DONALD DANFORTH
PLANT SCIENCE CENTER
DISCOVERY | COMMUNITY | IMPACT

2018 Annual Report

Celebrating 20 years:
Delivering on the Promise

OUR MISSION

Improve the human condition through plant science
Feed the hungry and improve human health
Preserve and renew the environment
Enhance the St. Louis region as a world center for plant science

Letter from the Chair

In 2018, we celebrated an important initiative begun some two decades earlier. Twenty years ago, Bill Danforth and others envisioned the crucial role of plant science in helping solve global challenges. Population growth, longer life spans, and rising living standards around the world were contributing to the consumption of Earth's resources faster than they could be replenished. The mission was deceptively simple: *to improve the human condition through plant science.* The twenty years of hard work toward delivering on that promise continues to bear fruit, as you will read in these pages.

The grand challenge has not waned. If anything, the situation is more urgent. By the year 2050, we will need to grow more food than in the entire previous history of humankind. Using current technology, there is not enough arable land and fresh water to do it. The real challenge for the Danforth Center is now to come up with science and applications that, in fact, provide more food with higher nutrition in a more difficult environment.

Part of the solution will be the work of Danforth Center scientists to unlock drought resistance and many other improvements in our most important food crops. Another part of the solution lies in entrepreneurial innovation. The 39 North district, anchored by the Center, will be the home of innovative companies that will speed the lab-to-market pipeline while providing jobs and investment in the region.

This accelerated research does not happen in a vacuum. The Danforth Center has received crucial and generous support from many partners and friends since our founding. Support from individuals, corporations, and organizations is essential to the work of the Center as its scientists address the challenges facing our home planet. I am heartened by a shared vision of a sustainable, bountiful world for all – and by the reality of the world-class scientists, staff, facilities, and partnerships that can make that vision possible.

John McDonnell

Letter from the President

I often hear the following from Danforth Center visitors and supporters: "Every time I come to the Center, I learn something new!" I love that feedback because, in part, it reflects the fact that we are constantly changing.

Albert Einstein said, "Life is like riding a bicycle. To keep your balance, you must keep moving." Delivering on our mission requires that we keep moving and constantly changing. The kind of research we do today is very different than what we did yesterday, and it requires talented scientists, engineers, mathematicians and support teams with skills to function more productively in the digital age. We seek to make advances in a world that is also changing rapidly.

We engage students and trainees differently than we used to. We've formed new partnerships with Washington University, the University of Missouri, and Saint Louis University to work at the interface between more disciplines. We've been growing differently through shared positions, like those occupied by Allison Miller (with SLU) and Keith Slotkin (with Mizzou). Some of our current facilities would have been unrecognizable just a few years ago due to new automation and advanced imaging.

The ways in which our work reaches the public are also changing, from spin-out companies like RNAissance in partnership with TechAccel, to how we work with companies in 39 North. We communicate through more engaging routes, like TapRoot, a popular podcast by Ivan Baxter and his Washington University collaborator, Liz Haswell.

We evolve as a Center because the needs change. I am grateful to our entire Danforth Center community, including those you hear about regularly and those individuals and teams that work so effectively behind the scenes. And I am grateful to our supporters, without whom our journey would not be possible.

James C. Carrington

Celebrating 20 years:
Delivering on the Promise

A Celebration 20 Years in the Making

400 Guests Celebrate the Center's 20th Anniversary at the Annual Plantasia Gala

A record number of people—including members of the Danforth Society and Center scientists—gathered on November 10, 2018 at the annual Plantasia gala to celebrate 20 years of "Delivering on the Promise." Following a cocktail reception in the McDonnell Gallery, guests gathered in the AT&T Auditorium and Langenberg Theater for the presentation of remarks, interspersed with a suite of videos featuring interviews with important figures in the Center's history and present day, including President James C. Carrington, Ph.D.; Past President Roger Beachy, Ph.D.; John F. McDonnell, chairman; Dr. William H. Danforth, founding chairman; as well as various Center scientists, students, donors, volunteers and supporters.

After the program, guests enjoyed dinner, dessert, music and casual remarks in the McDonnell Atrium and the William H. Danforth Wing Café.

Plantasia is an opportunity to express our gratitude to the members of the Danforth Society, whose generosity and dedication enable the Center to pursue its mission to *improve the human condition through plant science*. Special thanks to our sponsors, co-chairs, and committee members. *See page 37.*

1998

Donald Danforth Plant Science Center officially founded, Dr. William H. Danforth chairman, Ernest G. Jaworski, Ph.D., director

"We see grand opportunities to use science to benefit humankind–to feed the hungry, to protect the world's environment for our grandchildren and great-grandchildren, and to provide discoveries that will help spark the next generation of science-based industry."

- DR. WILLIAM H. DANFORTH, founding chairman

1999

Roger Beachy, Ph.D., begins as president

"What was needed here was different than what was needed... at any other institution we knew of. The Danforth Center was built to stand on its own science... it would have different expectations."

- ROGER BEACHY, Ph.D., former Danforth Center president

Danforth Center building groundbreaking

First Fall Symposium event, a partnership with Washington University in St. Louis

2000

First scientific group joins the Center

"Researchers that want to come here... are not risk-averse. They're usually quite ambitious and they want to achieve something big, something important."

- TONI KUTCHAN, Ph.D., vice president of research and Oliver M. Langenberg Distinguished Investigator

Facilities are organized: Computational Genomics, Integrated Microscopy, Tissue Culture and Transformation

2001

Danforth Center building dedicated and core facilities open

"There was no playbook... How were we going to do this? ... It was terrifying. We had some crumpled up pieces of paper and some great ideas."

- SAM FIORELLO, Danforth Center COO and president of BRDG Park

Friends Committee formed

2003

First NSF Research Experience for Undergraduates program

First Conversations event, moderated by James W. Davis, Ph.D.

Xuemin "Sam" Wang, Ph.D., named first joint faculty member with UMSL

2005

Bill & Melinda Gates Foundation makes first grant to the Center

2006

Danforth Center rated a "Best Place to Work in Academia"

First Plantasia event

Danforth Society founded

2007

Enterprise Rent-A-Car Institute for Renewable Fuels founded by gift of the Taylor family

2008

10th anniversary celebration

Greenhouse Range B opens

Tech Trunks for grades 9-12 developed

"Our education programs offer a lot of students not only science enrichment, but also scientists as role models because we take scientists into schools that are underserved."

- RUTH KAGGWA, Ph.D., science education and outreach manager

2009

First Ag Innovation Showcase (May 18-19)

BRDG Park opens

First spin-off company formed

Danforth Leadership Council formed

Philip Needleman, Ph.D., named interim president

"I had an appreciation of some very special things, what the Danforth Center could be in the next decade."

- PHILIP NEEDLEMAN, Ph.D., former Danforth Center interim president

2010

First field trials of virus-resistant cassava

First Seeds of Change event

2011

James C. Carrington, Ph.D., begins as president

"The foundation was built by pioneers. But we had the opportunity to take the Center to a new level and deliver on the mission on a larger scale."

