



# PATHWAYS

**At the Cancer Center at Illinois, our  
cancer research knows no bounds.**

*Everyday, CCIL scientists  
are uncovering translational  
biomedical innovations  
and technologies.*



**Cancer Center  
at Illinois**

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

**WINTER 2020**

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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.

**Editor:** Jordan Goebig

**Contributing Writers:** Carly Kwiecinski, Olivia Fleming, and Alisa King

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



Every day, 4,900 individuals are diagnosed with cancer. It's a staggering number. It's the reason that the Cancer Center at Illinois exists, and it's the reason why our large team of scientists and students continued to safely progress forward with our research efforts during a pandemic. A number of diseases, including cancer, will see an increase in cases and deaths due to COVID-19. We know this may be the case, and we must do what we can to combat these numbers.

Fortunately, cancer centers around the nation are collaborating, bringing the greatest minds together to find solutions to these problems. Many cancer centers, because of their organizational excellence, have been put into service to combat the effects of COVID for their institution. We are no exception. I am proud of the work Martin Burke, Paul Hergenrother, and Tim Fan have done to keep this campus open and enable our cancer researchers to work. Basic science, practical engineering, and a strong commitment lies at the heart of this success and it is a lesson for how we may address needs in cancer.

I'm also proud of our CCIL team that has made incredible progress during these times, working alongside CCIL members who have not wavered in their commitment to groundbreaking cancer research. In just the last six months, internally, the CCIL has undertaken long-term strategic planning, started a leadership program, enhanced our student programs – including a perfect score of 10 on our NIH T32 renewal proposal – and started the construction process on our tumor engineering and phenotyping (TEP) shared resource renovation in the Beckman Institute.

Externally, this issue of Pathways describes the achievements of CCIL members and students that make me optimistic about the coming years. David Shapiro and Paul Hergenrother continue to translate astonishing drug discoveries into cancer therapeutics. Erik Nelson was recently awarded one of the Department of Defense's highest honors, becoming just one of two scientists nationwide selected for the Era of Hope Scholar award to continue his progress in breast cancer research. Many of our members are developing technologies and bringing innovations to life that will not only benefit cancer patients but will have positive implications for the diagnosis and treatment of other diseases.

The milestones outlined in this magazine, the work that continues beyond publication, and the ideas that are dreamed up at CCIL gatherings every day, give me hope that we will succeed in this fight against cancer. Just as our researchers demonstrated for COVID, Illinois can and will tackle the largest and most difficult problems with our brand of scientific expertise, ingenuity, and "can-do" attitudes.

Stay safe and stay well,

**ROHIT BHARGAVA, CCIL DIRECTOR**



# Where Cancer Research Meets Drug Discovery



Left: David Shapiro. Right: Paul Hergenrother.

## Cancer Compound Developed by CCIL Scientists Leads to Major Licensing Deal

Cancer Center at Illinois (CCIL) scientists are leading the science behind a new global licensing agreement between Bayer AG, the pharmaceuticals company, and Systems Oncology, the cancer drug development company, for a new breast cancer treatment called ERSO.

Developed by Paul Hergenrother, professor of chemistry, and David Shapiro, professor of biochemistry, ERSO targets breast cancer cells that express the estrogen receptor (ER). An estimated 70% of women diagnosed with breast cancer have ER-positive breast cancer. According to Hergenrother, these breast cancer cells are very sensitive to ERSO, which kills the cells rapidly.

"To have a major company choosing to license ERSO speaks volumes about the societal impact Illinois research can have," Hergenrother said, who is also the CCIL Deputy Director.

Hergenrother and Shapiro understood the intricacies of getting a cancer drug from bench-to-bedside. Their expertise in chemistry and cancer biology, collaborations with other Illinois cancer researchers, and the imaging resources available at the U of I all contributed to the success of the new compound.

"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."

Drug-licensing agreements are complex, however, and Hergenrother's prior experience licensing anti-cancer compounds with Systems Oncology played a major role in pushing ERSO beyond the labs of Illinois.

"The partnership between myself and Paul was aided by a terrific team of Illinois collaborators. We really have amazing people at the University who have contributed beyond this partnership, and it's enabled the creation of this very robust and powerful set of data that was so attractive to Bayer," Shapiro said.



