CLOSER TO A CURE

WITH EVERY

SMALL STEP

PURDUE UNIVERSITY
CENTER FOR CANCER RESEARCH

ANNUAL REPORT 2018-19

2.2%

decrease in mortality from 2016 to 2017

Unifying for Progress

A message from Timothy Ratliff

ROBERT WALLACE MILLER DIRECTOR
PURDUE UNIVERSITY CENTER FOR CANCER RESEARCH

Cancer research has had a strong impact on treatment outcomes for cancer patients. The latest statistics show a dramatic decrease in mortality that many believe is the result of new immunotherapy treatments. Of course, prevention, early detection as well as the development of new chemotherapies also have contributed to the improved survival statistics.

Recent studies released by the American Cancer Society showed an overall 2.2% decrease in mortality from 2016 to 2017, which represents the latest data we have available for complete analysis. Within the overall decrease, we see that lung cancer mortality dropped by 5% and women's cancers by 4%. These are unprecedented numbers, and Purdue Center for Cancer Research scientists are working to make the numbers even better in the years to come.

PCCR researchers are working to better evaluate the differences between normal and cancer cells, enhance detection through better imaging technology, develop new and more efficient approaches for synthesizing cancer-treatment drugs, and explore new, highly impactful therapeutics. In this Annual Report, we highlight several of our faculty involved in these studies, including Nadia Lanman, who is leading the effort to harness large data sets to enable more sophisticated studies to understand what makes a cell a cancer cell; Darci Trader, who is leading the effort to develop faster cancer-screening techniques; and David Thompson, who is leading the effort to automate drug synthesis to produce drugs inexpensively. What amazing science! It is a privilege to be associated with all the outstanding PCCR scientists.

It is important to say that we cannot accomplish our objectives without your help. Your support enables us to test new ideas and push our science forward at a faster pace.

About 10 years ago, PCCR researcher Phil Low had developed new targeted therapy for prostate cancer but it was not moving toward the clinic. Because of the support from many of you, the PCCR sponsored and paid for an early-stage clinical trial in collaboration with researcher Thomas Gardner at Indiana University Simon Cancer Center.

"It is important to say that we cannot accomplish our objectives without your help. Your support enables us to test new ideas and push our science forward at a faster pace."

The results of this trial were spectacular, and led Purdue startup Endocyte Inc. to move the technology into therapeutic trials. Endocyte, a biotech company built around Low's research, has since been purchased for $2.1 billion by pharmaceutical company Novartis AG. The prostate cancer treatment that the PCCR launched has moved forward and currently is in the last stages of clinical studies. We anticipate that it should be submitted to the Food and Drug Administration soon to request approval for use in patients with advanced prostate cancer. We are very close to introducing a new treatment for advanced prostate cancer that we believe will make a big difference in survival of men with this disease.

These remarkable advancements would not have happened — or, at least, would have been significantly delayed — if we had not obtained support from our donors. Thank you! There is more to come, and we are very excited to partner with you to help make cancer a controllable disease.

WALTHER

CANCER FOUNDATION

Inspiring Continued Support

The Walther Cancer Foundation is a private grant-making foundation, based in Indianapolis, that supports and promotes interdisciplinary and inter-institution cancer research at the Purdue Center for Cancer Research and similar institutions. The foundation has invested almost $150 million in cancer-focused research, including more than $21.5 million in PCCR research grants.

PCCR support from Walther includes a $10 million matching funds gift, established in 2017. In part, this gift was designed to inspire those who are leading the fight against cancer to give endowed gifts in support of the PCCR and its groundbreaking research.

$10 MILLION

matching funds gift, established in 2017

WE ARE AT THE FRONTIER OF SCIENCE. THE STUFF WE'RE DOING, IT'S NEVER BEEN DONE BEFORE."

AHMED MUFTI

Purdue University drug developer and chemistry professor David Thompson dedicates himself to improving people's lives. So when he read that the skyrocketing price of chemotherapy drug lomustine was sending patients into bankruptcy — or causing them to quit the medication altogether — "I got really torqued," he says.

