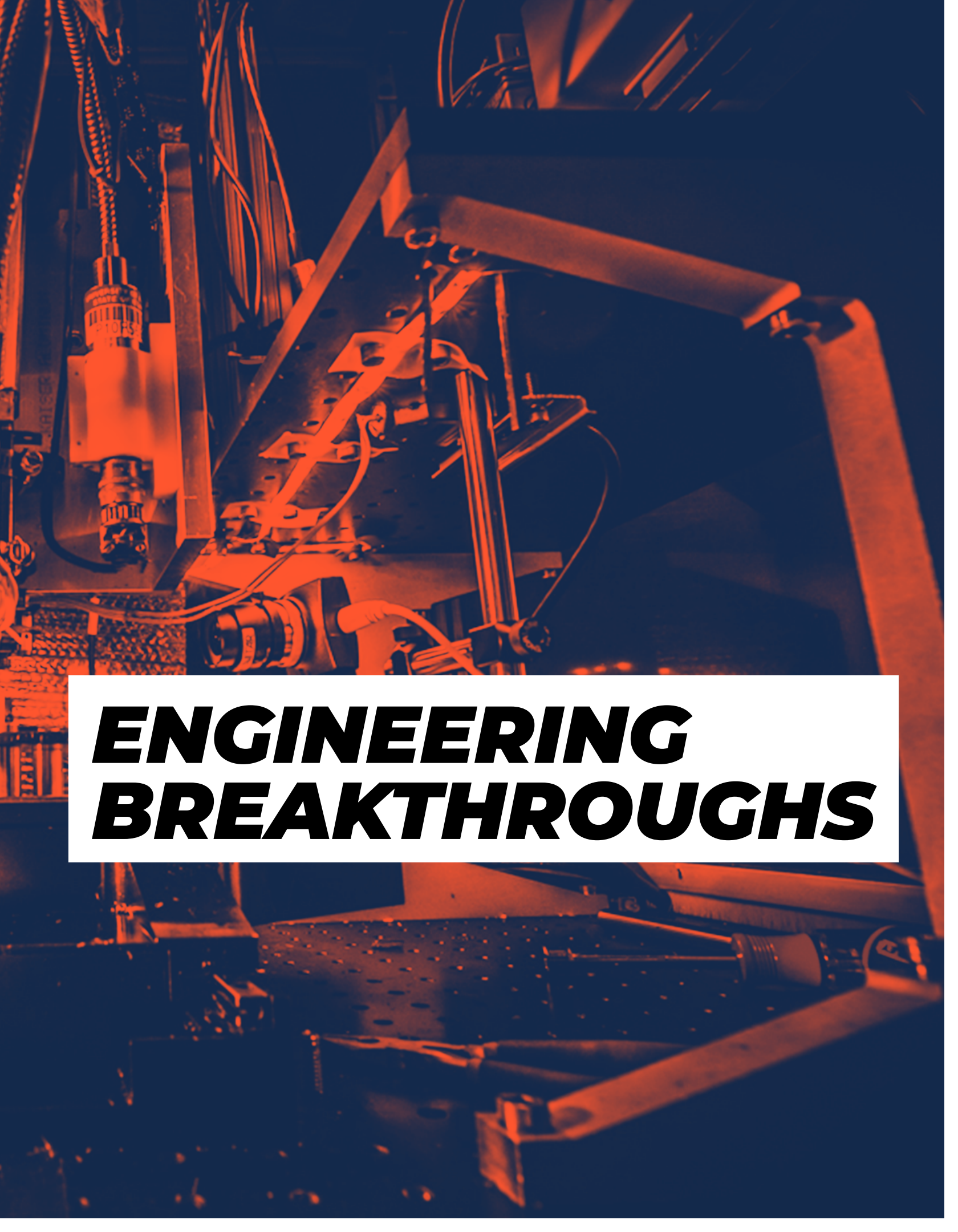
Virginia
- Massey Cancer Center

Washington
- Fred Hutchinson / University of Washington Cancer Consortium

Wisconsin
- University of Wisconsin Carbone Cancer Center


340+
Cancer Research Publications
50
NCI Designated Cancer Center Collaborations
27
Illinois departments
110
CCIL Members
8
University of Illinois Colleges
4
Shared Resources


WHERE
CANCER
RESEARCH
INSPIRES



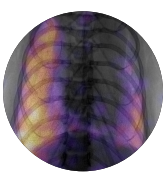
ENGINEERING BREAKTHROUGHS

RESEARCH

Cancer Measurement Technology and Data Science

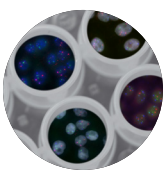
The Cancer Measurement Technology and Data Science (CMD) program deploys the University of Illinois' world-renowned expertise in engineering and technology to drive advances in medical imaging, cancer diagnostics, and computational methods. Discoveries by CMD members accelerate cancer research and provide clinical information more efficiently and accurately.

Working together, our research teams tackle fundamental investigations into developing cancer diagnostic innovations, engineering of novel imaging and molecular measurement technologies and data tools, creating advanced integrated systems for point of care deployment, and the development of protocols, policies, and simulation tools. The CMD program emphasizes the introduction of concepts from other diseases to benefit cancer-related research and applications, as well as translation of cancer-inspired technologies to other diseases and applications.



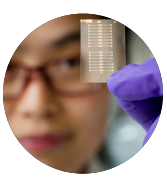
Imaging

Bringing enhanced, rapid diagnostic imaging to the patient.



Molecular Measurement

Developing technologies for early detection, treatment, monitoring, and personalized therapy.



Computational Biology and Engineering

Enabling state-of-the-art computing and artificial intelligence to transform the cancer research landscape.

PROGRAMS

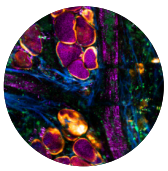
Cancer Discovery Platforms Bridging the Engineering-Biology Continuum

Harnessing the power of Illinois' scientific strengths, the Cancer Discovery Platforms Bridging the Engineering-Biology Continuum (CDP) Program was designed to develop platforms facilitating the study of the biological processes linked to cancer progression, drug effectiveness, and malignant cellular vulnerabilities through sophisticated model systems.

CDP members aim to develop and characterize state-of-the-art platforms that model the chaos and contextual complexity of the cancer microenvironment to accelerate the identification, targeting, and validation of new anticancer therapies. Fundamental scientific inquiry and early-stage development of molecules, models, and methods form the foundation of CCIL efforts in drug discovery and translation of these discoveries to industry, expediting their application to patients.