- JAMES C. CARRINGTON, Ph.D., Danforth Center president

Expansion planning initiated

Danforth Foundation makes final grant: $75M to endowment

2012

Institute for International Crop Improvement established by gift of the McDonnell family

Benson Hill co-founded by Danforth Center scientists

2013

John F. McDonnell named chairman of the board

"The real challenge for the Danforth Center is... to come up with science and applications that, in fact, provide more food in a more difficult environment."

- JOHN F. MCDONNELL, Danforth Center chairman of the board

Bellwether Foundation Phenotyping Facility opens

Greenhouse Range C opens

Young Friends formed

2015

Girls STEAM Ahead partnership with Girl Scouts debuts

First Raspberry Pi Jam

William H. Danforth Plant Science Fellowship esablished by Diana and Roy Vagelos

"The world's problems are our problems to solve, and we are here to actually make a difference."

- ANNE PHILLIPS, graduate student

2016

William H. Danforth Wing dedicated

39 North innovation district announced

"We have global relationships with different organizations... and I wish that they were all as vibrant and as impactful as what we are doing here with the Danforth Center."

- WARREN SCHAFER, Valent Biosciences VP of global R&D and regulatory affairs

1,000th published scientific discovery

2017

Venture Café @ 39 North launches

First Young Friends Party with the Plants event

Blake Meyers, Ph.D., named first joint faculty member with MU

2018

Allison Miller, Ph.D., named first joint faculty member with SLU

"Understanding how plants work, how we can grow better, more efficient, more nutritious crops, that is something we have to do. Whether we want to do it or not, it has to happen."

- ALLISON MILLER, Ph.D., Danforth Center principal investigator and SLU professor of biology

Don MacKenzie, Ph.D., named Institute for International Crop Improvement executive director

10th anniversary of Ag Innovation Showcase

20th anniversary celebration

INVESTING TO ACCELERATE DISCOVERY

Because we have a responsibility to the next generation.

Because human ingenuity can solve our most pressing challenges.

Because we only have one planet.

Because there is no time to waste.

It is up to each of us.

Center Welcomes New Executive Director of the Institute for International Crop Improvement

On April 2, 2018, Donald MacKenzie, Ph.D., joined the Danforth Center as the new executive director of the Institute for International Crop Improvement (IICI). The work of the IICI is dedicated to discovering food security solutions for the developing world. The arrival of MacKenzie represents a step closer to the delivery of improved crops to the people who need them most.

"We are extremely fortunate to have attracted Don MacKenzie to the Danforth Center and IICI," said Jim Carrington, Ph.D., president of the Danforth Center. "His expertise in moving scientific discovery into the marketplace to meet needs of farmers, including smallholder farmers, and consumers is matched by few others."

MacKenzie joins the Danforth Center from his position as the Regulatory Affairs and Stewardship Leader of the Golden Rice Project coordinated by the International Rice Research Institute. His proven track record of working with diverse stakeholder groups to achieve progressive policy outcomes was critical in his role as the Canola Global Regulatory Lead at DuPont Pioneer and Regulatory Affairs Leader for DuPont Pioneer Canada, where he provided direction and coordination across all regulatory and registration activities for canola globally.

The IICI works in partnership with international research institutions, NGOs, funding agencies and regulatory agencies. Members of the Institute are involved in international collaborations: connecting leading scientists and cutting-edge technologies, training international scientists, and providing regulatory, biosafety and project management services. This work is supported by a number of private sources and government agencies, including the James S. McDonnell Foundation, the Bill & Melinda Gates Foundation, USAID from the American People, and the annual giving of our individual and corporate donors.

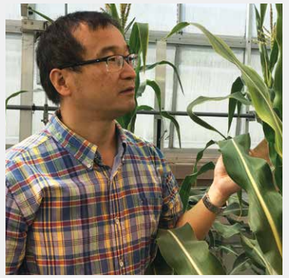
"I am excited by the opportunity... for improving food and nutrition/security, and... for addressing environmental and production challenges faced by farmers in developing countries."

- DON MACKENZIE, Ph.D.

New Joint Faculty Strengthen Research Collaboration and Training

ALLISON MILLER, Ph.D.

R. KEITH SLOTKIN, Ph.D.



BING YANG, Ph.D.

Three new joint faculty were added to the Danforth Center in 2018, expanding the Center's collaboration with the region's leading universities to attract accomplished scientists to strengthen regional plant and crop research and provide opportunities for undergraduate and graduate students.

In August, the Danforth Center and Saint Louis University (SLU) announced Allison Miller, Ph.D., professor of biology at SLU and research associate at the Missouri Botanical Garden, was appointed to a joint faculty position between the Danforth Center and SLU. Miller serves as member and principal investigator at the Danforth Center, and her research program is located at the Danforth Center.

Miller's research focuses on how perennial plants evolve in nature, how they withstand dynamic environmental stresses over the course of multiple years and how they can be domesticated for use in agriculture. Perennial plants offer many potential benefits in agriculture, including season over season production and deep root systems to reduce erosion. Understanding ways to improve and better use perennial crops can contribute to food security and ecosystem stability.

In addition, the Danforth Center and the University of Missouri (MU) announced R. Keith Slotkin, Ph.D. and Bing Yang, Ph.D., were appointed to joint faculty positions. They are the second and third faculty hired through a collaborative initiative that aims to elevate regional plant science to address global challenges.

The Slotkin laboratory are up and coming leaders in the field of 'epigenetics', which aims to understand how plant cells determine which regions of their DNA should be active or repressed. Slotkin started August 1 as associate member and principal investigator at the Danforth Center and as associate professor, Division of Biological Sciences, at MU. He is located at the Center.

Yang's research focuses on advanced biotechnologies that provide robust genetic and molecular tools to advance basic understanding of plant biology including plant responses to biotic and abiotic stresses.Yang's appointment as professor, Division of Plant Sciences, and as member and principal investigator at the Danforth Center started on September 1. Yang is housed on the MU campus.

Burgeoning Biodiversity

Danforth Center Prairie Dedicated and Celebrated

On September 21, 2018 the Danforth Center dedicated its native Missouri prairie with a special ceremony. Six acres of reconstructed Missouri prairie were planted in 2016 to reflect Center values and appreciation of biodiversity, including more than 75 species of native tall grasses and forbs.

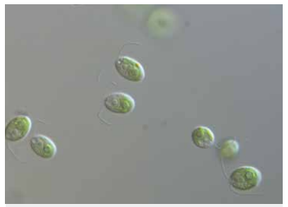
Prairie plants require little in the way of irrigation or inputs and produce deep roots that pull greenhouse gas carbons out of the air and store them underground. Prairie grasses are particularly drought- and heat-tolerant—and they are distant cousins of staple foods we eat like corn and wheat.

The prairie restoration reduces the Danforth Center's carbon footprint, while dramatically increasing biodiversity and contributing to a resurgence of pollinators, birds and other wildlife. New interpretive signs serve as a public education tool, providing visitors a glimpse of how Missouri would have appeared prior to European settlement. Visitors are welcome!