Lomustine has been an effective treatment for glioma and Hodgkin lymphoma since 1976. Although it's been off-patent for years, the company now distributing the drug has been steadily raising its price. There is no generic version.

"It was just a perfect storm of bad," Thompson says. "And I thought, 'You know, we can actually do something about this. We have the capacity here at Purdue.'"

In less than a year, Thompson, whose initial work on the problem was funded by U.S. Department of Defense's Defense Advanced Research Projects Agency (DARPA), had published a paper describing a novel "continuous" manufacturing process that can reduce the cost of lomustine.

Most drugs today are created in a "batch" process, wherein production is a series of discrete steps. By contrast, a continuous manufacturing process is a series of steps in a closed, self-contained system, like an assembly line. This process is far more efficient — and safer.

MAKING LOMUSTINE AT PURDUE

But the new process requires new FDA approval, which spurred Thompson to manufacture lomustine in his own lab.

Swiftly, Tim Ratliff, the Robert Wallace Miller Director of the Purdue Center for Cancer Research, connected Thompson with a group of Purdue alumni who helped him establish a company, Continuity Pharma.

Ratliff also provided vital startup funds from the Boilermaker Health Initiative, funds that support new drug companies through the so-called "dead zone" between discovery and initial clinical trial.

"We are gearing up to drive this process across the finish line to FDA approval," Thompson says.

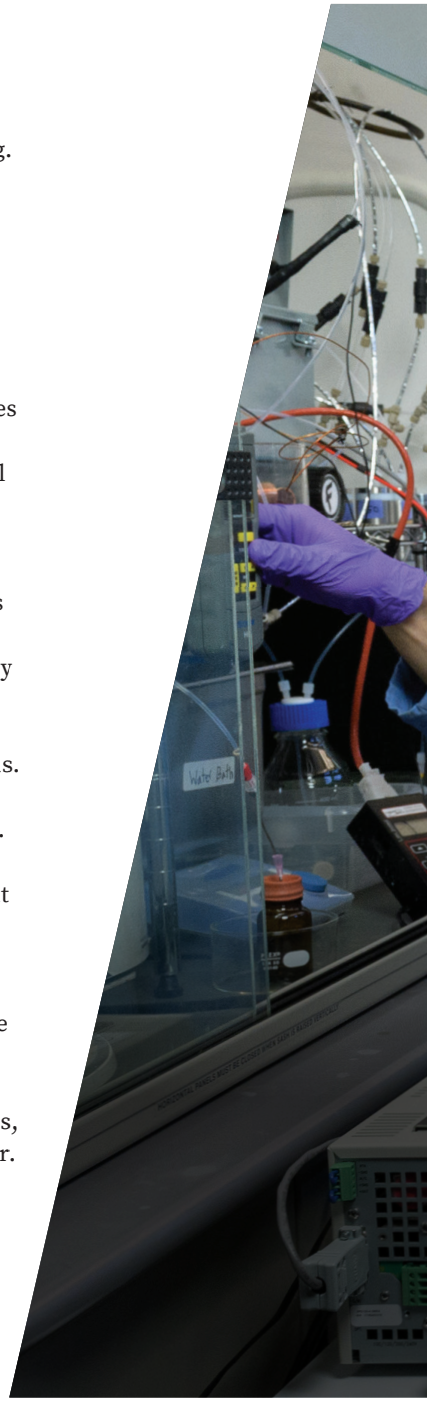
HANDS-ON BOILERMAKERS

Building the production line in the Thompson Lab are graduate students in the Department of Chemistry and the Davidson School of Chemical Engineering. Their goal is a completely self-contained production line, the first continuous manufacturing process for an anti-cancer pharmaceutical ingredient. Also, they plan to apply these methods to the continuous synthesis of new drug candidates emerging from PCCR and to help support early-stage clinical trials of those compounds.

