SPRING 2021

INNOVATION INSIDER

CANCER CENTER AT ILLINOIS

IMAGING

Bringing diagnostic imaging closer to the patient.

DRUG DISCOVERY

Accelerating cancer therapeutics through world-class expertise and collaborations.

WHERE CANCER RESEARCH MEETS TRAILBLAZING TECHNOLOGY

Harnessing the power of engineering to build devices and tech that will transform the medical field.

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Innovation Insider is a Cancer Center at Illinois publication that highlights the interdisciplinary and translational work of CCIL faculty, staff, students, and external partners.

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Special Thanks to Elizabeth Song for her contributions to this issue

DIRECTOR'S NOTE

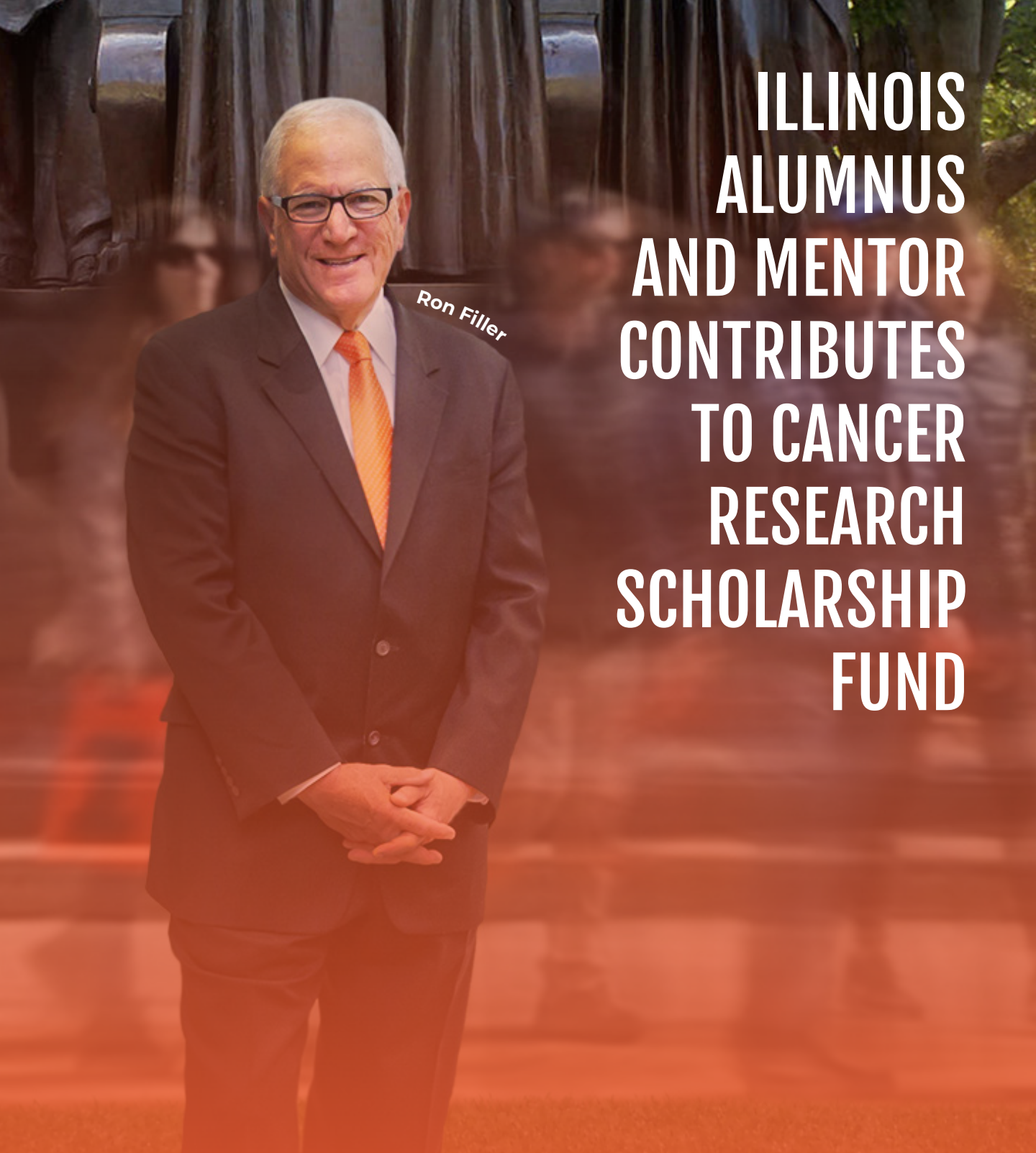
When COVID-19 reached the US in Spring 2020, massive shortages and shutdowns were sweeping across communities. As the Director of the Cancer Center at Illinois, one of my biggest priorities was ensuring that my staff, students, lab members, and their families were safe and secure, and our focus shifted to supporting the needs of the employees and research teams. Despite uncertainty and rapid changes at the CCIL, the people around me kept saying over and over, "How can we help?" "How can we keep moving forward?" "What can I do?"