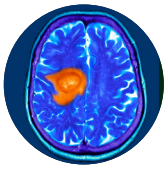
Pathways and Mechanisms

Advancing genetic and RNA insights to understand cancer biology and improve patient outcomes.



Drug Discovery

Accelerating therapeutic discovery and innovating next-generation precision treatment against cancer.



Natural and Model Systems

Developing new pipelines to accelerate and evaluation new cancer therapeutic interventions

PROGRAM PARTNERSHIPS

Researchers Develop New Technique to Study "Microcancers" and Screen Cancer-Fighting Drugs

A team from the Mayo Clinic and University of Illinois Urbana-Champaign including CCIL Cancer Measurement Technology and Data Science (CMD) Program members, Rashid Bashir and Andrew Smith, have developed a new technique for creating "*microcancer*" cell cultures.

The technique allows researchers to form hundreds of microcancers in a high-throughput format using a small, microfabricated chip, enabling direct measurement of cell health or response to drugs. It also allows researchers to control the shape of the culture using capillary forces and thus create cultures that more closely resemble in-vivo cells' three-dimensional geometry.

The study was published in Science Advances and was completed as part of the Mayo Clinic and Illinois Alliance for Technology-Based Healthcare.

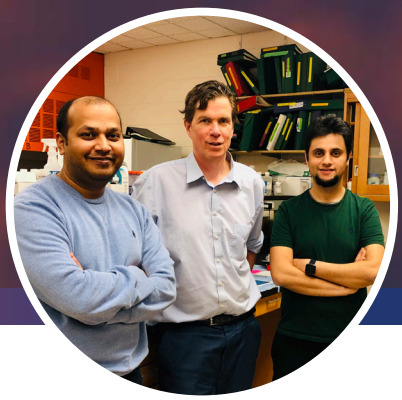
A cancerous tumor's microenvironment has significant influence on tumor progression and response to cancer-fighting medications. Reproducing those cells in a culture that can be imaged and studied is a crucial step in cancer treatment. Ideally, that culture takes a very small sample of a patient's tumor and produces an array of hundreds to thousands of tiny, uniform tumors – microcancers only a few hundred micrometers in diameter.

In the study, the team fabricated microchips with circular, square, and triangular wells etched into them. The chips are less than the size of a quarter and can contain as many as 900 square microwells. Exposing the chip to oxygen plasma makes the surface hydrophilic and spinning it in a centrifuge draws the sample of human cancer cells through the length of the well. Finally, the chip is inverted in mineral oil to create inverted hanging drops.

"The microcancer tumors that formed in the chip's well matched closely with the team's target sizes and were very consistent in size, shape, and molecular profile. This consistency means that the physiological function of the samples closely resemble activity in the human body. Cancer cells and their microenvironment exchange physical, chemical, and mechanical cues as they would in vivo," said Rashid Bashir, also dean of The Grainger College of Engineering and professor of bioengineering.

"This work is just one example of the positive impact that the Mayo Clinic and Illinois Alliance for Technology-Based Healthcare has had on advancing health," said Neal Cohen, director of the Interdisciplinary Health Science Institute. "These long-term, well-supported collaborations make all the difference as we strive to improve lives and expand the future of medicine."

PATIENT PROGRESS



CDP Program Member Links Epigenetics to Treatment of Testicular Cancer

Michael Spinella of the CCIL's Cancer Discovery Platforms Bridging the Engineering-Biology Continuum (CDP) Program linked epigenetic changes in testicular germ cell tumors to their cause and cure, opening new avenues of treatment for aggressive testicular cancers.

Spinella, also a professor of comparative biosciences, believed that the unknown cause for the high success rate of testicular cancer treatment may be due to epigenetics and cell differentiation.

"The approach with differentiation, instead of killing the cells, is to 'correct' them back into normal cells. It appears epigenetics plays an especially important role in testicular germ cell tumors, including what causes the cancer in the first place and its response to therapy," Spinella said.

Most types of cancer are thought to be genetics-based, caused by a build-up of mutations accumulated over time. However, in testicular germ cell tumors, there are many epigenetic changes observed, including DNA or histone methylation caused by environmental factors.

When these testicular tumor cells encounter conventional drug therapies such as cisplatin, they must either die or differentiate. Spinella explained this further with his "*Between a Rock and a Hard Place*" model in a review article published in Cancers by Spinella and his research team members, Ratnakar Singh (PhD) and Zeeshan Fazal (PhD).

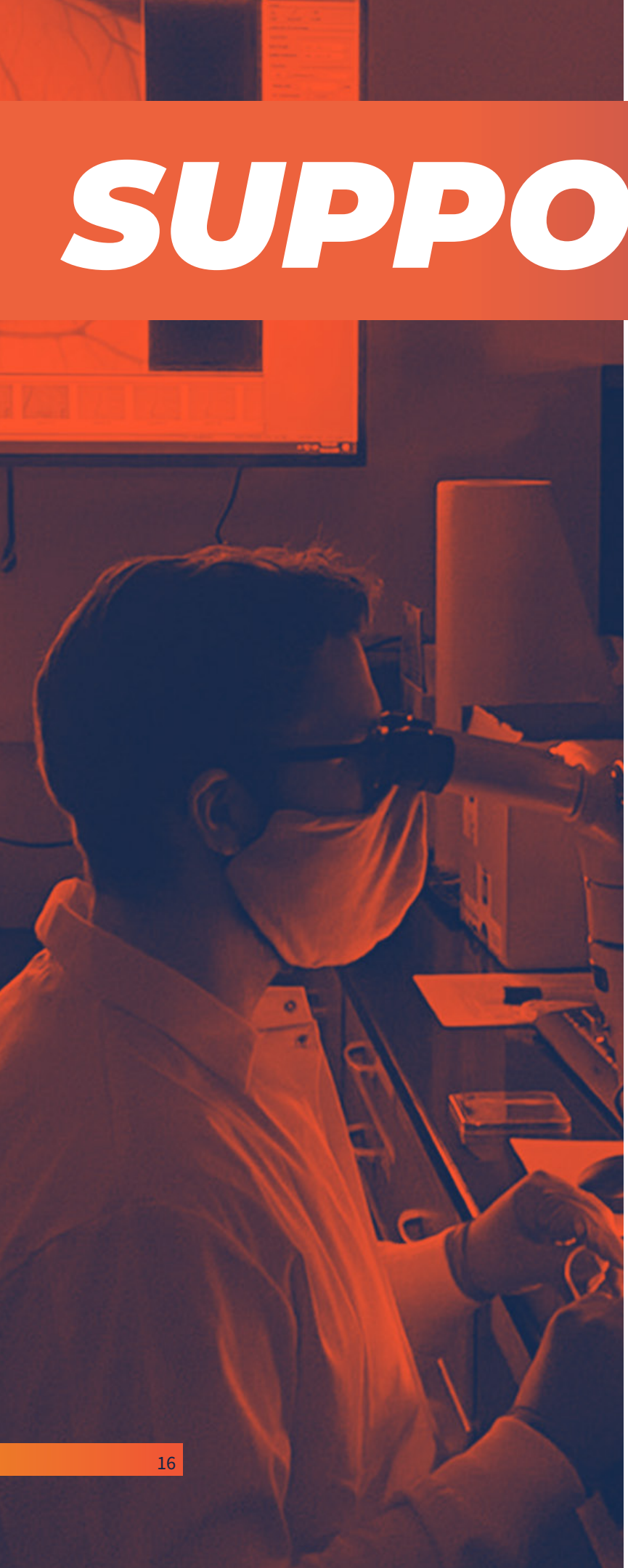
"When the testicular germ cell differentiates and becomes a benign mass — a teratoma — which is resistant to cisplatin, but no longer malignant. So, the malignant state is linked to chemo-sensitivity due to epigenetics," Spinella said.