"Prairie restoration projects typically take from three to five years to flourish, however, after just two years, the Danforth Center prairie is a runaway success. It is the best of its kind, relatively weed free and incredibly diverse."

- SCOTT WOODBURY, Shaw Nature Reserve

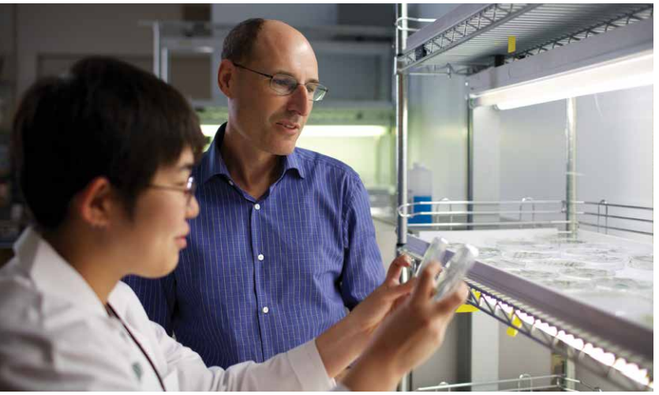
NIH Supports Research to Understand Cell Division Processes



CHLAMYDOMONAS

Researchers in the Center's Enterprise Institute for Renewable Fuels and their collaborators received a three-year, $675,000 grant from the National Institutes of Health (NIH) to understand cell-size control in the unicellular green alga *Chlamydomonas reinhardtii* (Chlamydomonas).

The collaboration will harness the complementary research expertise in algal cellular/molecular biology of James Umen, Ph.D., Joseph Varner Distinguished Investigator and member, Enterprise Rent-a-Car Institute for Renewable Fuels at the Danforth Center, and the mathematical modeling expertise of Abhyudai Singh, Ph.D., associate professor of Electrical and Computer Engineering, Biomedical Engineering and Mathematical Sciences, University of Delaware.



The grant will enable the Umen and Singh groups to begin unraveling the intriguing "counting" mechanism that underlies Chlamydomonas cell division, in which a period of uninterrupted growth (by as much as twenty-fold in size) is followed by a series of rapid successive divisions to produce daughter cells that return to a uniform starting size. For this mechanism to operate properly, larger mother cells must "count out" more divisions than smaller mother cells; but the division system exhibits imperfections. For example, two different Chlamydomonas mother cells of the exact same size won't always execute the exact same number of divisions; but the reasons for differing cell behaviors in the face of seemingly identical starting conditions are unknown.

Although human cells don't divide exactly the same way as Chlamydomonas, they also must make yes/no decisions about cell division that directly impact human health and disease. For example, cancer and other human diseases of cell proliferation occur when cell division decisions are made incorrectly. Cell size is often impacted by proliferative diseases, but it is not clear how cell size relates to abnormal cell physiology. In addition, some of the same molecular mechanisms controlling cell division in Chlamydomonas are also found in humans and in plants, so this research may yield insights into how cell division is controlled in more complex organisms where it is more difficult to study the impacts of noise on cellular decision making.

"Noise or stochasticity in decision making permeates biology, but the sources of noise and how they interact with more deterministic aspects of cellular control systems are poorly understood," said Umen. "This grant will enable us to model and better understand how noisy decision making impacts cell division in Chlamydomonas, and may also provide insights into other areas of biology that are impacted by stochastic behavior."

The grant will also support an educational component aimed at exposing students to topics at the interface of mathematics and systems biology through collaborative training of graduate students, summer workshops at the University of Delaware, and the Center's Research Experience for Undergraduates summer internship.

Danforth Center Scientists Selected to Participate in Elite NSF Program

A team of Center scientists to participate in the National Science Foundation's Enabling Discovery through Genomic Tools (EDGE) program to develop tools that will allow biologists to identify mechanisms that determine how genes affect an organism's physical and functional characteristics.

"We have a strong research team involving several investigators at the Danforth Center, specifically Rebecca Bart, Ph.D., and Kira Veley, Ph.D., who are Co-Principal Investigators on the project" said grant recipient Blake Meyers, Ph.D., principal investigator and member, Danforth Center and professor, Division of Plant Sciences, at the University of Missouri. "The outcome of our work will be a means to rapidly and inexpensively identify the rare plants or other organisms with precisely-designed genetic variants. One of our aims is to build on the exciting technology of gene editing by the development of our screening strategies."

The EDGE program helps the research community overcome the impediments that restrict progress in the biology of organisms, including their structure, function and other traits. Specifically, EDGE supports the development and dissemination of new functional genomic tools, approaches and associated infrastructure to directly test gene function in organisms.

"Researchers in the 10 big ideas program are creating innovative tools that will advance efforts to identify links between genes and complex organismal-level characteristics in a wide range of species."

- JOANNE TORNOW, Acting Assistant Director for the NSF Directorate of Biological Sciences

SCIENTIFIC DISCOVERY AND ACHIEVEMENT

Between now and the year 2050, we will need to grow more food than in the entire previous history of humankind. Using current technology, there is not enough arable land and fresh water to do it. We must invent a different future.

2018 Danforth Center Principal Investigators

DOUGLAS ALLEN, Ph.D.

Associate Member and USDA-ARS Research Scientist

The Allen laboratory used isotopes to assess plant growth and development that contributes to seeds that make more lipids.

REBECCA BART, Ph.D.

Associate Member

The Bart laboratory combined genetics with molecular and computational biology to develop disease control strategies for important crops including, cassava, sorghum and cotton.

IVAN BAXTER, Ph.D.

Associate Member

The Baxter laboratory used the Bellwether facility to understand the genetic architecture of water use in response to drought.

JAMES CARRINGTON, Ph.D.

President, Member

The Carrington laboratory focused on how plants resist viruses, mechanisms of epigenetics, and how crops can be improved to increase productivity.

BRADLEY EVANS, Ph.D.

Principal Investigator and Director, Proteomics and Mass Spectrometry

The Evans laboratory used high performance mass spectrometry, proteomics and metabolomics for connecting molecular phenotypes with the macroscopic form and function of organisms.

ANDREA EVELAND, Ph.D.

Assistant Member

The Eveland laboratory used experimental and computational approaches to investigate the regulation of grain production in cereal crops.

NOAH FAHLGREN, Ph.D.

Principal Investigator and Director, Bioinformatics Core Facility

The Bioinformatics team developed computer vision-based software to enable high-throughput measurement of plant physical and physiological features and analysis of dynamic responses to the environment.

MALIA GEHAN, Ph.D.

Assistant Member

The Gehan laboratory developed high-throughput phenotyping approaches to study mechanisms of crop resilience under temperature stress.

ELIZABETH KELLOGG, Ph.D.

Robert E. King Distinguished Investigator, Member

The Kellogg laboratory studied genomes, growth and development of sorghum, maize and their wild relatives, using biodiversity research to make ecosystems and agriculture more sustainable.

TONI KUTCHAN, Ph.D.