The statistics on cancer diagnosis and survival rates are always on the minds of cancer center staff. As COVID-19 transformed medical care, the impact it would have on cancer patients was not lost on us. According to the American Cancer Society, the focus on COVID-19 treatment has delayed cancer interventions and screenings, leading to an increase in later stage cancer diagnoses and lowering the chance of patient survivability. This issue has become a concern at cancer centers around the country. I am proud to walk beside CCIL researchers and administrative team members who wanted to forge ahead, even remotely, to ensure that cancer research progress would continue. This issue of Innovation Insider is dedicated to the science, to the research, and to the accomplishments of the entire CCIL team. We usually use the term "innovation" to discuss our breakthroughs in technology, but it has taken on a deeper meaning amidst the pandemic. The CCIL is innovating in all areas – in how we work remotely, how we provide educational opportunities, how we organize projects and meetings, and how we conduct research safely.

In Innovation Insider, you will learn about the advancements we have made in Spring 2021. At the beginning of the year, World Cancer Day gave our scientists an opportunity to share the inspiration behind their cancer research journeys. Collaborative projects between Illinois faculty are creating transformative outcomes – Brendan Harley and Paul Hergenrother have teamed up to tackle glioblastoma, the most aggressive form of brain cancer. Several CCIL grant recipients – Taher Saif, Prasanth Kannanganattu, Zeynep Madak-Erdogan, and Hee-Sun Han – have grown their ideas from our initial seed grants to large, self-sustaining projects that will positively impact the cancer research landscape. Though it has been an especially challenging year for our students, the Cancer Scholars Program trainees stepped in to provide support for the incoming, fully remote freshman class by creating a mentor program.

As I read through this issue, in spite of the above statistics, it made me feel hopeful about the future. The Cancer Center at Illinois has some of the greatest minds in science, engineering, and technology working to change the numbers. Our technology will improve cancer diagnostics, leading to quicker intervention measures. Our discoveries will provide patients with personalized targeted treatments, that are easier on the human body, and ultimately, will save lives.

Rohit Bhargava, CCIL Director



ILLINOIS ALUMNUS AND MENTOR CONTRIBUTES TO CANCER RESEARCH SCHOLARSHIP FUND

SUPPORT CANCER CENTER AT ILLINOIS EDUCATION

Donor support creates transformative career opportunities for future and current Illinois students. Cancer Center at Illinois donors have played an integral part in developing and funding cancer-focused educational opportunities and scholarships for students.

When Ron Filler (LAS '70) learned about the groundbreaking research conducted at the Cancer Center at Illinois (CCIL), he knew he needed to bring his "Filler Effect" – the spirit of giving and mentorship – to support cancer research education.

"My Dad died of lung cancer, and unfortunately, I've lost many members of my family this way," Filler said. "I think very highly of the cancer research at the Cancer Center at Illinois. And I wanted to help support students who want to help save someone else, even if it's not a cure, but can help alleviate someone's pain or end suffering, then it's worth it."