Jaron Mackey, a fourth-year PhD student, says that Purdue's reputation in pharmaceutical manufacturing was the primary reason he chose Purdue for graduate school. "We have this pilot plant right here on campus. Opportunities like this don't come about every day," he says.

Along with former PhD student Zinia Jaman (now working for DuPont), first-year graduate student Ahmed Mufti helped scout out the conditions for the chemical reactions needed to manufacture lomustine and develop the continuous process, according to Thompson's paper.

"We are at the frontier of science," Mufti says. "The stuff we're doing, it's never been done before."



DAVID THOMPSON

Making a Cancer Drug Affordable

PURDUE CHEMIST DEVELOPS NOVEL MANUFACTURING PROCESS
FOR CHEMOTHERAPY DRUG

> CANCER IN PARTICULAR HAS TOUCHED THE LIVES OF MANY OF OUR FRIENDS AND FAMILIES, SO BEING ABLE TO CONTRIBUTE TO BETTER DETECTION METHODS IS VERY SPECIAL TO US."

Treatment options for cancer have increased significantly the past several years, but early detection remains one of the best methods of treatment. For patients waiting for the results of a cancer-screening test, this waiting game can feel like an eternity — especially when early diagnosis and quick action are tied to better outcomes.

According to Cancer Research UK, more than nine in 10 bowel cancer patients will survive the disease for more than five years if diagnosed at the earliest stage. More than 80% of lung cancer patients will survive for at least a year if diagnosed at the earliest stage compared with around 15% for people diagnosed in the most advanced stage of disease.

A passion to improve screening techniques for a wide variety of diseases, including cancer, motivated PCCR researcher Darci Trader to develop a technique to detect cancer cells faster. Trader, an assistant professor of medicinal chemistry and molecular pharmacology, created a process to analyze proteins expressed on cancer cells.

"Identifying cancers early is correlated to better patient outcomes," she says. "Cancer in particular has touched the lives of many of our friends and families, so being able to contribute to better detection methods is very special to us."

TARGETING PROTEINS

Trader says pathogen or cancer cell identification often relies on culturing a sample, which can take several days. Her team's novel screening technique speeds up the process by screening one-bead-one-compound libraries against biological targets, such as proteins or antibodies. This technique provides an alternative to current methods, which require very specialized equipment and complex analysis to measure the proteins that are binding small molecules.

Trader says this screening method also could be developed into a rapid, sensitive technique to identify cancer cells in patient blood samples and expedite cancer diagnoses. Researchers think the method will be sensitive enough to detect forms of cancer in very early stages.

"The activity of the biological target being tested also does not need to be known or monitored with the Purdue technique, which increases the types of proteins that can be screened," Trader says.

Development of this new test will involve mixing a biological sample, such as cancer cells or blood plasma, with an emitting fluorophore in the near-infrared range. The protein is allowed to interact with small molecules, so doctors and scientists can measure the intensity of the light produced by the protein binding the small molecule. Certain intensity rates can indicate the presence of cancer cells or other pathogens in the body.

"We hope to be able to develop it to a point where it can be marketed as a diagnostic technique for a variety of diseases using small molecules synthesized on beads that are specifically recognized by specific cell types," Trader says.

DARCI TRADER

Hurrying up the Wait

PHARMACY RESEARCHER DEVELOPS
IMPROVED SCREENING TECHNIQUE

THIS RESEARCH WOULD ENABLE US TO – WITHOUT PUTTING A PERSON THROUGH CHEMOTHERAPY – PREDICT HOW THEY'RE GOING TO RESPOND TO IT AND COULD ENABLE PHYSICIANS TO TAILOR TREATMENTS TO THESE PATIENTS."

If you run into Nadia Atallah Lanman in an airport, you might notice that she's carrying a book of puzzles and mathematical riddles. Lanman's innate penchant for solving puzzles led her to the field of bioinformatics — the science of collecting and analyzing complex biological data. Fortunately for the Purdue Center for Cancer Research (PCCR), her problem-solving proclivity and high-level software-coding skills are helping optimize Purdue cancer research.