Vice President of Research and Oliver M. Langenberg Distinguished Investigator, Member

The Kutchan laboratory studied the production of the anticancer compound cyclopamine in corn lily and the oilseed crop camelina as a source of renewable fuel.

DONALD MACKENZIE, Ph.D.

Executive Director, Institute for International Crop Improvement

Dr. MacKenzie assumed leadership of the Institute for International Crop Improvement (IICI), which translates key discoveries in plant science into new solutions for food quality and availability challenges in developing regions and provides regulatory, biosafety, and project management to develop improved crop varieties.

BLAKE MEYERS, Ph.D.

Member, and Professor, Division of Plant Sciences, University of Missouri

The Meyers laboratory used experimental and computational approaches to study plant reproduction and fertility to enhance yield gains in crop plants.

ALLISON MILLER, Ph.D.

Member and Professor, Saint Louis University

The Miller lab explored how long-lived plants respond to dynamic environments, with the goal of developing perennial crops that support ecologically sustainable agricultural systems.

TODD MOCKLER, Ph.D.

Geraldine and Robert Virgil Distinguished Investigator, Member

The Mockler laboratory used genomics, high-resolution phenotyping and bioinformatics to understand plant responses to environmental stresses to improve productivity in food and energy crops.

DMITRI NUSINOW, Ph.D.

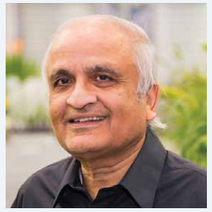
Assistant Member

The Nusinow laboratory found new genes that have the potential to increase productivity in response to daily and seasonal changes in light and temperature.

SONA PANDEY, Ph.D.

Associate Member

The Pandey laboratory used molecular, biochemical and functional studies to understand the mechanisms of stress tolerance and yield improvement in plants by G-proteins.



DILIP SHAH, Ph.D.

Associate Research Member

The Shah lab investigated modes of action of antifungal plant defensins and defensin-like peptides to enable development of fungal disease resistant crops for increased yields.

R. KEITH SLOTKIN, Ph.D.

Associate Member and Associate Professor, Division of Biological Sciences, University of Missouri

The Slotkin laboratory studied how plants determine which regions of their genomes should be expressed, and which regions should not be expressed, to create new technologies in plant biology.

NIGEL TAYLOR, Ph.D.

Dorothy J. King Distinguished Investigator and Associate Member

The Taylor laboratory advanced virus-resistant cassava into regulatory field trials in East Africa as a critical step toward delivering enhanced planting materials to farmers.

CHRISTOPHER TOPP, Ph.D.

Assistant Member

The Topp laboratory implemented X-ray-based imaging and analysis of corn and other root systems to develop more robust and sustainable crops.

JAMES UMEN, Ph.D.

Joseph Varner Distinguished Investigator, Member

The Umen laboratory investigated the genetics and cell biology of green algae to enable development of sustainable sources of biofuel and other high-value compounds.

SAM WANG, Ph.D.

Member and E. Desmond Lee and Family Endowed Professor

The Wang laboratory focused on lipid metabolism and signaling in plant response to nitrogen/phosphorus deficiency and seed oil production

TERRY WOODFORD-THOMAS, Ph.D.

Sally and Derick Driemeyer Director of Science Education and Outreach

The team enhanced public understanding of plant science and new technologies used to improve agriculture and guided young scientists in research.

BING YANG, Ph.D.

Member and Professor, Division of Plant Sciences, University of Missouri

The Yang laboratory used enhanced genetic and molecular tools to increase the understanding of plant responses to biotic and abiotic stresses that can be coupled with enabling technologies to develop improved crops.

RU ZHANG, Ph.D.

Assistant Member

The Zhang laboratory studied how photosynthesis responds to high temperatures in order to engineer more heat-resistant crops and algae for improved food and biofuel production.

105 Publications in 2018 for a total of 1,218 since inception

Representative publications from 2018 (selected listing below)

Beyene, G., Solomon, F.R., Chauhan, R.D., Gaitan-Solis, E., Narayanan, N., Gehan, J., Siritunga, D., Stevens, R.L., Jifon, J., Van Eck, J., Linsler, E., Gehan, M., Ilyas, M., Fregene, M., Sayre, R.T., Anderson, P., Taylor, N.J. and Cahoon, E.B. (2018) Provitamin a biofortification of cassava enhances shelf life but reduces dry matter content of storage roots due to altered carbon partitioning into starch. Plant Biotechnol J 16, 1186-1200. doi:10.1111/pbi.12862

Deng, X., Yuan, S., Cao, H., Lam, S.M., Shui, G., Hong, Y. and Wang, X. (2018) Phosphatidylinositol-hydrolyzing phospholipase C4 modulates rice response to salt and drought. Pl Cell Envir 42, 536-548. doi:10.1111/pce.13437

Fei, Q., Yu, Y., Liu, L., Zhang, Y., Baldrich, P., Dai, Q., Chen, X. and Meyers, B.C. (2018) Biogenesis of a 22-nt microRNA in Phaseoleae species by precursor-programmed uridylation. Proc Natl Acad Sci U S A 31, 8037-8042. doi:10.1073/pnas.1807403115

Geng, S., Miyagi, A. and Umen, J.G. (2018) Evolutionary divergence of the sex-determining gene MID uncoupled from the transition to anisogamy in volvocine algae. Development 145, dev162537. doi:10.1242/dev.162537

Gomez, M.A., Lin, Z.D., Moll, T., Chauhan, R.D., Hayden, L., Renninger, K., Beyene, G., Taylor, N.J., Carrington, J., Staskawicz, B. and Bart, R. (2018) Simultaneous CRISPR/Cas9-mediated editing of cassava eiF4E isoforms nCBP-1 and nCBP-2 reduces cassava brown streak disease symptom severity and incidence. Plant Biotech J 17, 421-434. doi:10.1111/pbi.12987

Kohler, I.H., Huber, S.C., Bernacchi, C.J. and Baxter, I.R. (2018) Increased temperatures may safeguard the nutritional quality of crops under future elevated CO2 concentrations. Plant J. doi:10.1111/tpj.14166

Schaefer, R.J., Michno, J.-M., Jeffers, J., Hoekenga, O., Dilkes, B., Baxter, I. and Myers, C. (2018) Integrating co-expression networks with GWAS to prioritize causal genes in maize. Plant Cell. doi:10.1105/tpc.18.00299

Velivelli, S.L.S., Islam, K.T., Hobson, E. and Shah, D.M. (2018) Modes of action of a bi-domain plant defensin MtDef5 against a bacterial pathogen Xanthomonas campestris. Front Microbiology 9, 934. doi:10.3389/fmicb.2018.00934

Wittmeyer, K., Cui, J., Chatterjee, D., Lee, T.F., Tan, Q., Xue, W., Jiao, Y., Wang, P.H., Gaffoor, I., Ware, D., Meyers, B.C. and Chopra, S. (2018) The dominant and poor penetrant phenotypes of the maize mutation Unstable factor for orange1 are caused by DNA methylation changes at a linked transposon. Plant Cell. doi:10.1105/tpc.18.00546

Ziegler, G., Nelson, R., Granada, S., Krishnan, H.B., Gillman, J.D. and Baxter, I. (2018) Genome-wide association study of ionomics traits on diverse soybean populations from germplasm collections. Plant Direct 2, e00033. doi:10.1002/pld3.33

Growing Cereal Yield Potential

"The genetics and genomics tools that are emerging for Setaria enable more rapid dissection of molecular pathways and allow us to manipulate them directly in a system that is closely related to the food crops we aim to improve."