Through providing funding for cancer research, Filler is honoring his father, the man who inspired his kindness and generosity. Filler grew up in a small country town in northwest Tennessee. Solidly middle-class, there was not a lot of extra to give out, but what the Filler's could give went to those in need.

"My Dad would literally help anyone who didn't have as much as we had. Not that we had a lot, but he always found a way," Filler said. "My Dad helped to finance my next-door neighbors' college and medical school education – and he came back to our small town to become the OB/GYN. He said he never forgot what my parents did for him. The spirit of helping and giving came from my Dad, and I've always taken that belief that if you have the opportunity you should try and give back."

Following in his father's footsteps, Filler is now providing support for college student and aspiring scientist, Ege Onal, an undergraduate in bioengineering and student in the CCIL's Cancer Scholars Program.

"It truly means a lot to receive the Filler Scholarship, and I got emotional when I learned that I had received it. Having role models, like Mr. Filler, strengthens my hope for the future and motivates me to one day give back to students and the University," Onal said. "It is my utmost honor to receive this award."

Onal conducts cancer research in the lab of Brian Cunningham, CCIL Research Program Leader and professor of electrical and computer engineering. Their research group has been on the forefront of cancer diagnostic technology, and Onal contributed to a project that can quickly detect cancer biomarkers with a small sample of blood.

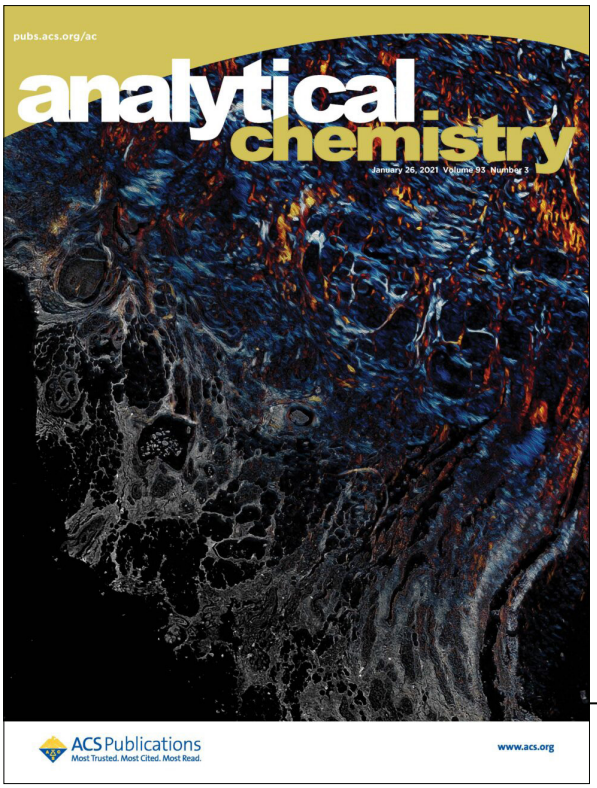
"Cancer is a disease that has been around since ancient times, and it remains one of humanity's biggest challenges. One day, I believe we will alleviate all known cancer, but it can't be achieved singlehandedly; it is something we can accomplish hand-in-hand," Onal said. "For the future, my goal is to pursue cancer research by standing on the shoulders of many giants that came before me. I believe that one day we will beat cancer together."

CANCER IMAGING RESEARCH AT THE CCIL

Many members of the CCIL's Cancer Measurement Technology and Data Science (CMD) program focus on bringing imaging diagnostics, especially rapid and molecularly inspired, to the patient. These are some of the members bringing Illinois cancer imaging research to national and international attention.

Rohit Bhargava

Professor, Bioengineering



Analytical Chemistry, January 26 2021; cover image of infrared absorbance images of breast tissue from Bhargava's research

An infrared spectroscopic microscope has been developed in CCIL Director Rohit Bhargava's lab. The instrument enables researchers to obtain optical measurements of molecular conformations and orientations from biological samples more quickly and accurately by using a quantum cascade laser.