## CCIL Student Receives Prestigious NCI Award for Novel Breast Cancer Treatment

Matthew Boudreau, a chemistry PhD candidate, was awarded a prestigious F99/K00 grant from the National Cancer Institute (NCI). Boudreau's research focused on a novel therapeutic, ERSO, now licensed by Systems Oncology and Bayer.

ERSO has successfully eradicated hormone-positive (ER+) breast cancer in multiple preclinical mouse models and continues to be translated towards the clinic. The drug selectively kills cancer cells by leveraging the overexpression of the estrogen receptor and is also capable of crossing the blood-brain barrier, enabling treatment of metastasis to the brain.

"We continue to see patients with drug-resistant disease, and in the case of 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," Boudreau said.

ERSO was discovered by Boudreau in collaboration with CCIL members Paul Hergenrother (Deputy Director), David Shapiro, Timothy Fan, and Erik Nelson. Boudreau attributes the success of the research to the invaluable collaborations that empower students and faculty on the University of Illinois campus.

"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.

Boudreau's motivation stems from a personal desire to further the understanding of clinical oncology and make an impact on large patient populations. He describes the research in his field as a superpower that synergistically combines the worlds of chemistry and cancer biology to investigate and eradicate cancer.

**LEARN MORE:** <https://go.illinois.edu/ERSOBoudreau>



*Boudreau works in CCIL Deputy Director Paul Hergenrother's lab.*



# Where Cancer Research Meets Patient Progress

## Breast Cancer Survivors Inspire Research Leading to \$4.5M DoD Award

Erik Nelson, CCIL member, has always recognized the value of consulting cancer survivors and research advocates to guide his research to address real patient concerns.

Following the insights of Cancer Research Advocacy Group (CRAG) members, Nelson and his research team have focused their efforts on breast cancer metastasis and progression. Recently, Liqian Ma, an Illinois graduate student in Nelson's lab, published a cancer research study influenced by cancer survivors. Ma's research found that 27-hydroxycholesterol, a primary cholesterol metabolite, acts upon macrophages, a specialized cell, to inhibit immune cell activity, allowing cancer cells to survive, proliferate, and progress.

"We have the opportunity to directly talk to advocates and interact with patients, cancer survivors, or their relatives. [It] continues to inspire us to pursue this path and save more lives," Ma said.

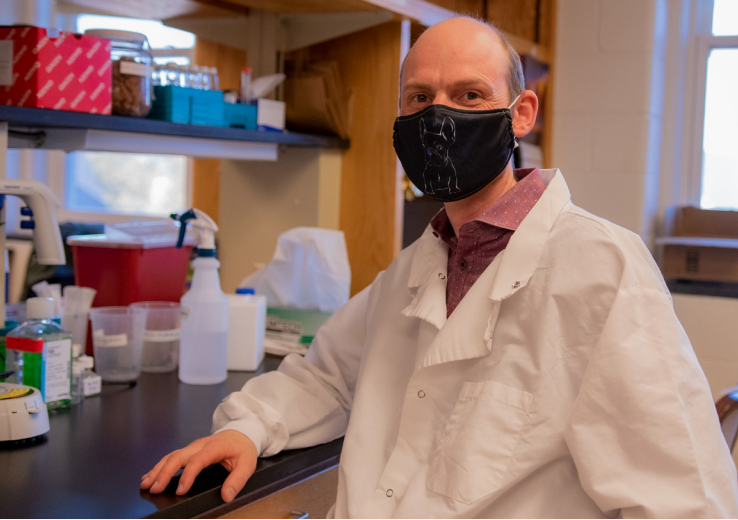
Nelson's commitment to breast cancer research was recently recognized by the United States Department of Defense (DoD) Breast Cancer Research Program. The program awarded Nelson the Era of Hope Scholar Award, providing the researcher with \$4.5M to support his continued research of metastatic breast cancer.

"I look forward to asking some big questions and [continuing] to translate our studies into meaningful change for breast cancer patients," Nelson said. "I strive to not just develop better treatments to spare people's lives, but also minimize side effects."