- ANDREA EVELAND, Ph.D.

Danforth Scientists Uncover Mechanism that Could Enhance Cereal Crops

Solving the world's food, feed and bioenergy challenges require integration of multiple approaches and diverse skills. Andrea Eveland, Ph.D., assistant member at the Danforth Center, and her team identified a genetic mechanism that controls developmental traits related to grain production in cereals.

The Eveland laboratory's research findings, "Brassinosteroids modulate meristem fate and differentiation of unique inflorescence morphology in *Setaria viridis*," were published in the journal *The Plant Cell*. In their study, Yang et al. mapped a genetic locus in the Setaria viridis genome that controls growth of sterile branches called bristles, which are produced on the grain-bearing inflorescences of some grass species. Their research revealed that these sterile bristles are initially programmed to be spikelets; grass-specific structures that produce flowers and grain. Eveland's work showed that conversion of a spikelet to a bristle is determined early in inflorescence development and regulated by a class of plant hormones called brassinosteroids (BRs), which modulate a range of physiological processes in plant growth, development and immunity. In addition to converting a sterile structure to a seed-bearing one, the research also showed that localized disruption of BR synthesis can lead to production of two flowers per spikelet rather than the single one that typically forms. These BR-dependent phenotypes therefore represent two potential avenues for enhancing grain production in millets, including subsistence crops in many developing countries that remain largely untapped for genetic improvement.

Sam Wang Recognized for Outstanding Achievement and Collaboration

Sam Wang, Ph.D., member, Danforth Center and E. Desmond Lee Professor of Plant Sciences, University of Missouri-St. Louis (UMSL), received the 2018 George Engelmann Interdisciplinary Award from the St. Louis Academy of Science at their 24th Annual Outstanding Scientists Awards Dinner. The award recognizes outstanding achievement in science, engineering, or technology that results from collaboration among two or three individuals across disciplinary or institutional boundaries.

Wang joined both the Danforth Center and the department of Biology at UMSL as an adjunct professor in 2004. His research aims to discover and understand the signaling and regulatory processes that mediate plant stress response and oil production and translating knowledge to improve plant oil and biomass production. Wang and his collaborators have made important discoveries in cell signaling and have identified genes, pathways and mechanisms that increase oil production in plants.

Burst of Morning Gene Activity Tells Plants When to Flower

"This work showed us that plants are integrating many different signals together when making the critical decision of when to flower."

- DMITRI NUSINOW, Ph.D.

For angiosperms — or flowering plants — one of the most important decisions facing them each year is when to flower. It is no trivial undertaking. To flower, they must cease vegetative growth and commit to making those energetically expensive reproductive structures that will bring about the next generation. Knowledge of this process at the cellular level is critical for understanding how plants allocate resources to produce grains, tubers, leaves, nuts and fruits that mean so much to humans and animals alike.

In a paper, *Molecular basis of flowering under natural long-day conditions in Arabidopsis*, published in the journal Nature Plants, He Huang, Ph.D., research scientist, and Dmitri A. Nusinow, Ph.D., assistant member, Danforth Center, and an international team of researchers demonstrated that the gene *FT* — the primary driver of the transition to flowering in plants each spring — does something unexpected in *Arabidopsis thaliana* plants grown in natural environments, with implications for the artificial growing conditions scientists commonly use in the lab.

The research team showed that *FT* has a peak of activity every morning leading up to the transition, something that scientists had not previously seen in Arabidopsis, a model plant that is widely studied for understanding the molecular details of the transition to flowering. The morning peak of *FT* activity causes plants to transition earlier from vegetative growth to flowering.

Prior research, which saw only an evening peak of *FT* gene activity, had been conducted on *Arabidopsis* plants grown indoors under fluorescent light. The team — which included researchers in Switzerland, Scotland, South Korea and Japan — grew their plants outside under sunlight in Seattle because conditions at the summer solstice are similar to the standardized, artificial "long-day" growing conditions for Arabidopsis: 16 hours of light and eight hours of darkness.

Outdoor plants produced fewer leaves than indoor plants, indicating that the outdoor plants flowered earlier. Both outdoor and indoor plants showed evening peaks of *FT* gene activity, but outdoor-grown plants also showed a morning peak of *FT* activity. Researchers concluded that the indoor, artificial growing conditions missed key qualities of natural conditions, throwing off expression of the *FT* gene and the trait it governs.

To identify the differences between indoor and outdoor growing conditions, the group focused on light. The fluorescent bulbs commonly used in *Arabidopsis* research do not emit the same wavelengths of light that sunlight does. When the researchers added a far-red LED lamp to the indoor growth chambers to mimic outside light, the *Arabidopsis* plants then showed a morning peak of *FT* gene activity. In addition, by modifying the temperatures in the indoor growth chambers to cycle daily from about 16 degrees Celsius to almost 23 C — or from 61 degrees Fahrenheit to about 73 F — the evening *FT* gene activity was reduced, similar to the outdoor plants.

GROWING THE NEXT GENERATION OF SCIENTISTS

Our future depends on the next generation of creative, ambitious scientists and leaders. Scientist-educators at the Danforth Center inspire young people to learn more about plants and prepare for careers in plant science.

Inspiring Young Minds

Danforth Center K-12 curriculum packages are designed to teach important skills such as critical thinking, developing and testing hypotheses, observing outcomes, communicating results, lab etiquette and teamwork. Ultimately, many students will choose to continue their studies and go on to obtain sustainable employment in science and technology field providing the region with a diverse talent pool to fuel the rapidly growing ag-innovation economy.

STEM IMMERSION

The Science Technology Engineering and Math (STEM) immersion initiative provides opportunities for K-5th grade students in underserved schools to interact with Center scientists for learning enrichment. In 2018, over 675 students from Jury and Marvin elementary schools in the Hazelwood and Ritenour school districts were mentored by 20 Center scientists who stepped out of their laboratories and into the classrooms to engage students in exciting hands-on STEM activities. The Education and Outreach team also assisted the Clayton school district's STEM career day for more than 200 5th graders.

GREEN MEANS GROW

Helps students understand the origin of their food, appreciate food choices and farming practices throughout the world and grasp the importance of global food security.

MUTANT MILLETS

Multi-state program offers high school students the opportunity for hands-on, observation-based scientific research.

TECH TRUNKS

Provides enrichment opportunities for St. Louis-area high school students to conduct experiments in biology, biotechnology and genetics.