"This project was possible only by bringing together thinking from different fields," Bhargava said. "It's in our DNA ... to take that kind of approach to solving problems."

READ MORE: GO.ILLINOIS.EDU/BHARGAVA_IMAGING

Hua Li

Research Associate Professor, Bioengineering

Since receiving $2M from the National Cancer Institute for her research on head and neck cancers, CCIL member Hua Li has been continuing to further the field of image-guided radiation therapy. Li aims to provide optimal images with each imaging modality to support clinicians and ensure accurate diagnosis and treatment for patients.

“Imaging plays a very critical role in the diagnosis and treatment of cancer and other diseases. It touches all aspects of the diagnostic and treatment workflow, so there are many opportunities for me to apply my expertise,” Li said.

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Pengfei Song

Assistant Professor, Electrical and Computer Engineering

Pengfei Song and Shigao Chen (Professor, Mayo Clinic College of Medicine) were awarded $2.2M from the US Department of Defense for their collaborative development of a new 3D multimodal ultrasound imaging technique to more reliably screen women with dense breast tissue for breast cancer.

“Now is the time to revisit ultrasound… Powerful functional ultrasound modalities such as elastography and microvessel imaging, especially when paired with machine learning, can be the answer to the screening issue,” Song said.

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World Cancer Day 2021

For World Cancer Day this year, we asked our researchers to share their inspiration and commitment in joining the fight against cancer. Here are some of their stories.

CECILIA LEAL

Associate Professor, Materials Science and Engineering

"My mother, Benilde Leal, and her two siblings died relatively young of a rare cancer: liposarcoma. When she died, I was working as a researcher at a cancer hospital. I realized that my choice of pursuing basic research and engineering can greatly impact the advancement of cancer treatment.

My mother always told me: work hard, honestly, and put your heart into it. By doing exactly that, I hope that my work will contribute to our understanding and defeat of this tragic disease," Leal said.

LIQIAN MA

PhD Candidate, Nelson Lab

"To me, cancer has the face of my grandmother, Chang'e Wang, who was diagnosed with esophageal cancer. She underwent radical surgery for middle and lower esophageal squamous cell carcinoma. I was too little to grasp all of these medical terms, but I knew one thing — I wanted my beloved grandmother to be alive, to not suffer that much, and continue to be my superhero of everyday life.

As a cancer researcher, I hope to not only advance cancer therapeutics but also reduce the short-term and long-term adverse events associated with treatment regimens," Ma said.

OCTOPUS-INSPIRED TECHNOLOGY COULD IMPROVE CANCER TESTING AND TREATMENTS

At the intersection of cell engineering and biomaterials, Hyunjoon Kong, professor of chemical and biomolecular engineering, approaches cancer with big questions and even bigger ideas. Kong and his team have developed cephalopod-mimicking technology to assist in transferring thin sheets of cell clusters and bioelectronic sensors.

The project started as a solution to the lab's own issues with handling thin materials. However, they quickly realized the broad applications of the suction cup tool, including in cancer drug delivery and cell therapy. Now, Kong is leading a new Multi-Cellular Engineered Living Systems (M-CELS) theme within the Carl R. Woese Institute for Genomic Biology.

"Our research will allow people to see how normal and cancer cells are communicating with each other. The question mark is around the balance between normal and cancer cells and how they communicate to develop or overcome cancer," Kong said.

READ MORE: GO.ILLINOIS.EDU/KONG

CANCER SCIENTISTS ACROSS DISCIPLINES COLLABORATE TO DEVELOP BRAIN CANCER TREATMENT

Several Cancer Center at Illinois members are joining forces with scientists from the Mayo Clinic and Georgetown University on an expansive project targeting improved treatment for glioblastoma (GBM), the most aggressive form of brain cancer. The team, led by Brendan Harley, professor of chemical and biomolecular engineering, recently received a $3M grant from the National Cancer Institute (NCI) for their research which will unite the cell biology, bioengineering, and chemistry behind cancer drug development.