**LEARN MORE:** <https://go.illinois.edu/EraOfHope>

*The views expressed in this article are those of the author and may not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government*



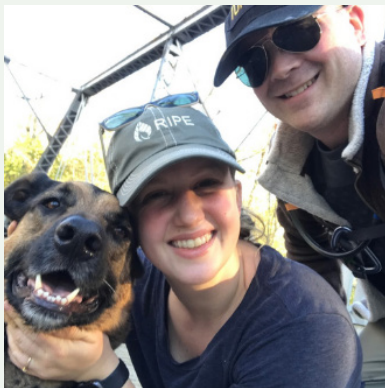


Left: Erik Nelson, professor of molecular and integrative physiology. Right: Nelson talks with members of his lab group.

## Recognizing Cancer Caregiver's Contributions to Cancer Care

Cancer caregivers are remarkable individuals who devote their lives to supporting their family, friends, colleagues, and acquaintances stricken with the disease. In continuous recognition for their care, the Cancer Center at Illinois has collected the stories of several caregivers, providing insight into their experience and what cancer research means to them.

### The "Benjaberg" Family



"It's not lost on me that dealing with a dog with cancer is very different than dealing with a human...In some ways it is such a privilege that we have that choice when Bruno is really in pain, but it is such a burden of choice," Claire said. Claire Benjamin and Henry Fineberg's dog Bruno is undergoing treatment for stage five leukemia.

### Jenn Shimon



"I'm trying to give people a moment of peace during a moment that is not very peaceful," Jenn said. Jenn is a breast cancer survivor and works as a cancer patient massage therapist.

### Marie Morgenthaler



"I've learned that even though it was one person that had cancer, the cancer affected all of us and it is going to affect all of us," Marie said. Marie lost her father to pancreatic cancer.

**LEARN MORE:** [go.illinois.edu/CancerCaregivers](https://go.illinois.edu/CancerCaregivers)





# Transforming Medicine Through Cancer Research

Cancer Center at Illinois (CCIL) scientists often find that the techniques and knowledge obtained from other fields of study can inform their own cancer research. Additionally, CCIL researchers have found that their cancer studies can help inform the research of other pathologies, forming new collaborations between Illinois faculty, clinicians, industry partners, and external researchers. These innovative researchers include Brian Cunningham, Joseph Irudayaraj, and Jun Song.



## CANCER AND VIRUS STUDIES

Brian Cunningham, professor of electrical and computer engineering and CCIL research program leader, focuses his research on diagnostics through blood samples which reveal the concentration of molecules like proteins and nucleic acid sequences. For cancer patients, these tests can be used to diagnose cancer and determine the efficacy of their treatment.

Since the early days of COVID-19, Cunningham and his lab have re-purposed their expertise in creating such tests to detect the presence of viruses. Other tests can be very costly and take a long time, but Cunningham's tests are designed for point-of-care use and are very sensitive, delivering results in as little as 15 minutes.

"We've had to change the molecular biology of our approach a bit, but it's still the same technology that we are using to detect cancer, and it gives us a very sensitive, single-step test [for viruses]," Cunningham said.

**LEARN MORE:** [go.illinois.edu/DetectingViruses](https://go.illinois.edu/DetectingViruses)

## CANCER AND EYE DISEASE

Joseph Irudayaraj, professor of bioengineering, develops and tests biosensors and nanotechnology that aim to improve cancer diagnostics and treatment. His lab is particularly interested in epigenetics, the chemical modification of DNA, and its role in cancer and the microbiome. This facilitates the research of several types of cancer, including pancreatic, but has also led Irudayaraj to a new field of study: treating the human eye.

Cancerous tissue is often hypoxic (lacks oxygen) and is thereby non-responsive to therapy. Irudayaraj's previous research included the development of nanoparticles that deliver oxygen to such environments. Now, in a collaboration with Carle physicians, Irudayaraj is developing similar nanoparticles to treat central retinal artery occlusion (CRAO), which causes blockages in the blood vessels of the eye that result in blindness.