The model proposes that in certain cases of testicular germ cell cancers, malignancy and chemo-sensitivity can become unlinked, producing malignant tumors that are also resistant to treatment. This relationship suggests that epigenetic-based therapies may be successful in treating the significant number of patients who demonstrate resistance to cisplatin.

"I call my research translational and I'm excited to be a part of the Cancer Center at Illinois because it was just starting up when I joined. And I remember thinking I could make more of a difference here. A lot of the innovation that happens in cell biology happens in cancer-related research that looks to solve cancer-related problems," Spinella said.


WHERE
CANCER
RESEARCH
INSPIRES
ENDLESS
POSSIBILITIES

SUPPORTING



CCIL Seed Grant

Since launching in 2019, CCIL seed grant funding has supported interdisciplinary cancer research projects that facilitate cross-campus collaboration. To meet the robust and evolving needs of CCIL members, the CCIL offers several grant programs year-round to ensure that Illinois researchers have the support, resources, and personnel that will progress critical cancer research to new directions. These grant funding opportunities, supported through donor and university initiatives, are designed to foster new collaborations that reach across the engineering and biology continuum and leverage research team results for submitting external multi-PI grants in the cancer area.

"CCIL scientists are making bold discoveries and leading innovative initiatives that will create technologies and techniques that will translate from labs to clinics. The depth of science, engineering, and technology expertise at the University of Illinois Urbana-Champaign will transform the cancer industry for years to come."

– Paul Hergenrother, CCIL Deputy Director

27
Cancer Research Projects Funded

3
Grant Programs

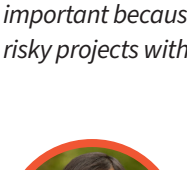
CANCER RESEARCH & INNOVATION

Grant Recipients: Where are they now?

Auinash Kalsotra

Kalsotra's lab is focused on uncovering intricacies of cell biological mechanisms that may lead to more targeted and improved cancer therapies. Understanding RNA splicing, a biological process in which precursor RNA is transformed into messenger RNA (mRNA), has opened tremendous opportunities to research teams, like Kalsotra's. His lab is investigating the misregulation that occurs in RNA splicing, and how the proteins produced are more likely to cause diseases like cancer.

"*The CCIL has allowed scientists to explore new areas in cancer research, make fundamental discoveries, and better understand the physiological and pathophysiological processes. The initial project funding support from CCIL is what leads to bigger grants - receiving foundational funding to start a project from a new idea into results is incredibly important because organizations like NIH won't fund new and risky projects without preliminary data*." – Auinish Kalsotra



Aditi Das

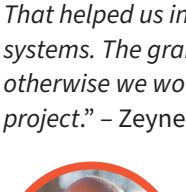
Aditi Das, in collaboration with the CCIL's David Sarlah and Timothy Fan, was awarded a CCIL Seed Grant to evaluate the role of rare and minor cannabinoids on immune cell phenotypes and biological activities related to lung cancer metastases. Cannabis is already used widely in cancer patients for pain management. The team's studies will bring scientific evidence and clarity to understanding how these compounds work - providing fundamental research for cancer drug development.

"*This exciting project would not have been possible without the seed grant support. It has given us a great opportunity to study the effect of the compounds. There are many other phytocannabinoids whose properties are not well understood due to lack of efficient synthesis processes. In this study, we synthesize these compounds and study their anti-cancer properties*." – Aditi Das

Zeynep Madak-Erdogan

Madak-Erdogan is investigating how metastatic estrogen receptor positive (ER+) breast cancer cells adapt to their tumor environment. As the tumors grow and spread for ER+ breast cancer patients, the chance of survival significantly decreases. By understanding how these cells adapt and thrive in the tumor environment, researchers can better target and treat the cancer – significantly increasing survival rates. Data collected from the CCIL grant led to development of two new cancer therapeutics. Published research funded by the grant led to more funding for clinical trials with MD Anderson.

"*The CCIL grant gave us initial sources that helped us start the project…we were able to advance molecular biology analysis, including RNA sequencing and chip sequencing. That helped us initially characterize the bioengineered systems. The grant was extremely helpful because otherwise we wouldn't have a dedicated grant to this project*." – Zeynep Madak-Erdogan



Taher Saif

The Saif Research Group is exploring how cancer cells recruit normal cells – and use these cells to promote tumor metastasis. By better understanding the tumor microenvironment and metastatic journey of these cells, the Saif group will continue to work with collaborators to remove the metastatic abilities of the cancer cells. This will lead to more effective cancer treatments, significantly reduce cancer re-occurrence rates, and save lives.

"*When you are thinking about an idea, but there is no proof of concept, Cancer Center at Illinois grants are the only ones that allow you to take the risks. When I started to develop the sensors, I had no proof of concept, just an idea. All of these ideas could have gone down the drain without the grant funding*." – Taher Saif

LEADING THE NEXT GRANT

CCIL Seed Grant Leads to $1.25M NIH Grant for Breast Cancer Research

In 2019, CCIL member Prasanth Kumar V. Kannanganattu was awarded a CCIL seed grant in support of his research of the characterization of oncogenic noncoding RNAs in breast cancer progression and metastasis. In 2020, the project was further recognized and funded by a $1.25M National Institutes of Health (NIH) Research Grant (R01).