Glioblastoma is historically difficult to treat, with only a 25% survival rate over five years. When a cancer patient is diagnosed with GBM, they will most likely be undergoing surgery to remove the tumor – which is made significantly more difficult due to its sensitive location.

Brendan Harley

"Glioblastoma patients tend to have tumor re-occurrences within six to seven months of the surgery, and it's within centimeters of the tumor margin," Harley said. "It's caused by the cancerous cells that could not be removed. This issue is what got our team really interested in how we can develop better therapeutic treatments."

Harley, also a CCIL Research Program Theme leader, is an expert in building tissue microenvironments, by using bioengineering techniques to re-create the brain tissue. His lab is partnering with the Mayo Clinic and Rebecca Riggins, associate professor of oncology at Georgetown, to provide cell lines engineered to be resistant to temozolomide (TMZ), the primary chemotherapy used to treat GBM today.

Patient-derived cell lines, provided by Dr. Jann Sarkaria of Mayo Clinic who is another investigator on this project, bring another key element of the work. They are developing a biomaterial that simulates the vascular environment in the brain in order to understand how the tumor microenvironment can promote GBM cell resistance to drugs.

"When you treat a patient with TMZ, it causes damage to the DNA in the cancerous cells, causing them to die. However, these cells are able to avoid this damage in a number of ways, but a primary way is through MGMT [a DNA repair enzyme]," Harley said. "TMZ induces a mutation to the cancerous cell's DNA to destroy it, but MGMT can reverse that."

"So if a patient is MGMT-positive, they are more likely to be resistant to TMZ. Unfortunately, more than 60% of GBM patients are MGMT-positive, so the current frontline drug is given to GBM patients who have the primary resistance to the treatment living in their bodies," Harley said.

Harley and his team have shown that the brain vasculature mimics they have developed provide new insight into MGMT resistance. If you are MGMT-negative, you have a two-year survival rate of 50%, but if you are MGM- positive, you only have a two-year survival rate of 15%.

During a separate project, Harley and Paul Hergenrother, professor of chemistry and the CCIL's Deputy Director, realized that Hergenrother's expertise in cancer therapeutics could aid the team in addressing MGMT.

"Since we knew the high level of resistance because of MGMT, my lab thought that we could design a compound that applies another mutation to the DNA that would not get removed, as well as something that gets into the brain more efficiently," Hergenrother said. "The

Paul Hergenrother

Harley lab will develop more predictive models, which will help us to evaluate the success of the cancer agents we create at a more rapid pace."

The research team will explore how they can create a mutated version of TMZ that MGMT cannot remove, allowing for this new version of TMZ to successfully destroy cancerous cells. This grant is a part of the NCI's Cancer Tissue Engineering Collaborative which will support the team's efforts to better understand the physiological processes driving cancer progression and drug resistance.

"This program is committed to supporting research groups that are pushing the boundaries of tissue engineering technologies for cancer," Harley said. "It connects us to both collaboration opportunities as well as what challenges our colleagues are facing so that we can work together to address them."

Harley is the Robert W. Schaefer Professor of Chemical and Biomolecular Engineering and a research theme leader in the Carl R. Woese Institute for Genomic Biology (IGB). Hergenrother is the Kenneth L. Rinehart Jr. Endowed Chair in Natural Products Chemistry, a research theme leader in IGB, and the Director of the NIH Chemistry-Biology Interface Training Program.

CCIL GRANT RECIPIENTS: WHERE ARE THEY NOW?