MO DIRT

Crowd sources soil analyses and data collection to Missouri citizens, including K-12 students, who record relevant data about the physical, chemical and biological properties of soils to assess the current state of soil health across Missouri.

2018

Education and Outreach Programs Reached 3,500 Students in 95 Schools

Mutant Millets: "A solid cohort of 30 students felt this was one of the best experiences they have had in school."

- BARRY CROOK, Wydown Middle School

Expanding STEM Education

Boeing provided a $80,000 grant in support of Green Means Grow, a centerpiece of the Danforth Center's STEM education and outreach, the second investment in the program.

In 2018, 980 students were engaged in Green Means Grow activities including a new pilot partnership with Boys & Girls Clubs of Greater St. Louis, focusing on schools in the Ferguson-Florissant School District. Funding also supported an expanded STEM Splash Day, a one-day immersive STEM experience based in schools whereby classrooms are transformed into laboratories for hands-on/minds-on STEM activities and demonstrations facilitated by scientist volunteers from the Danforth Center. Students learn a range of science and math concepts through a variety of activities including planting, cultivating and harvesting crops.

One hundred percent of participating instructors indicated that program activities and lessons were age-level appropriate for their students. Further, 94 percent of teachers indicated that they learned new information with more than 90 percent indicating that Center programming provided them with their first opportunity for formal STEM professional development.

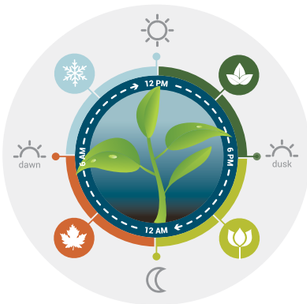
2018 William H. Danforth Plant Science Scholar

Maria Sorkin is a second year Ph.D. student at Washington University in St. Louis. During her undergraduate studies at Kenyon College she developed a passion for science communication and outreach serving as the STEM Community Intern and member and president of the Kenyon STEM organization. Here in St. Louis, she serves as the head of the Genetics and Genomics Teaching Team with the Washington University Young Scientists Program (YSP), which develop and carry out interactive science activities related to a wide-variety of STEM topics in classroom visits to K-12 schools. Maria is working to develop a new Genetics and Genomics module centered on plant biology to promote the plant sciences in St. Louis public schools.

"I have many plant biologists to thank for showing me that plants are not the green backdrop of biology, but in fact play the lead role in countless scientific stories."

- MARIA SORKIN

As an undergraduate Maria participated in a National Science Foundation Research Experience for Undergraduates internship at North Carolina State University, during which she developed a fascination with the circadian clock—an endogenous timekeeper that synchronizes the plant with daily and seasonal cues from the environment. Maria continues this work in her doctoral research in Dmitri Nusinow's lab. Her dissertation research focuses on identifying the protein-protein interactions involved in circadian clock function.



"Ultimately, we can use our knowledge about the circadian clock to manipulate agriculturally relevant, clock-regulated phenotypes, such as flowering time," Sorkin said.

At Kenyon Maria was recognized by ASPB as an up and coming leader in the plant sciences and awarded the American Society of Plant Biologists (ASPB) Summer Undergraduate Research Fellowship (SURF). During her first year of graduate school, she was named the 2017-2018 Catharine M. Lieneman Scholar at Washington University for her continued efforts to promote the plant sciences and she was selected to join the inaugural class of ASPB Conviron Scholars.

Because medical and other kinds of research receive significantly more federal and foundation funding than plant science, the William H. Danforth Graduate Fellowship is especially important for enabling talented young scientists like Maria to pursue careers in this critically important field. Thanks to Roy and Diana Vagelos, she and others will have the opportunity to conduct their research with the guidance of outstanding principal investigators at the Danforth Center.

Record Crowd Explores Scientific Innovation and Robotics at the Raspberry Pi Jam

"Awesome, inspiring, inventive! Our Girl Scout troop was intrigued by all the hands-on activities and demonstrations. Thank you for providing such a wonderful opportunity and revealing a bright future for our new leaders of this world."

- WINNIE COLLIER, Attendee

On Saturday, January 27, 2018, the Danforth Center hosted its fourth St. Louis Raspberry Pi Jam bringing together 900 students, educators, makers, scientists and community members of all ages interested in the world of scientific innovation and robotics.

The $35 Raspberry Pi microcomputer is a technology used by educators, scientists and hobbyists to construct low-cost hardware and software engineering tools. The interactive Jam offered participants a unique opportunity to explore science through robotics, a Pi-powered photo booth, DIY activities, demonstrations, art, 3D printing and more.

"We hope that our Jams inspire current and future scientists to embrace using Raspberry Pi and other open-source hardware to interact and discover the natural world," said Dmitri Nusinow, Ph.D., assistant member at the Danforth Center and co-founder of the Center's Maker Group.

More than 60 percent of labs in the Center are involved in maker activities, which includes education and outreach and research projects. For more information on the Danforth Center's Maker Group, follow them on Twitter @DDPSCmaker.

Former Interns Receive National Recognition

Mayla Ayers, a 2017 REU intern received first place honors for an undergraduate oral presentation in the Ecology, Environmental and Earth Sciences category at the 2018 Emerging Researchers National (ERN) Conference held in Washington, DC, in February. Ayers is a Junior Sustainability and Urban Ecology major at Harris-Stowe State University. Her presentation entitled "PCH1 Regulates Thermoresponsive Growth in Arabidopsis thaliana," summarized the findings of her summer research in the Nusinow lab. He Huang, Ph.D., research scientist served as her mentor for the project. "Our lab was very fortunate to work with Mayla. Her success reflects her perseverance, hard work and intellect both during her time in lab and in preparation for her presentation at the conference," said Nusinow.

Ellie Tiley was a 2018 REU intern in the Carrington lab and worked under the mentorship of Dr. Dan Lin. She was chosen to attend the "Research Experiences for Undergraduates Symposium" hosted by the Council on Undergraduate Research, where she presented her summer research project "Investigating Susceptibility and Virulence Factor Interactions in a Plant-Virus Infection." Tiley is a Senior at Oberlin College and majoring in Biology. Her career goal is to study the underlying genetics of pathology in staple crops in developing countries to increase harvest yields.

Summer Immersion in Plant Science

2018 marked the 15th year that the Danforth Center hosted an 11- week intensive *Research Experience for Undergraduates* summer program, with generous support from the National Science Foundation (NSF). Rigorous training for undergraduate students combines hands-on research activities with mentoring from top-tier scientists helping to create a pipeline of plant scientists prepared to address both current and future global challenges. Center staff work to facilitate connections among interns and their scientific colleagues through discussion forums, informal lunches and social gatherings.