The initial project was conducted by Kannanganattu and co-investigators Auinash Kalsotra, Erik Nelson, and Wawrzyniec Dobrucki, also CCIL members. Their goal was to provide molecular insight into the role of long non-coding RNAs (lncRNAs), which are often aberrantly expressed in cancer.

Kannanganattu, professor of cell and developmental biology, focused on MALAT1, a lncRNA that is highly upregulated in several subtypes of breast cancer and heavily affects patient survival rates.

Previous research found that MALAT1 controls the activity of splicing regulator protein SRSF1, a key oncogene in breast cancers. Using several high-throughput analyses, Kannanganattu and collaborators continued to analyze the relationship between these genes and breast cancer, screening and identifying hundreds of genes that require MALAT1 and SRSF1 for their hypoxia-responsive alternative splicing.

Knocking out MALAT1 showed a significant decrease in tumor growth and metastasis in mouse models, but Kannanganattu proposed further research to understand the precise mechanisms. The study presented in the NIH grant aims to further the research by determining the role of MALAT1 in underlying pathways and metastasis of breast cancer.

Preliminary results have found that hypoxia induces higher levels of MALAT1 in mice with breast cancer. Additionally, knocking out MALAT1 and reinducing hypoxia produced splicing changes of genes responsible for metastatic events.

“Now, we ask how MALAT1 is controlling SRSF1, how much of it is required to form a tumor, and find out what happens to key processes associated with hypoxia, such as angiogenesis and gene regulation, when we knock out MALAT1,” Kannanganattu said.

MAJOR BREAKTHROUGH STORIES

Illinois Chemist Developing Noncoding RNA-mRNA Interactome Map for Breast Cancer Progression

Hee-Sun Han, assistant professor of chemistry, is using her expertise in optics, chemistry, and computational biology to tackle breast cancer. Her research aims to understand the underlying principles involved during cancer growth, its evolution, and patient response to treatment.

In support of her research, Han received a CCIL seed grant to help fund the development of a new imaging system and a computational model to analyze the interactions between RNA which code for protein and the other 90% of regulatory RNA.

Despite the central dogma of biology which defines the role of RNA as the intermediary of information flow, recent studies have shown that the majority of RNAs do not code proteins. Instead, these RNA are believed to play important regulatory roles. This new discovery has led to the development of an interactome map which will help researchers better understand the functions and interactions of non-coding RNA and their roles in cancer cells.

"The new imaging platform provides a completely new approach to study RNA interactions. Instead of performing affinity-based assays, the new method monitors the position of all RNA molecules in a cell and infers RNA interactions," Han said.

This research can also be generalized to other infectious and neurogenerative diseases, as well as the study of healthy cells.

The Han Lab is also currently developing other, new technologies to unveil fundamental mechanisms underlying complex biological systems. This research includes the development of drop microfluidics-based single virus genomics, with which Han aims to elucidate the relationships between individual cells and viruses, and how they work together to drive systems level functions.

"The Illinois campus is one of the best campuses for truly fostering interdisciplinary research and, I do believe, to study complex biological systems like cancers and viruses [that have] a tight connection with all different scientific disciplines," Han said. "The research in my own group is limited, but the CCIL forces you to interact with people who you may have never talked to. It pushes us to open up our boundaries and learn new things."

CUTTING-EDGE FACILITY

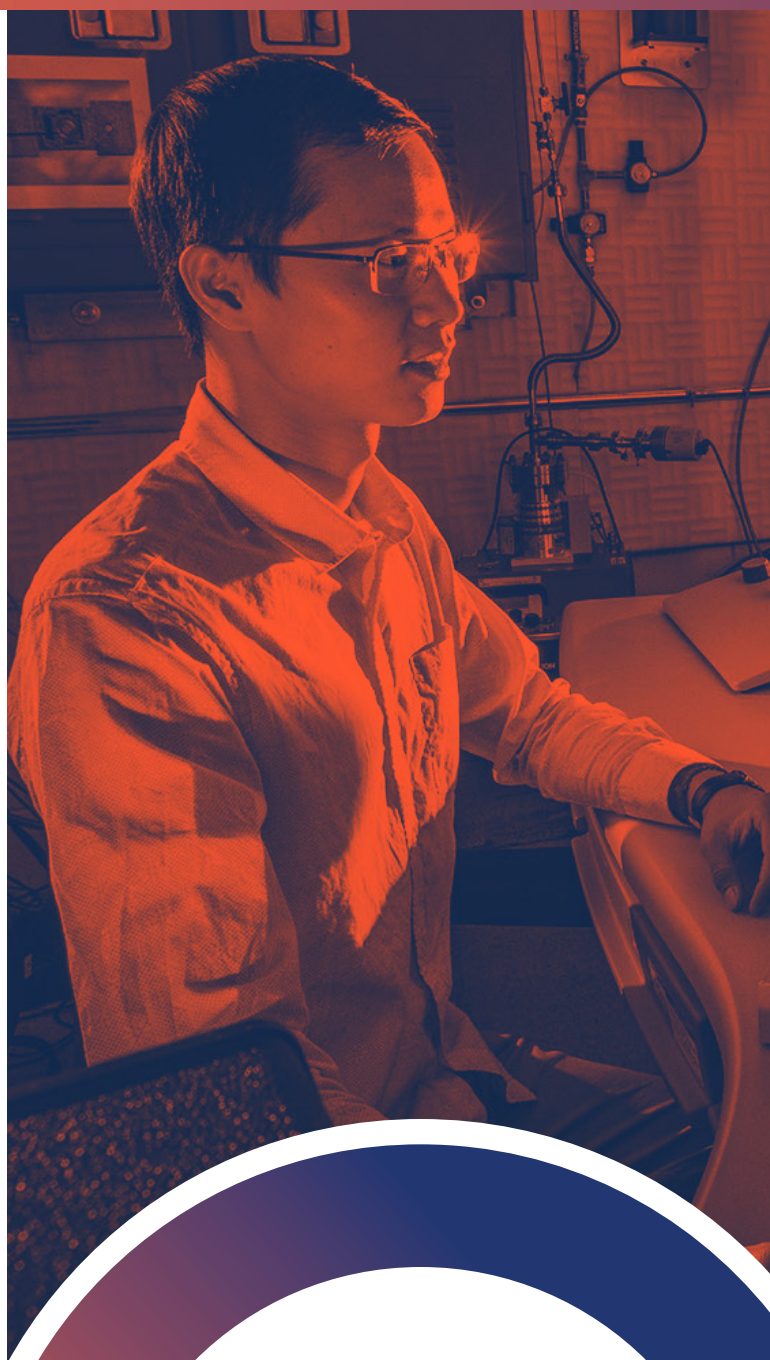
The **Tumor Engineering and Phenotyping (TEP) Shared Resource** is the largest space dedicated to cancer research on the University of Illinois Urbana-Champaign's campus. The overarching goal of TEP is to provide access to specialized technologies, cancer models, services, and expertise that enhance scientific interaction and productivity while aiding greater collaborations, stability, reliability, cost-effectiveness, and quality control.