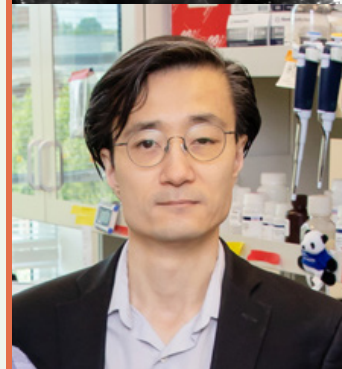
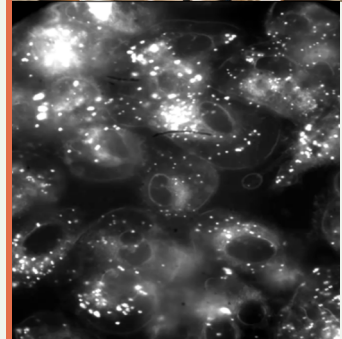
**LEARN MORE:** [go.illinois.edu/PancreaticCancer](https://go.illinois.edu/PancreaticCancer)

## THEORETICAL PHYSICS AND GENOMICS

For most, when thinking of cancer research, probability theory and statistical models are not the first techniques that come to mind. However, Jun Song, professor of physics, is applying his background in high-energy physics to cancer-related high-throughput genomics analyses. Through these studies, Song is revealing the secrets of non-coding areas of DNA that often include oncogenes.

Collaborating with other CCIL researchers, including Pablo Perez-Pinera and Paul Selvin, Song is using tools from physics and mathematics to model the geometry of genomic information with a particular focus on the distribution of proteins on DNA. He is also applying machine learning and AI to extract biologically relevant features to inform the diagnosis and treatment of melanomas, gliomas, and estrogen-receptor positive breast cancer.

**LEARN MORE:** [go.illinois.edu/JunSong](https://go.illinois.edu/JunSong)





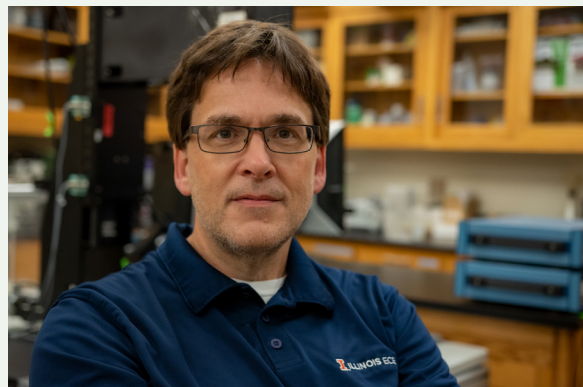
# Leading the next major breakthrough.

CCIL Scientists are revolutionizing breast cancer research.

Cancer Center at Illinois scientists and students work towards improving the lives of breast cancer patients by developing tools and discovering new treatments. This October, we highlighted their stories for Breast Cancer Awareness Month.

Michael Oelze, professor of electrical and computer engineering, recently received an \$2M National Cancer Institute grant for his novel imaging techniques using quantitative ultrasound imaging and radiological clips to identify the efficacy of a cancer treatment in a matter of weeks. This study will be conducted in collaboration with researchers from Sunnybrook Health Sciences Centre in Toronto, Canada, and the Carle Illinois College of Medicine.

**LEARN MORE:** [go.illinois.edu/OelzeClips](https://go.illinois.edu/OelzeClips)



Zeynep Madak-Erdogan, associate professor of nutrition, has secured a \$2M clinical trial to continue her research on breast cancer and health disparities, with a focus on African-American women in Southside Chicago. This funding was secured with collaborators from MD Anderson to study a cancer treatment combination in advanced breast cancer patients.

"Many of my projects are shaped by research advocates and cancer survivors. I appreciate it a lot and I think it should be more widespread; it's always great to work with cancer survivors and bring in their perspective," said Madak-Erdogan.

**LEARN MORE:** [go.illinois.edu/MadakErdogan](https://go.illinois.edu/MadakErdogan)



## Supporting the Next Generation of Cancer Researchers

When Kristine Neuhoﬀ Twyman (LAS '89) lost her battle with breast cancer, her husband Scott established a scholarship at the University of Illinois Urbana-Champaign in her honor to support students dedicated to breast cancer research.