"In the field of bioinformatics, you can connect different types of data and sort through massive data sets," Lanman says. "You can figure out what seems important and what's less important.

"In one case, we are trying to figure out what's involved in developing chemotherapy resistance in a very aggressive type of lymphoma. We're also trying to predict which patients will show resistance to that chemotherapy."

In this work, Lanman is supporting the research of David Nolte, the Edward M. Purcell Distinguished Professor of Physics and Astronomy; John Turek, professor of basic medical sciences; and Michael Childress, associate professor of veterinary medical oncology. The research uses Doppler light scattering to determine a patient's prospective response to chemotherapy.

"This research would enable us to — without putting a person through chemotherapy — predict how they're going to respond to it and could enable physicians to tailor treatments to these patients," Lanman says. "I've been brought in to do some of the computational analyses. We are trying to help learn more by combining these research findings with other types of data — specifically, which genes are turned on or off."

IDENTIFYING PATHWAYS

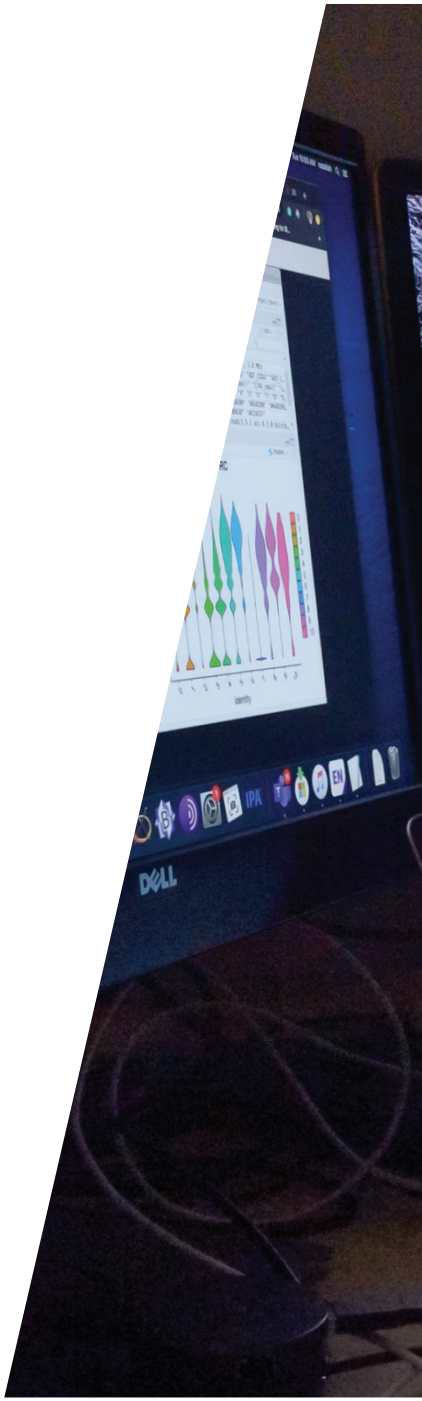
Lanman works in bioinformatics, predictive modeling and data science as a member of the Cancer Bioinformatics Core (C3B), a shared facility between Indiana University Melvin and Bren Simon Cancer Center and the PCCR. The C3B is supported by the Walther Cancer Foundation, which has given more than $16 million in grants to support cancer-fighting work at Purdue.

Timothy Ratliff, Distinguished Professor of Comparative Pathobiology and the Robert Wallace Miller Director of the PCCR, also is taking advantage of Lanman's bioinformatics expertise to support his work on prostate cancer.

"This work is aimed at identifying drivers and potential new methods for detecting prostate cancer," Lanman says. "We identified pathways that seem to be involved in prostate cancer development and could be potential targets for future treatments."