A one-stop shop for advice, resources, and validation to support discovery or technology development with biological experiments and analyses.

TEP is on a mission to maintain a state-of-the-art facility for cell and tissue evaluation while providing a broad range of services related to cell and molecular biology. CCIL members have special access to the vast array of services and specialized support staff that TEP offers to accelerate their cancer research projects. TEP has been recognized for introducing advanced techniques and tools to campus researchers, and its continued expansion and capabilities to serve the evolving needs of cancer researchers.

In collaboration with the Beckman Institute for Advanced Science and Technology, the CCIL received a National Institutes of Health (NIH) grant to construct and maintain TEP's space. The over 5,500 sq. ft. lab is under renovation in the Beckman Institute, and all upgrades will be completed by May 2022. At full capacity, TEP will provide CCIL members with four BSL2 cell culture rooms equipped with biosafety storage, imaging, and general lab spaces with access to Beckman's extensive animal, computational, and visualization facilities.

TEP provides hands-on cancer research training for students, with a direct connection to the CCIL's TiMe Program, scholars, and the staff who offer expert guidance in experimental design and the analysis pipeline.



10

Projects Completed

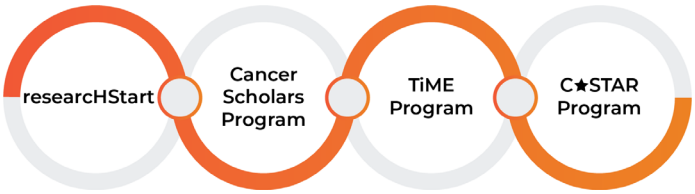
COLLABORATIVE SUPPORT

CANCER RESEARCH TRAINING &

EDUCATION COORDINATION

The CCIL facilitates transformative educational programs, allowing students to work in cancer research laboratory spaces, alongside world-renowned scientists and clinical oncologists, to solve grand challenges facing real cancer patients. From research opportunities and fellowships to workforce development and advocacy, we embolden our students to pursue scientific breakthroughs — and lead lives of impact.

Since the CCIL's inception over a decade ago, we have been committed to building an outstanding talent pipeline. By nurturing the growth and development of our future scientists, the CCIL will help build the economy, create jobs, and support innovative businesses that market our life-changing breakthroughs.



researcHStart
An 8-week high school research-intensive summer program.

Cancer Scholars Program
A unique undergraduate learning experience through early exposure to research opportunities.

Tissue Microenvironment (TiME) Program
An NIH-funded graduate program focused on interdisciplinary research in tissue microenvironments.

Cancer Scholars for Translational & Applied Research (C★STAR)
A graduate program that provides education, mentoring, and translational research opportunities between students and physician collaborators.

THE NEXT GENERATION

"Fighting Cancer" Takes on New Meaning for Former CCIL Student

When Catherine Applegate, former CCIL TiMe program trainee, began her graduate research into the effects of diet on cancer, she had no idea that soon she would be experiencing cancer from a completely different perspective – as a patient.

When she received her breast cancer diagnosis at the beginning of the final year of her doctoral program in nutritional sciences, Applegate was determined to finish her degree on time while simultaneously managing chemotherapy treatments and surgery.

"This goal would not have been met were I not surrounded by the resources I needed and an amazingly collaborative network," Applegate said. "The support I received from my advisor, collaborators, colleagues and department was absolutely amazing and heart-warming."

Seeing an opportunity to confront the disease through her research, she continued her work in the lab of John Erdman, professor emeritus of nutrition and food science. Her research focused on the impact of diet and obesity on prostate cancer progression. Although it was a different type of cancer from her own, she found renewed purpose and urgency to the work.

"The whole experience has been continuously teaching me to view my research not only as a scientist who strives to make an impression within the scientific community, but also as a patient whose future and quality of life may be highly impacted by that research," Applegate said.

The CCIL became another helpful source of support and inspiration. Applegate joined the Cancer Research Advocacy Group, a team that brings researchers, physicians, patients, and survivors together to offer input and feedback. She also became a Cancer Center Ambassador, reaching out to students, potential future cancer scholars, and the public.

"The Cancer Center at Illinois holds great significance for me as it represents my affiliation to cancer research both from a scientist's and a patient's standpoint," she said.

RESEARCH PIONEERS

Student in CCIL Lab Awarded Prestigious NCI Fellowship for Discovery of Transformative Breast Cancer Treatment

Matthew Boudreau, a chemistry PhD candidate in the CCIL's Deputy Director Paul Hergenrother's lab, has been awarded the prestigious F99/K00 grant from the National Cancer Institute (NCI). Boudreau's research has centered around a novel therapeutic, ErSO, that successfully eradicates hormone-positive (ER+) breast cancer in multiple preclinical mouse models.

ErSO was discovered by Boudreau, in collaboration with CCIL researcher David Shapiro's lab. Boudreau attributes the success of the research to the invaluable collaborations that empower students and faculty on the University of Illinois campus. These collaborations have involved many other CCIL members including Timothy Fan, professor of veterinary oncology, and Erik Nelson, associate professor of molecular and integrative physiology.

"Having a collaborative environment like the Cancer Center at Illinois that is super excited about treating cancer is so empowering. When you're around passionate people, that's where the best science happens," Boudreau said. "A high tide raises all boats."

ErSO kills cancer cells selectively by leveraging the overexpression of the estrogen receptor, and in turn, hyperactivating the anticipatory unfolded protein response (UPR). This over-activation leads to a potent anticancer effect, ultimately resulting in quantitative tumor regressions in murine models. Notably, ErSO also crosses the blood-brain barrier, enabling future applications for the treatment of breast cancers that have metastasized to the brain. Most therapeutics cannot enter the brain, making brain metastases difficult to treat.

"As we get better at treating cancer, we continue to see patients with challenging, drug-resistant disease. In the case of these challenging brain metastases, there are significantly less therapeutic options," Boudreau said. "ErSO may be well-positioned to fill this therapeutic void in breast cancer treatment."