Qianying Zuo, a graduate student in CCIL member Zeynep Madak-Erdogan's lab, and Joy Chen, an undergraduate student in Erik Nelson's lab, were each awarded the scholarship in recognition of the impact their research will have on the lives of breast cancer patients and their loved ones.

Chen is studying the role of cholesterol in breast cancer metastasis and reoccurrence from dormancy, and Zuo is developing 3D metastatic breast tissue models to detect the impact of diet on therapy responses.

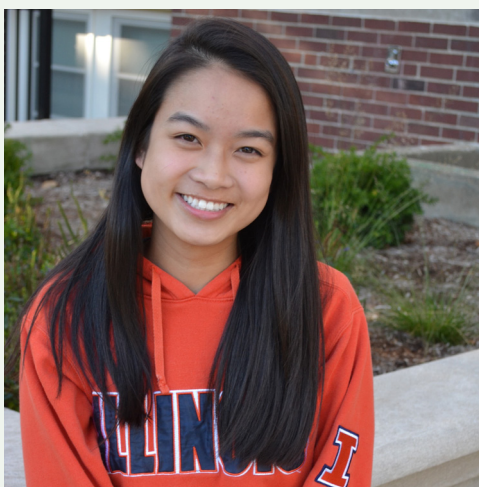
"The mission behind this scholarship is a powerful one, as research in the breast cancer field is critical. I am appreciative to have received this scholarship and intend to continue research in the cancer field during graduate school," Chen said.

"Receiving the Kristine Neuhoﬀ Twyman Breast Cancer Scholarship means a lot to me. I have always been trying to make my research relevant and helpful to save more lives," Zuo added.

### LEARN MORE:

[go.illinois.edu/TwymanScholarship](https://go.illinois.edu/TwymanScholarship)

*Left: Joy Chen. Right: Qianying Zuo.*



## Donate to the Cancer Center at Illinois.

Annually, millions of individuals are negatively impacted by cancer. Due to the pandemic, the future for cancer patients remains uncertain. **But your gift can change that.**

Every day, Cancer Center at Illinois researchers put on their masks and walk into their labs with one goal in mind: to save lives. Through your financial support, you can ensure that this lab research continues and new opportunities are funded and explored through the Cancer Center at Illinois Seed and Planning Grant Programs. To learn more about how you can support cancer research at the CCIL, **contact Amber Lannert, Senior Director for Advancement, at [alannert@illinois.edu](mailto:alannert@illinois.edu).**

## Curiosity Drives CCIL Scientist's Protein Synthesis Research

Current cancer treatments lack specificity for cancer cells and consequently attack healthy cells as well. CCIL member and professor of biophysics and quantitative biology, Hong Jin, is addressing the issue by focusing on protein synthesis.

Jin is specifically targeting non-canonical protein translation pathways, which would allow researchers to develop drugs with targeted specificity.

Her current research aims to uncover the precise function of

developmentally-regulated GTP-ase (Drg), a potential gene that promotes tumor progression in lung cancer.

"I was drawn to this type of research because I wanted to find the fundamental principles of life. I feel [they] are so incredible, and I want to see how the science leads us," Jin said.

**LEARN MORE:** [go.illinois.edu/DRG](https://go.illinois.edu/DRG)



## Cancer Center at Illinois — In The News



Hua Wang, assistant professor in materials science and engineering, joined the CCIL in Fall 2020. Wang, an expert in cancer immunotherapy research, focuses on biomaterials, cell targeting, and immunoengineering.



Doug Mitchell, professor of chemistry, is one of the co-founders of Lassogen, a start-up developing lasso peptides as a new therapeutic modality. Lassogen recently raised \$4.5M to develop novel therapeutics. The company will focus efforts on immuno-oncology.



COVID testing efforts, led by several CCIL members, continues to expand. Locally, over 1 million tests have been run, and the success of the SHIELD program has led to partnerships with universities and organizations across the U.S.