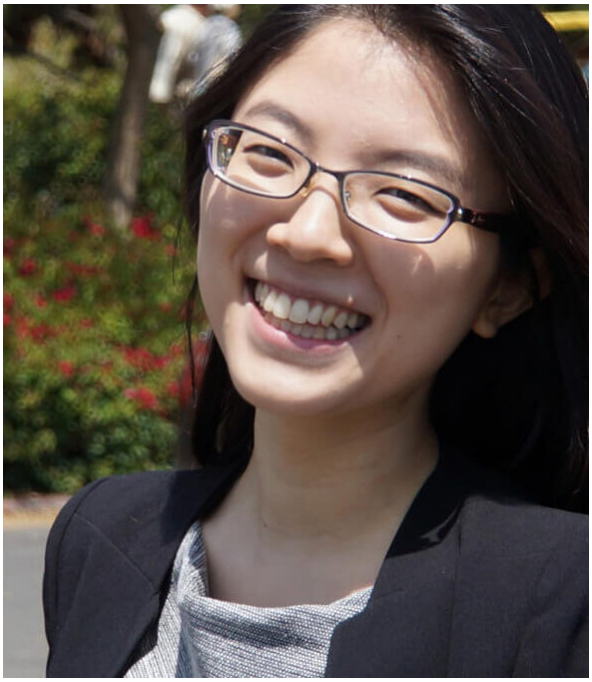
Taher Saif

Saif, professor of mechanical science and engineering, has spent the past decade applying his expertise towards fighting cancer. Saif's lab has been working on an extensive project to better understand the effect of tumor stiffness and force of tumor cells. His current projects have primarily focused on colon cancer.

A 2019 CCIL Planning Grant award has allowed Saif to push his research to where it is today — and the next steps could have an impact on how cancer is treated in the future.

READ MORE: GO.ILLINOIS.EDU/CELLFORCE

"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 ... All of these ideas could have gone down the drain without the grant funding," Saif said.



Hee-Sun Han

Han, assistant professor of chemistry received a 2020 CCIL Seed Grant supporting her lab's development of a new imaging system and a computational model to analyze the interactions between RNA that code for protein and the other 90% of regulatory RNA.

"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 infer RNA interactions," Han said.

The Han Lab is developing new technologies in hopes of understanding how individual cells or viruses work together to drive system level functions.

READ MORE: GO.ILLINOIS.EDU/HAN

Prasanth Kumar V. Kannanganattu

Kannanganattu, professor of cell and developmental biology, was awarded a 2019 CCIL Seed Grant in support of his research of the characterization of oncogenic noncoding RNAs in breast cancer progression and metastasis. Kannanganattu's studies focus on MALAT1, a long non-coding RNA (lncRNA) that is highly upregulated in several subtypes of breast cancer and heavily affects patient survival rates.

This research has been further funded by a $1.25 National Institutes of Health research grant. "The support from the CCIL seed grant and cross-campus collaborations helped answer key questions, created a much stronger proposal, and was instrumental in obtaining the R01," Kannanganattu said.

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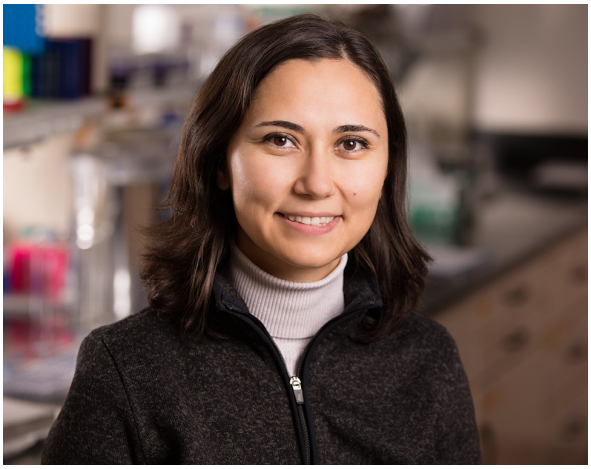
CANCER CENTER AT ILLINOIS RESEARCH – IN THE NEWS