As ErSO moves to clinical translation, the University of Illinois has licensed ErSO and its related technologies to Bayer and Systems Oncology, who are partnering to develop ErSO as a therapeutic approach for the treatment of metastatic breast cancer.

RESEARCH HIGHLIGHTS

CCIL Member and Collaborators Develop Personalized Oncopig Cancer Model

A collaboration between the University of Illinois Urbana-Champaign, University of Illinois Chicago, and their respective Cancer Centers was initiated by CCIL member and UIUC Gutgsell professor of animal sciences, Lawrence Schook. The team followed their mantra, "*to meet the unmet clinical need*," throughout the project. Their Modeling Oncology on Demand (MOOD) technique, combined with the oncopig model enables researchers to create a tumor that resembles and behaves just like a human tumor.

The MOOD patent has been submitted by the University of Illinois and licensed by SUS Clinicals, Inc.

Illinois Researcher Applies Behavioral Science to Promote HPV-Related Cancer Prevention

Jessie Chin, assistant professor at the School of Information Sciences, is analyzing risk perceptions surrounding HPV vaccinations, which suffer from low uptake rates, with a computational model that employs psycholinguistics, machine learning, and natural language processing. The low uptake rates for the HPV vaccine are partially attributed to scientific misinformation and scientific terminology that describes false information and causality, especially through social media platforms such as Twitter.

"*As researchers, we are dedicated to advancing human knowledge, but it can be difficult to know how that is being translated to the public," Chin said. "So, I am interested in knowing how we can better facilitate the process of disseminating the information and implementing the evidence-based science*."

Jie Chen Receives Campus Award for Graduate Student Mentoring

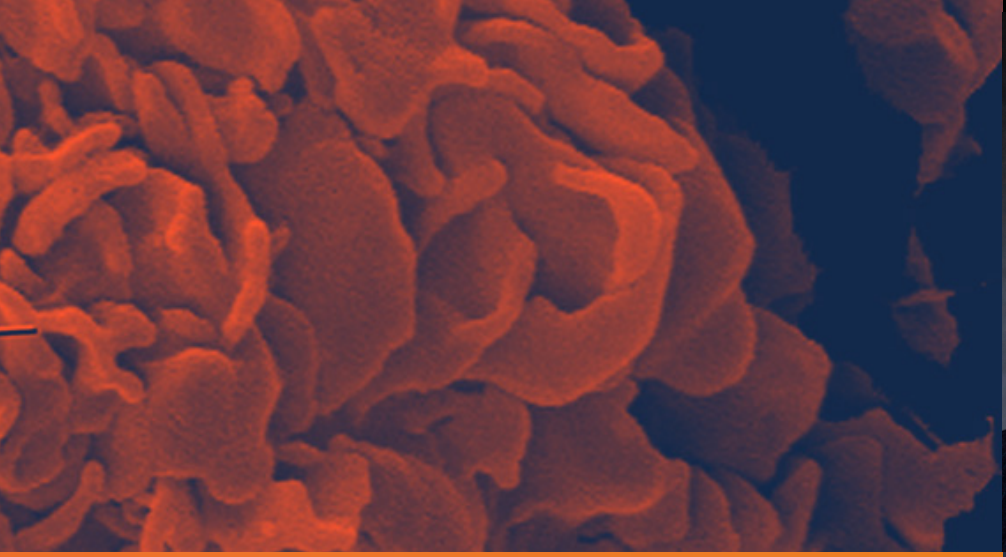
Jie Chen, professor of cell and developmental biology, was honored with the 2021 Campus Award for Excellence in Graduate Student Mentoring. The award recognizes faculty members for their sustained excellence in graduate student mentoring, innovative approaches to graduate advising, and their impact on graduate student scholarship and professional development.

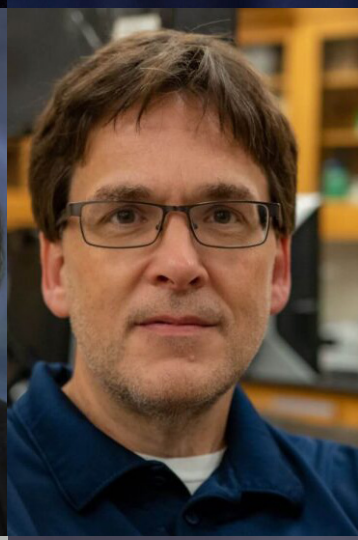
As described by her nominator, Chen pushes students to think critically while also teaching them to effectively design and execute experiments. Her motto, that the health and sanity of her students are paramount, is a testament to her commitment as a kind and considerate mentor.

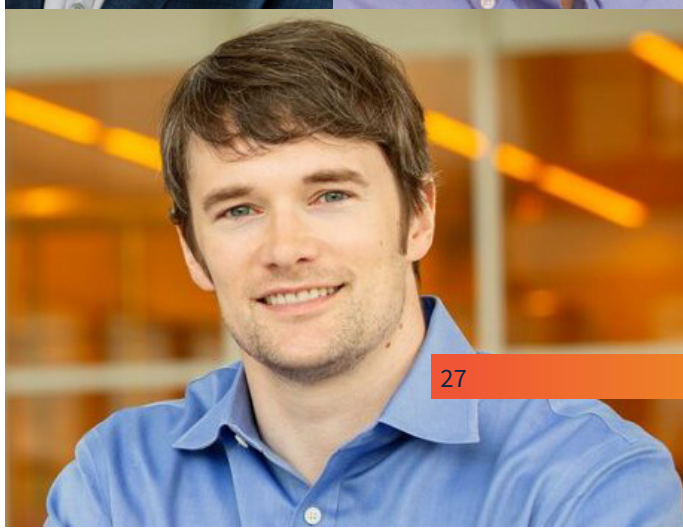
CCIL Scientist's Research in Ultrasound Technology Leads to $2M NCI Grant

Michael Oelze, professor of electrical and computer engineering, and his collaborative breast cancer and ultrasound imaging study with Sunnybrook Health Sciences Centre in Toronto, Canada, was awarded a $2M grant from the National Cancer Institute (NCI). Oelze, also an affiliate with the Carle Illinois College of Medicine and Beckman Institute, is working with Professor Gregory Czarnota (MD, PhD) on a project that aims to identify the early response of breast cancer patients to neoadjuvant chemotherapy using quantitative ultrasound imaging technology.

"The [project] isn't looking at trying to diagnose breast cancer, it's looking at how early and how well we can detect early response of breast cancer patients to neoadjuvant chemotherapy," Oelze said.