2018

303 interns have completed our REU program

Discover the 2018 REU Summer Internship Program by the numbers:

- The Center hosted 17 interns.
- Individuals were selected from a competitive pool of 250 applicants from 48 states/US territories.
- 35% of the interns were from schools that have limited research opportunities.
- 10 interns were supported by the NSF REU site grant and seven were supported by NSF funding received individually through Principal Investigators.
- 18% of the interns were from underrepresented minority groups.
- 94% of former interns are working in a STEM career or pursuing an advanced degree in STEM. 48% have achieved or are pursuing doctorates.
- From 2009-2015, 26 out of 188 interns received the prestigious NSF graduate research fellowship award or received honorable mentions.
- Interns have contributed to 41 peer-reviewed publications with additional publications pending.

The 2018 REU summer internship program was organized by Sona Pandey, Ph.D., associate member and principal investigator, Ru Zhang, Ph.D., assistant member and principal investigator, Cathy Kromer, grant manager and Shannon Rapp, administrative assistant.

BUILDING A STRONGER INNOVATION COMMUNITY

The Danforth Center believes in science coupled to real-life impact, where innovation brings discovery to market. St. Louis, with the Danforth Center, BRDG Park, Helix Center, 39 North and Ag Innovation Showcase, is changing the world.

A Decade of Growth

Ten years ago, the Ag Innovation Showcase began its remarkable journey to curate technologies, converse about trends, and cultivate a community of innovators, investors and influencers who are driving the future of Ag.

On September 10-12, 2018, the tenth annual event hosted by the Danforth Center organized in partnership with Larta Institute welcomed 500 people from around the globe. The Ag Showcase has established a loyal following. Nearly 4,000 people from 26 countries have participated. The panels, presentations and spotlights have charted the arc of innovation in agriculture, exploring the convergence of food, health and energy sectors. More than 200 technologies have been presented. Nearly 90% of companies found new investor leads and six had successful exits through acquisitions

Attendees gained valuable insight from featured speakers, Mehmood Khan, M.D., PepsiCo's vice chairman and chief scientific officer of Global Research and Development and Chris Chinn, director of the Missouri Department of Agriculture, a fifth-generation farmer, who has been an early adopter of new technologies used to streamline processes and expand productivity on her family farm in Shelby County, MO.

Central to the event was a celebration of the accomplishments of alumni companies, many of whom have brought their ideas to fruition and are key players in the industry across the value chain.

"The rapid growth and success of the Ag Showcase has positioned the region as a global leader of innovation and has helped establish new networks, companies and investments that are accelerating sustainable agriculture world-wide," said Sam Fiorello, chief operating officer, Danforth Center and president, BRDG Park.

The tenth anniversary theme, *"From Farm to Plate"* underscored the commitment of the 2018 Showcase to establish clarity, dialogue and excellence in a time of increased consumer scrutiny, interest and demand.

We are tremendously thankful for our sponsors, who are not only the financial pillars of Ag Showcase, but contribute as speakers, thought leaders, and curators for many facets of the event and to our advisors who have given their leadership, energy and enthusiasm to make this a truly unique and productive gathering.

2018

186 presenting companies have collectively raised more than **$1.1B**

"We had no money and a bunch of ideas. The Ag Showcase gave us an opportunity and a platform to present what we were doing."

- TOM LAURITA,
CEO, NewLeaf Symbiotics

Wells Fargo Funded Innovation Incubator Joins with Danforth Center

"We are extremely pleased to be working with an organization that deeply understands the trifecta of basic science, innovation and commercialization."

- TRISH COZART, IN² Program Manager at NREL

In 2018, the Wells Fargo Innovation Incubator (IN²), a technology incubator and platform funded by the Wells Fargo Foundation and administered by the National Renewable Energy Laboratory (NREL), announced expansion into the food, energy, water nexus in a strategic partnership with the Danforth Center. Center scientists will focus on research and validation of innovative solutions that address how to use digital agriculture to produce food more sustainably, much like the way NREL leads the program's validation of technologies related to commercial buildings. Future IN² activities under the food-water-energy nexus will include food system inefficiencies and water conservation to help meet IN²'s goal of advancing smart, connected communities.

IN² finds and selects companies through a network of Channel Partners consisting of incubators, accelerators and universities across the U.S. After validation, participating companies with commercially ready technologies have the potential to beta test with a strategic program partner. To date, IN² has funded 20 early-stage companies that have gone on to raise $89.5 million in follow-on funding from external sources.

"For 20 years, the Danforth Center has been a driver in the growth of the food and agriculture innovation ecosystem," said Sam Fiorello, chief operating officer, Danforth Center. "By leveraging the Center's excellence in plant research and its best-in-class technology infrastructure, the expanded IN² platform will help accelerate agriculture technology commercialization for early-stage companies across the world."

Cane Technology Company Selects BRDG Park for Research HQ

Leaders of Centro de Tecnologia Canavieira (CTC), the world's largest sugarcane technology company, headquartered in Piracicaba, São Paulo, Brazil selected BRDG Park to locate its North American research headquarters following a nationwide search.

The newly formed subsidiary, CTC Genomics, will focus on developing new platforms for sugarcane which will allow substantial quality and productivity gains. The company plans to initially employ 10-15 people in its BRDG Park location enabling them to access some of the Danforth Center's state-of-the-art facilities including the Center's Transformation Facility.

"St. Louis has a world-class constellation of plant science assets that is perfectly matched for what CTC needs to transform sugarcane, one of the most complex crops to develop. CTC leaders made a wise choice of placing their bet on St. Louis to help them make sugarcane a competitive and valuable crop for farmers and consumers," said Vijay Chauhan, GlobalSTL lead.

The State of Missouri provided various incentives including $175,000 in funding from the Missouri Technology Corporation's Missouri Building Entrepreneurial Capacity Program to help offset a portion of the buildout costs of CTC's lab space.

"After visiting multiple sites, our encounter with St. Louis was the perfect environment to attract talent, and access unique infrastructures and transformation expertise for our bold start in the U.S."

- DIEGO HENRIQUE SOUZA FERRES, head of R&D

39 North Innovation District Gains Momentum, Recognition

The 39 North Innovation District advanced several key components of the Strategic Master Plan and has attracted more than $6 million in funding for three infrastructure projects, monthly programming and marketing.

- Olive and Lindbergh Boulevard interchange ($5 Million) Engineering for the interchange redesign and construction.
- Old Olive Street Road ($500,000) Planning and redesign of to create a localized, main-street look and feel, and improved mobility.
- Great Rivers Greenway ($400,000) Planning and design of an open space framework and biking and pedestrian paths that connect to the Centennial Greenway.
- Venture Café @ 39 North gatherings are held on the third Tuesday of every month at the Danforth Center. In 2018, more than 2,000 people attended. 154 breakout sessions were held. We are grateful to our sponsors for their continued support.
- In June Creve Coeur and Olivette maintenance crews hung street pole banners attached to Ameren electric poles along Warson Road, Old Olive Street Road and Olive Boulevard to build awareness of the 39 North Innovation District.

In 2018 the East-West Gateway Council of Governments presented 39 North the award for Exemplary Collaboration, and Partnership highlighting the work of corporate, government and institutional leaders to create a common vision for its growth. Venture Café presented the Super Collider Award for Economic Development to 39 North at its annual Kinesis Gala.