**LEARN MORE:** [go.illinois.edu/SHIELDcommittee](https://go.illinois.edu/SHIELDcommittee)



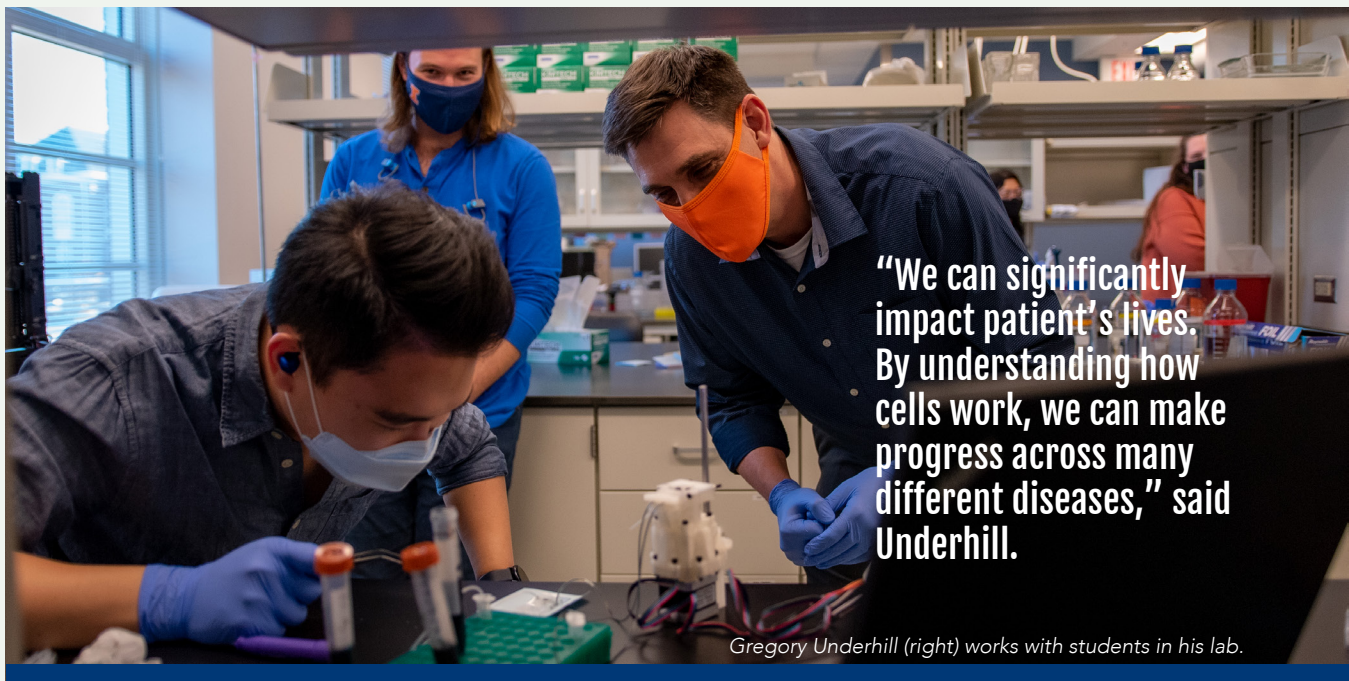
# CCIL Scientist Focuses on Fundamentals of Cancer Research

Gregory H. Underhill, associate professor of bioengineering, and his research team have focused recent research efforts on exploring liver tissue and applying a variety of engineering techniques to liver stem cells to improve our understanding of the liver environment.

"My lab is striving to understand how tissues develop in the body, in both normal, healthy conditions, and how they change in the settings of various diseases, like cancer," Underhill said. "There's still a lot unknown, but we have an opportunity to push science to the next levels."

By creating better models of the liver's processes, Underhill aims to facilitate the pipeline towards creating targeted therapies and effective drugs for lung cancer and other pathologies that affect the liver, such as non-alcoholic fatty liver disease.