Cancer Compound Originating from University of Illinois Scientists Leads to Major Licensing Deal

Paul Hergenrother, CCIL Deputy Director and professor of chemistry, and David Shapiro, CCIL member and professor of biochemistry, discovered a novel small molecule compound, ErSO, that is now the subject of a new global licensing agreement between the pharmaceutical company Bayer AG and the cancer drug development company Systems Oncology LLC. Systems Oncology originally licensed the IP related to the compound in 2018, and this new deal will now give Bayer the exclusive rights to develop the compound as a cancer therapy.

"Using the very sophisticated imaging technology available at the university allowed us to actually visualize live tumors and to see how well the drug was doing, and it allowed us to see how tumors have spread to other sites," Shapiro said. "We would not have been able to do this without these tools."

CCIL Member Research Optimizes Quantum Dot Probe Size for Single-Receptor Imaging

A team of Illinois researchers, including CCIL members Andrew Smith, professor of bioengineering, and Pablo Perez-Pinera, associate professor of bioengineering, has created the smallest quantum dots to date. The scientists found that the smaller fluorescent nanoparticles produced better single-molecule imaging results. ACS Nano published their findings in a paper titled, "*Optimizing quantum dot probe size for single-receptor imaging*."

"This study shows that there is substantial merit in further engineering to shrink the size of quantum dot labels which is an ongoing project in our lab in collaboration with other labs on the paper," Smith said.

New Computational Models to Understand Colon Cancer

In a new study published in Genome Biology, a research team, including CCIL member and professor of computer science Saurabh Sinha, has developed a new modeling approach to better understand how tumors become aggressive. The researchers pooled the data from their own experiments as well as publicly available data to develop the model, which was based on a simpler 2018 model that investigated regulators of cancer drug resistance. In this paper, the researchers focused on transcription factors, proteins that control gene expression by binding to the DNA.

"Increasingly, these technologies provide us complimentary views of cellular changes during disease progression. [This] work provides us with a general-purpose recipe to combine those different views into one meaningful whole, giving us more than any one view can," Sinha said.

Carle Physicians Partner with CCIL Members to Address Gynecologic and Breast Cancers

Carle Foundation Hospital oncologists and surgeons, Georgina Cheng and Anna Higham, are collaborating on several projects with CCIL scientists to address a number of cancers that predominantly impact women. Cheng's expertise is currently informing a CCIL seed grant-funded project looking to treat ovarian cancer with ErSO, a novel breast cancer therapeutic developed by David Shapiro and Paul Hergenrother, both CCIL researchers.

Higham is mentoring Anirudh Mittal, a student in the CCIL's C★STAR program, which connects Illinois graduate students with Carle physician-scientists to foster translational research. Their project seeks to develop CCIL director Rohit Bhargava's infrared spectroscopy imaging tool for real-time use in the operating room.

Microscope that Detects Individual Viruses could Power Rapid Diagnostics

A fast and low-cost technique, Photonic Resonator Interferometric Scattering Microscopy (PRISM), was developed by an Illinois team led by Brian Cunningham, CCIL research program leader and professor of electrical and computer engineering. Published in Nature Communications, PRISM detects and counts viruses or proteins from a sample in real time, without any chemicals or dyes, and could underpin a new class of devices for rapid diagnostics and viral load monitoring, including HIV and the virus that causes COVID-19.

"We can use it for very rapid and sensitive forms of diagnostic testing, and also as a very powerful tool for understanding biological processes at the scale of individual items, like counting individual proteins or recording individual protein interactions," Cunningham said.

Lassogen Raises $4.5M in Seed Round to Develop Novel Therapeutics

Douglas Mitchell, CCIL member and professor of chemistry, is combining the power of antibodies and small molecule drugs with the San Diego-based startup Lassogen to develop lasso peptides as a new therapeutic modality. With $4.5 million raised in a seed round, the company moved one step closer to demonstrating the power of lasso peptides for treating human diseases such as cancer and autoimmune disorders.

"Lassogen has strategically targeted G protein-coupled receptors (GPCRs) that are not exploited medicinally by other therapeutic modalities," Mitchell said. "There are G protein-coupled receptors that are involved in various types of cancer where there is good validation that modulation of that target could be beneficial for stopping tumor growth or enabling the immune response to eliminate the tumor."

Computer Scientist Earns NSF Career Award to Further Develop Understanding of Cancerous Tumors

Mohammed El-Kebir, professor of computer science, earned a $500,000 NSF CAREER Award in 2021 to fund his research on single-cell sequencing (SCS). El-Kebir believes that an opportunity to find a new path toward more effective cancer treatment lies within SCS, due to its ability to "precisely reconstruct a tumor's evolutionary history at single-cell resolution."