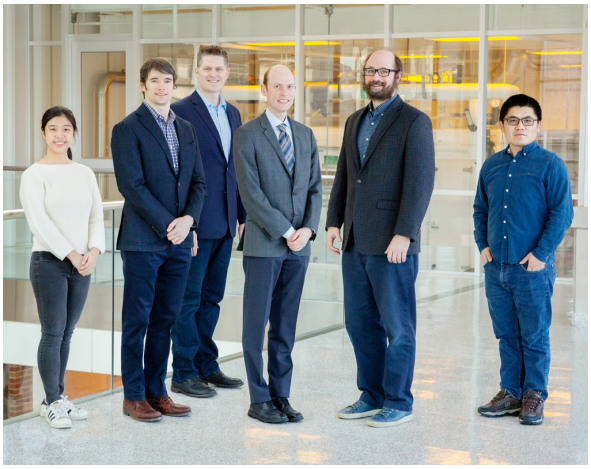


Illinois Researchers Investigate Liver Toxicity

A team led by CCIL scientist Zeynep Madak-Erdogan and CCIL Director Rohit Bhargava developed a gene biomarker technique that can predict toxicity and liver cancer, which can be caused by exposure to toxic compounds.

"We are assessing the best prediction techniques and finding the best indicators for liver toxicity... Now we can just treat a few mice for 24 hours, collect livers, look at the biomarkers we identified, and predict whether the animal will potentially develop liver cancer or not," Madak-Erdogan said.

READ MORE: GO.ILLINOIS.EDU/LIVER_TOX



Immune Response to Obesity

A team including CCIL researchers Andrew Smith, Mark Anastasio, and Erik Nelson are studying inflammation in fat tissues, which are more prone to developing type 2 diabetes, cancer, and cardiovascular disease. The researchers employed 3D microscopy to determine the volume, number, size, and distribution of the fat tissue.

"Right now, we know that some patients are overweight but metabolically healthy, while others are underweight and metabolically unhealthy," Smith said. "We believe that having the ability to look deep into the microenvironments with fat tissue may unlock some of the reasons why this is."

READ MORE: GO.ILLINOIS.EDU/3D_ADIPOSE

2021 Arthur C. Cope Award

David Sarlah, professor of chemistry, was presented this award by the American Chemical Society for his work with arene paraphotocycloadditions. Sarlah is also a recipient of a CCIL Seed Grant for a project that seeks to understand the role of minor cannabinoids on immune cells involved in lung cancer metastatic progression.

"Being part of this academic lineage is a tremendous honor and responsibility, and I use my passion for synthesis to motivate and inspire students around me," Sarlah said.

Alternative Pain Killers

Illinois researchers have found that lipid epoxides are effective in interrupting pain and inflammation pathways. The study, led by Aditi Das, professor of comparative biosciences, is part of a long-term effort to understand the potentially therapeutic byproducts of lipid metabolism.

"Understanding pain regulation in the body is important because we know we have an opioid crisis. We're looking for lipid-based alternatives ... that can be used to design therapeutics to reduce pain," said Das.

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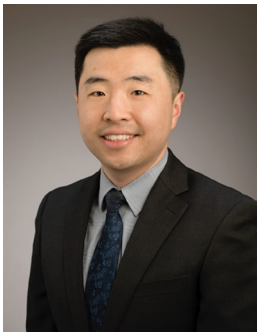

Ultrasound Expertise

Pengfei Song, assistant professor of electrical and computer engineering, received a National Institute of Biomedical Imaging and Bioengineering Trailblazer R21 Award for his work with ultrasound localization microscopy (ULM). This technique has clinical significance for diagnosis, treatment, and therapy development.

"ULM stands out because it produces spectacular images of tissue microvasculature in vivo at depth... As such, ULM rapidly gained traction and found many applications such as cancer and neural imaging," Song said.

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Identifying Hormone-Therapy Resistance

A team from Washington University and the University of Illinois are developing techniques to better predict hormone therapy response in breast cancer patients. John Katzenellenbogen, professor of chemistry, has designed an imaging agent, FFNP, that attaches to progesterone receptors and can be identified via a positron emission tomography (PET) scan.

READ MORE: GO.ILLINOIS.EDU/FFNP

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 Program.

Join us in the fight against cancer. Support a number of CCIL initiatives.