Lanman says that when it comes to fighting cancer, athletic rivals Purdue and Indiana are on the same team, and are grateful for the Walther Cancer Foundation support.

"I'm very passionate about cancer prevention and treatment, as well as tackling some of these really resistant cancers. I know our colleagues at IU also are passionate about it," Lanman says. "Because I'm working in collaboration with IU, I'm able to make a larger impact than I would individually."



NADIA ATALLAH LANMAN

Riddles and Remedies

PURDUE BIOINFORMATICIAN LAYS
FOUNDATION FOR CANCER SOLUTIONS

CONTINUING A LEGACY

Student duo appointed to Director's Advancement Board

A pair of Purdue University students who have personal connections to cancer will help carry on the legacy of Tyler Trent, a Purdue graduate and superfan who died from a rare type of bone cancer.

Anni Osborne and **Evan Boudreaux** have been appointed as student members of the Director's Advancement Board for the Purdue University Center for Cancer Research. The students will work with the board and leadership from the center to raise awareness of the research and advancements being made at Purdue in the fight against cancer.

Trent died in early 2019 after a battle with osteosarcoma,

a rare form of bone cancer. Trent, an inspiration to many for his faith and grace as he battled cancer and cheered for his Boilermakers, was the first student member of the center's Director's Advancement Board, and he donated his osteosarcoma tumors before his death to be used for research to help others.

"The board decided that having student representation made such a huge impact and we could gain the insights from a younger generation," said Tim Ratliff, a distinguished professor of comparative pathobiology in Purdue's College of Veterinary Medicine and the Robert Wallace Miller Director of the Purdue University Center for Cancer Research.

Osborne, who grew up with Trent and considered him a best friend, plans to become a pediatric oncology nurse.

"Tyler would get so excited when he would tell me about the things he was doing on the board and the kind of research they were doing," Osborne said. "I was ecstatic when I was asked but it also made me cry. I got emotional thinking I would have the opportunity to be a part of something that meant so much to him."

Boudreaux said he jumped at the chance when invited to join the board because his father is a cancer survivor.

"I want to help spread the word among students that incredible research is being done with cancer here at Purdue," said Boudreaux, a member of the Purdue men's basketball team. "What's being done here has and will continue to touch thousands of lives."

FROM HEARTBREAK TO ACTION

Pickett created fund after mother's death

More than 57,000 Americans are expected to be diagnosed with pancreatic cancer in 2020, according to the American Cancer Society. The total is more than 158 diagnoses every day. The overall survival rate is only 9%.

Purdue alumna Jenny Pickett lost her mother, Joyce Fox Jordan, to this terrible disease. After battling the cancer for 23 months, Fox Jordan died in 1993 at age 61. In 2008, Pickett joined with Robin Walsh to create the Jordan-Rieger Fund for Pancreatic Cancer. Walsh's father, Robert Rieger, also died of pancreatic cancer.

"It was of vital importance to me to help establish this endowment," Pickett says. "I know firsthand how devasting pancreatic cancer can be for both the patient and the patient's support network of family and friends."

The chances of surviving pancreatic cancer are much better if it is diagnosed early. The problem is that its symptoms can appear to be those of common illnesses, so it is difficult to catch early.

Fox Jordan was diagnosed with pancreatic cancer after seven months of being treated for other conditions. After searching for the best treatments, hospitals and doctors, Fox Jordan enrolled in a promising clinical trial. She responded to the drug, and the tumor stopped growing — it even showed signs of decreasing in size.

However, doctors soon discovered that Fox Jordan's cancer had metastasized into the liver, which required her to discontinue the experimental treatment. There were few treatment options left, and she ultimately succumbed.

Years later, Pickett spoke with Walsh, whose father had undergone the same treatment as Pickett's mother. They saw that little progress had been made to find new treatments, and decided that awareness and research were desperately needed in order to increase a survival rate that was only 5% at the time. So, Pickett and Walsh established the endowment.