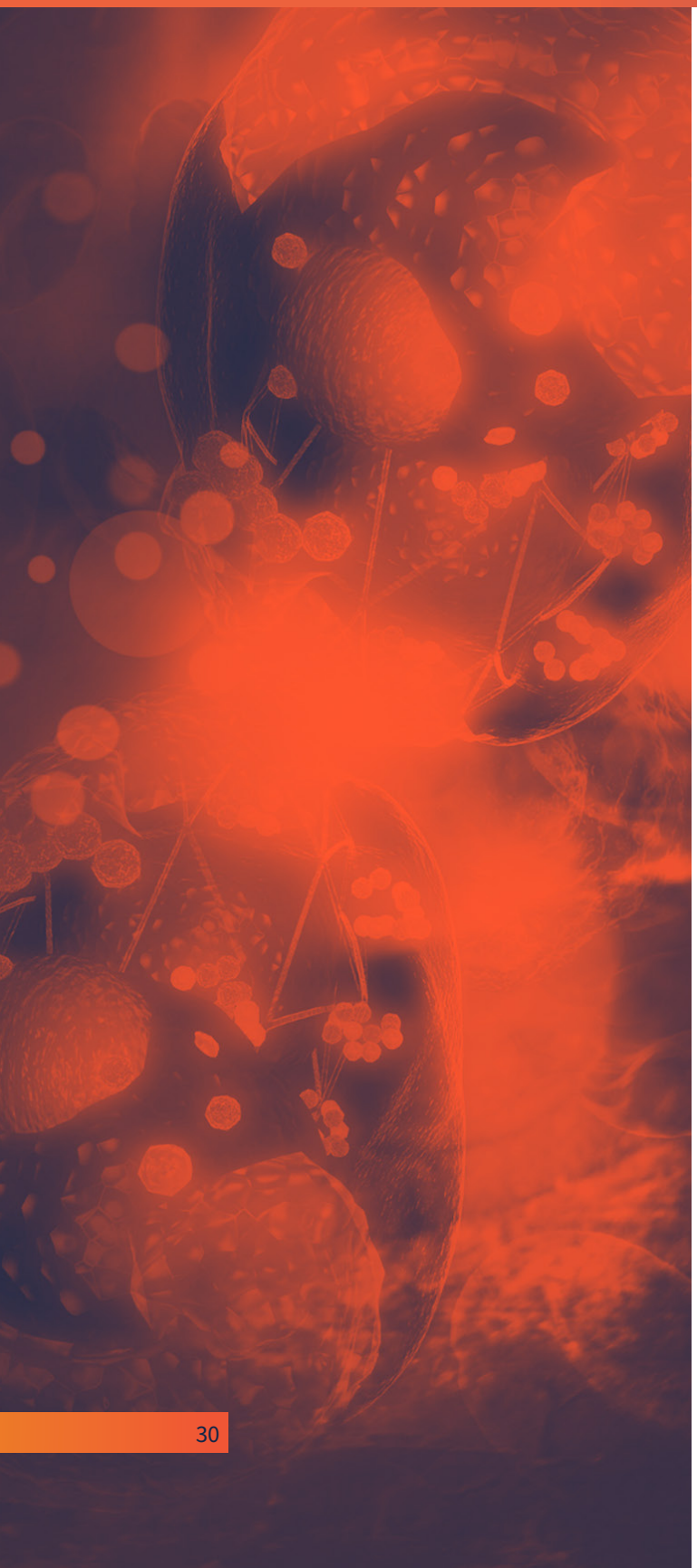
"*We are trying to unravel the mystery behind tumor behavior by identifying its evolutionary trajectory," El-Kebir said. "In essence, we want to find out all the rules of the game to cancer evolution. We want to find tendencies, which will help the community forecast what will happen next with a tumor – thus identifying the best way to treat it.*"

CCIL Members Collaborate with Oxford University in Piecing Together the LanCL Puzzle

A team of researchers from Oxford University and the University of Illinois, including the CCIL's Satish Nair, professor of biochemistry, and Jie Chen, professor of cell and developmental biology, have published a paper in Cell reporting the function of LanCL proteins. These proteins are found in eukaryotic cells but their function was previously unknown. The study is the first step towards understanding the importance of these ubiquitous proteins, and the role they play in diseases like cancer.

"*When you have abnormal kinases, it can cause all kinds of problems, including cancer. LanCL proteins eliminate these damaged kinases and it is possible that they also affect other proteins that we are not aware of," Chen said.*

ACCOLADES



CCIL Member Elected Senior Member of National Academy of Inventors

Pengfei Song, assistant professor of electrical and computer engineering, was nominated to the senior rank of the National Academy of Inventors. NAI Senior Members are recognized for their achievements in their field, positive social impact, and mentorship of future inventors.

CCIL Research Program Leader Awarded for Commitment to Veterinary Oncology

Timothy Fan, professor of veterinary oncology, was awarded with the Career Achievement Award in Canine Research by the American Veterinary Medical Association. Fan's lab works to evaluate novel cancer therapeutics.

Timothy Fan

CCIL Member Appointed First Female Head in Chemistry Department History

Catherine Murphy, Larry R. Faulkner Endowed Chair in Chemistry, was appointed the first female Head of Chemistry at the University of Illinois Urbana-Champaign. Murphy's lab makes inorganic nanoparticles with controlled size, shape, and surface chemistry.

CCIL Scientist Earns Clemson Award from the Society for Biomaterials

Brendan Harley, professor of chemical and biomolecular engineering, was awarded the 2021 Clemson Award for Basic Research by The Society for Biomaterials (SFB) for his advances in regenerating tissues with biomaterials.

CONTINUED PROGRESS & INNOVATION IN 2020

CCIL Researcher Named Editor-in-Chief of Endocrine Society Journal

Zeynep Madak-Erdogan, associate professor of food science and human nutrition, was named Editor-in-Chief of the Journal of the Endocrine Society (JES). JES is a peer-reviewed, Open Access journal providing rapid publication of clinical research, clinical practice information, and basic research in all areas of endocrinology.

CCIL Endocrinologist Named Gunsalus Scholar

Erik Nelson, assistant professor of molecular and integrative physiology, was named the Illinois College of Liberal Arts and Sciences 2020-2021 Gunsalus Scholar. Nelson was recognized for his outstanding work on cholesterol metabolism and cancers of the breast or ovary.

Natural Systems Research Leads to Royal Society of Chemistry Award

Yi Lu, professor of chemistry, has been named the winner of the Royal Society of Chemistry's Joseph Chatt Award. Lu's research interests lie at the interface between chemistry and biology, and his group is developing new chemical approaches to provide deeper insight into biological systems.

CCIL Member Receives AIMBE Professional Impact Award

Rashid Bashir, professor of bioengineering, was awarded the American Institute for Medical and Biological Engineering's 2021 Professional Impact Award for Education for his commitment to advancing bioengineering education.

Rashid Bashir

Zeynep Madak-Erdogan

CCIL Appoints World-Renowned Scientist to Senior Advisor Position

Benita S. Katzenellenbogen, professor of molecular and integrative physiology, has been appointed Senior Advisor to the Director of the CCIL. Katzenellenbogen will provide advice and guidance regarding the CCIL's positioning and relationship in the national cancer research landscape.

CCIL Scientists Named IAMBE 2021 Fellows

Mark A. Anastasio, head of bioengineering, Stephen Boppart, Grainger Distinguished Chair in Engineering, and Joseph Irudayaraj, professor of bioengineering, were named International Academy of Medical and Biological Engineering (IAMBE) 2021 Fellows for their outstanding contributions to the profession of medical and biological engineering.

CCIL Scientist Receives National Recognition for Nutritional Research

Aditi Das, associate professor of comparative biosciences, was honored with the E.L.R. Stokstad Award by the American Society for Nutrition. Das' research aims to discover anti-inflammatory molecules that can be used to reduce inflammation in brain, tumor, and cardiovascular diseases.

Sarlah Named American Cancer Society Scholar

David Sarlah, assistant professor of chemistry, was recognized as an American Cancer Society Scholar – an award that provides cancer research funding. Sarlah's lab is exploring natural compounds and the role they play in cancer therapeutics.

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Deputy Director
Professor of Chemistry

Rohit Bhargava
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Professor of Electrical and Computer Engineering

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