Infrastructure

Cancer Center Research Building

Provide a home for our scientists and their labs to undertake ground-breaking research, supported by world-class physical resources

Centers of Excellence

Support a specific research initiative in an interdisciplinary manner. Endowing a center of excellence will support cancer changing research, faculty, students, and equipment

Innovation

Director's Innovation Fund

An unrestricted fund to be used at the Director's discretion to support pioneering, high impact research and translation, new innovative programs, and events

Directorship

Assist the Cancer Center at Illinois in retaining and supporting our current Director and invest in the recruitment of future leaders

Instruction

Educational Programming

Train and recruit future cancer researchers. Support high school through postdoctoral students working in cancer research labs

Professorships

Support faculty excellence, recruitment, and retention

Learn more about how you can support the Cancer Center at Illinois.

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CANCER SCHOLARS MENTOR PROGRAM CONNECTS STUDENT RESEARCHERS

The CCIL Cancer Scholars Program (CSP) provides undergraduate students with the unique opportunity to engage in interdisciplinary student learning experiences through research and challenges. Recently, the program launched a new mentoring model between senior- and under-classmen.

Many of the mentees stated that the program has given them a glimpse into their future careers as well as the confidence they need to reach their goals.

"The mentor program built my confidence for reaching out to do something more than just my academics. From the Cancer Scholars Program, I was able to pick up a research position and help out with the research project. I don't think I would've been able to do that if I didn't have my mentor, Annie Hart, or the Cancer Scholars program," Romir Sigla said, mentee and undergraduate student in bioengineering.

The mentors also gained a lot from the experience of fostering relationships with their mentees, seizing this chance to become guides for under-classmen and "pay it forward."

"I thought it was a really great way to give back. I know as a freshman coming into college, it was a scary time trying to navigate academics and research — among other things. Since I already navigated through it and supported my friends, it was nice to help out freshmen and give them advice," Annie Hart said, mentor and undergraduate in bioengineering.

READ MORE: GO.ILLINOIS.EDU/CSPMENTOR

STUDENT SPOTLIGHT: AMIR MOGHADDAM, TiMe PROGRAM

The TiMe Training Program invites graduate students to advance their professional development as researchers. Supported by a T32 grant from the NIH, trainees engage in the integration of three technological approaches: sensing and imaging, bioengineering, and computational modeling.

Amir Moghaddam, PhD candidate in mechanical science and engineering, focuses on the biophysical properties of soft tissues in his research. His work can help improve the characterization of the tissue microenvironment and uncover links between tissues' mechanical properties and their function.

What sparked your interest in science, technology, and cancer research?

My parents influenced me a lot. They were both health care providers and placed a high value on curiosity, learning, hard work, and perseverance. I was very curious about what they did and they patiently answered my questions. My interest gradually evolved and I became interested in the underlying mechanisms that cause diseases.

What kind of research are you working on? What is something that most people might not know about your work?

My research focuses on the biophysical properties of soft tissues, such as microstructure, composition, and mechanical properties. We develop novel techniques to improve the characterization of the tissue microenvironment and these techniques can be applied to a range of tissue types as well as healthy, diseased, or regenerating tissues. Many people are not aware of the link between the mechanical properties of tissues and their function; changes in the mechanical microenvironment of tissue can lead to diseases and unwanted conditions such as preterm birth.

How has being in the TiMe program helped you grow?

In the TiMe program, I have had the opportunity to connect to nice people and great scientists from various backgrounds. This allowed me to look into my research questions from new perspectives and learn more about the topics and ideas that I was less exposed to.

Have you had any interesting / unexpected breakthroughs or discoveries?

I have repeatedly observed interesting and unexpected links between the tissue microstructure and its mechanical behavior. These correlations do not always follow the accepted views about tissue behavior.

What sort of impact will your research have on society?

Preterm birth affects millions of babies and their families each year; my work on this area provides a better understanding of the underlying mechanisms of cervical remodeling and paves the way for predicting and preventing this condition. The methods that we have developed have a direct and indirect impact on the areas of tissue mechanics, tissue engineering, and medicine. Our findings can be used to develop fast, reliable, and clinically applicable tools for the diagnosis of diseases related to tissue structure and mechanical properties, which in turn improve patient care.

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