"I was 26 when my mother died," Pickett says. "I was newly married and had not yet started my family. Words cannot describe how heartbroken I was and still am after all these years. The fact that my three children never knew my mom is very difficult."

Recent pancreatic cancer research has led to earlier detection, improved medications and a renewed confidence that a breakthrough could be right around the corner. But breakthroughs come at great expense, and the number of diagnosed cases of the cancer are on the rise.

"A pancreatic cancer diagnosis doesn't have to mean a death sentence," says Timothy Ratliff, the Robert Wallace Miller Director of the Purdue University Center for Cancer Research. "Because of research, more people are surviving the disease. Each day, we get closer to breakthroughs that will allow for sharp increases in survival. The PCCR is grateful for Jenny Pickett's persistent pursuit of a cure for pancreatic cancer."

UP CLOSE:
Roger Fine and Michelle Liratni, both members of the PCCR family, are living proof that even small steps in pancreatic cancer research can save lives. Fine, first diagnosed in 2018, experienced early success but is still fighting the disease. Originally diagnosed in 2012, Liratni has been in remission for eight years.

Roger Fine ▲
Land Surveyor at Fisher Engineering

Michelle Liratni ▼
Administrative Assistant at PCCR

INVESTING IN RESEARCH

In terms of gifts received, funds raised and awards distributed, fiscal year 2018-19 was another outstanding one for the Purdue Center for Cancer Research. Contributions to the $10 million matching funds gift presented by the Walther Cancer Foundation in 2017 rose from $1.6 million to $5.3 million, and more than $614,000 in awards across four core research areas was distributed.

CELL IDENTITY AND SIGNALING

Research Awards	$30,300
Student Awards	$64,314
Total	**$94,614**

TARGETS, STRUCTURES AND DRUGS

Research Awards	$298,711
Student Awards	$61,617
Total	**$360,328**

DRUG DELIVERY + MOLECULAR SENSING

Research Awards	$127,250
Student Awards	$7,000
Total	**$134,250**

NON-PROGRAM STUDENT AWARD

Bioinformatics	$24,960
Total	**$24,960**

TOTAL AWARDS

$614,152

WALTHER CANCER FOUNDATION

MATCHING FUNDS GIFT

Total Amount Raised

$5.3 MILLION

It was another banner year for the Purdue Center for Cancer Research as a leading NCI-designated basic-research cancer center under the leadership of Director Timothy Ratliff.

We continue to benefit from generous donations and the $10 million matching funds gift from the Walther Cancer Foundation.

This support has enabled our 128 researchers, representing seven colleges from 22 departments across the Purdue campus, to make many significant advancements. This includes work by:

- **Phil Low**, who completed Phase III clinical trials of a prostate-targeted radiotherapy effective in treating late-stage metastatic prostate cancer.
- **R. Graham Cooks**, whose desorption electrospray ionization mass spectrometry is being successfully used in the operating room to identify a mutation that is indicative of aggressive brain cancer.
- **Yoon Yeo**, who is working on nanoparticle delivery of chemotherapeutic agents that enhance current immunotherapy.
- **David Nolte** and **John Turek**, who are developing approaches using their Doppler measurement of cell motion to identify chemotherapy sensitivity to osteosarcoma. This project is a collaboration with Dr. Jamie Renbarger and Karen Pollok at Riley Hospital for Children to identify ways to treat each individual osteosarcoma patient.

The late Tyler Trent, a Purdue graduate and the first student member of the PCCR Director's Advancement Board, knew that research is the key. Trent died of osteosarcoma in early 2019, and tumors from Tyler are being used in the project led by Nolte and Turek.

In the end, Trent's family said it best: "Tyler had everything going for him … except a cure." With your continued support, we will find those cures.

CELEBRATING A BANNER YEAR

A message from Marti Schmidt

PCCR Director's Advancement Board Chair

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Center for Cancer Research

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EA/EOU • Produced by Purdue Marketing and Media • EVPRP-19-12435

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