**LEARN MORE:** [go.illinois.edu/Underhill\\_Fundamentals](https://go.illinois.edu/Underhill_Fundamentals)



**"We can significantly impact patient's lives. By understanding how cells work, we can make progress across many different diseases," said Underhill.**

*Gregory Underhill (right) works with students in his lab.*

## **Tumor Engineering and Phenotyping Shared Resource** **CCIL, in partnership with the Beckman Institute, opens laboratory for scientists and students**

The Tumor Engineering and Phenotyping Shared Resources (TEP), the U of I's first dedicated cancer research laboratory, opened for operation in Fall 2020. Though still undergoing renovations in the lower level of the Beckman Institute, TEP has been able to offer CCIL scientists a variety of services to accelerate cancer research projects. Current services for researchers include: 2D/3D cell culture, cell repository and authentication, cell-based assays, and mycoplasma testing, in addition to offering more advanced technologies on campus. TEP staff are trained to provide project support, and it will be used as an educational training space for CCIL students.

**LEARN MORE:** [tep.illinois.edu](https://tep.illinois.edu)



## CCIL Student Ambassadors Advocate for Cancer Research

The Cancer Center at Illinois' Ambassador program enables students with an early-rising passion for cancer research to make an impact while they are on the Urbana campus. The ambassadors take part in promoting cancer research efforts, educate fellow students about the CCIL's mission, encourage students to explore cancer research as a career, and volunteer at events.

Courtney Ketchum and Ege Onal were already students in the CCIL's Cancer Scholars program when they volunteered for the role. Ketchum's research has focused on the use of ultrasound for tumor treatment, and Onal has worked with nanoparticle contrast agents for image-guided surgery.

"It is extremely rewarding to know that the work we do in spreading awareness is vital to the research process," Ketchum said

**LEARN MORE:** [go.illinois.edu/CCILAmbassadors](http://go.illinois.edu/CCILAmbassadors)



Top: Courtney Ketchum. Bottom: Ege Onal.



Where Cancer Research  
Meets The Classroom



### **Vongai Tizora, Bioengineering Undergrad, Cancer Scholars Program**

#### **Did you have research experience before joining the Cancer Scholars Program?**

The spring semester of my freshman year I joined the Chemical Imaging and Structures Lab, run by Dr. Rohit Bhargava. My main role since the summer of 2019 has been investigating the effect of sample preparation variation on IR data and downstream processing. As a first step, I am focusing on the impact of sample thickness on data.

#### **What first led to your interest in science?**

Ever since I was a kid, I have always had somewhat of a natural affinity for science, although it still took a healthy amount of effort to understand the content as with any other subject. My interest was further enhanced when I came to the conclusion that I wanted to become a physician someday. Understanding that physicians need to have a strong science background, I continued to build upon my knowledge in this field and took the necessary steps to ensure that I was on track to realize my long-term goal. My decision to go into bioengineering for my undergraduate degree was partially due to my interest in tissue engineering and gene editing, which I learned a bit about as an upperclassman at Huntley High School.

#### **Why is cancer research important to you?**

For a long time, I have dreamt of helping people. At the same time, I could not avoid occasionally feeling like I couldn't make a difference given my level of education and the vast amount of knowledge I had yet to obtain. Aware that I had many more years before becoming a physician, I started looking into other ways that I could start contributing to society. Naturally, research has allowed me to contribute to the scientific community and continue to grow at the same time.

Cancer research in particular holds a very special place in my heart. I, as well as countless others, have known and lost loved ones battling cancer. Cancer, as with many diseases, impacts us all regardless of where we are from or what we do in life, and it is that truth that connects all of us. If I can contribute my time and efforts towards lessening the impact of cancer in our lives, I would consider it a great honor.

#### **What are your future plans?**

In the future I hope to use my bioengineering background as a physician to help improve the healthcare outcomes of individuals living in underserved communities both within the U.S. and abroad (most likely in Zimbabwe). I would love to work on a team of interdisciplinary individuals all striving towards the common goal of improving the human condition for everyone.

#### **What are your interests or hobbies?**

Currently I serve as the Internal Vice-President of the National Society of Black Engineers, and I am a member of Alpha Omega Epsilon, a sorority for women in technical sciences and engineering. Over the summer of 2020, I was a part of the Anti-Racism Task Force (ARTF) through the Grainger College of Engineering & IDEA Institute and our detailed recommendations were recently published. In my free time I love to read, write, and edit videos.

**CANCER CENTER AT ILLINOIS**

405 N. MATHEWS AVE.

URBANA, IL 61801



CANCER.ILLINOIS.EDU

@CANCERCENTERIL