"The implementation of the agtech cluster effort is distinguished by the fact that the region took a broad approach from the very beginning, with parallel strategies focused on every major area of need: capital, talent, facilities, and networks."

- BROOKINGS REPORT, Rethinking Cluster Initiatives

Growing a 21st Century Economy

In 2018, the Danforth Center was the recipient of a $25,000 Bank of America grant to support the formation of new business, the attraction of job-creating companies to the region, the growth of the St. Louis bioscience community, new and improved technology, and greater diversity/sustainability. Bank of America had previously funded the program with a $10,000 gift in 2017.

The Danforth Center provides small businesses and start-ups with vital resources including R&D facilities, expert consultation and technical assistance, and participation in investment networks. As a direct result of the Center's efforts, BRDG Park is home to 13 enterprises, employing 250 people currently with a plan for an eventual 1,100 permanent jobs. An additional 23 companies are located at the Helix Center, a biotech business incubator adjacent the Center. Together with the Danforth Center, these facilities anchor the new innovation district 39 North.

2018

Combined operations of the Danforth Center, BRDG Park and Helix Center have a **$256M** annual impact on the St. Louis economy.*

** St. Louis Regional Chamber, 2018 Economic Impact Report*

COMMUNITY ENGAGEMENT AND CONTRIBUTIONS

Donors are essential partners in our mission. They are our volunteers, our investors, our brand ambassadors, our community builders. Together, Danforth Center community members and supporters expand our sphere and grow our enterprise in service to humanity.

Remembering Two Gracious Ambassadors

JIM KNIGHT 1927 – 2018

It is with deep sadness that the Danforth Center acknowledges the passing of Newell Sloss "Jim" Knight, Jr., on Tuesday, September 25, 2018. Jim and his wife Janet were friends of Ibby and Bill Danforth and were involved with the Danforth Center from the very beginning. Jim was renowned for his warmth, positivity, and passionate commitment. A founding member of the Friends Committee (later chair), he was also a member of the Danforth Society Membership Committee, the Legacy Society, and the Plantasia event planning committee. He led tours of the Danforth Center as a docent for many years, personally introducing scores of new people to the Center and its mission. Jim was not just an advocate of great causes, but of people, whom he welcomed with open arms, everyone a new friend to be made. He will be deeply missed by his many friends at the Danforth Center. His booming laugh will resonate throughout the Center's walls and in the hearts of those he touched for years to come.

FOUNDING MEMBER,
FRIENDS COMMITTEE

MARIE OETTING 1927 – 2018

The Danforth Center lost a dear friend and dedicated supporter when Marie Dorothy Prange Oetting passed away on Tuesday, October 9, 2018. A graduate of Washington University, Marie was an early believer in and passionate volunteer for the Danforth Center. She was a founding member of the Friends Committee and a longtime member of the Plantasia gala committee. It thrilled her to introduce friends to the Center's mission, and she was known for her steadfast attendance at events and for her gracious hosting of guests and new potential members there. She also brought her family to the Danforth Center, including her grandson Davey Oetting, current vice-chair of the Center's Young Friends. Marie was active on many boards and quietly helped many individuals achieve their educational goals. She was also deeply involved with her alma mater. She will be deeply missed by her many friends at the Danforth Center—and by all those inspired by her commitment to lifelong learning and self-betterment.

FOUNDING MEMBER,
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Plantasia Gala 2018

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"Celebrating 20 years of delivering on the promise at the Danforth Center was a night to remember—and the largest Plantasia attendance yet."

- RUTH KIM, JD, Member, Friends Committee; Table Patron

2018 Friends Committee

The Friends Committee promotes the work of the Center and grows membership and financial support through annual giving.

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"The Friends Committee continues to build relationships through the Conversations series, the Plantasia gala, and other outreach. Membership in the Danforth Society grew an outstanding 10 percent in 2018. Thank you for your continued support."

- MOLLY CLINE, Ph.D.,
Chair, Danforth Society
Membership Committee

Danforth Society Membership Committee

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Kathleen Woodworth

† deceased

2018 *Conversations Series*

The discussion series is organized by members of the Danforth Center Friends Committee and offers individuals the opportunity to learn about the work of the Center and the partners who help to sustain it. Discussions are focused on topics of both regional and global urgency and feature leading experts in plant science and related disciplines.

THE FUTURE OF FOOD IN A WEALTHIER, WARMER WORLD

Around the world, increases in population, urban density and economic prosperity are predicted to create unprecedented demands for both more and different foods, placing added strain on our natural resources. The first discussion of the 2018 series focused on the nexus of food production and the environment and how to ensure that we can meet the needs of a growing human population without doing irreparable damage to the planet.

Date: Thursday, March 8, 2018

Panelists: Jason Clay, Ph.D., Senior Vice President, Markets & Food for the World Wildlife Fund, and Allison Miller, Ph.D., Member and Principal Investigator, Danforth Plant Science Center and Professor Department of Biology, Saint Louis University

Moderator: Stephanie Regagnon, CEO of FieldWatch, Inc.

NEXUS OF CREATIVE SCIENCE AND THE MARKETPLACE: PARTNERSHIPS THAT WORK

Alignment of basic scientific research with marketable products that meet a need occurs all too infrequently. Converting fundamental science in the laboratory into products and services that improve lives is challenging, usually requiring multidisciplinary partnerships between the public and private sectors. This program's panelists discussed elements of successful partnerships between for-profit companies and not-for-profit research institutions, and how advanced imaging technologies are bridging the gaps between fundamental science and commercial applications.

Date: Thursday, August 23, 2018

Panelists: Christopher Topp, Ph.D., Assistant Member and Principal Investigator, Donald Danforth Plant Science Center and Warren Shafer, Ph.D., Vice President Global R&D and Regulatory Affairs, Valent Biosciences LLC

Moderator: Vijay Chauhan, Global STL Lead at BioSTL

THE ENTREPRENEURS – ARTISTS OF INNOVATION

Albert Einstein once said, "Logic will get you from A to B. Imagination will take you everywhere." Today, entrepreneurs are driving change in business, redefining how we interact, and creating new opportunities for better lives around the world. The intersection of imagination, risk-taking, motivation and talent of the entrepreneur is fueling dramatic change in all sectors of business and across all parts of modern society. The final program of the 2018 series featured three special guests for a conversation about the art of innovation and how our region is evolving by embracing entrepreneurs.

Date: Thursday, October 18, 2018

Panelists: Jerry Kent, Chairman and CEO of TierPoint and Cequell III; Matt Crisp, President and CEO of Benson Hill Biosystems; and Emily Lohse-Busch, Executive Director of Arch Grants

Moderator: Sam Fiorello, COO, Danforth Plant Science Center

Sponsored by

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Media sponsors: St. Louis Public Radio and HEC-TV

The annual Seeds of Change program is hosted by the Danforth Leadership Council

Seeds of Change 2018: Celebrating Women in Agriculture

The Honorable Dr. Ruth Oniang'o spoke at the annual Seeds of Change event before a crowd of more than 250 people on May 2, 2018. A professor of botany and former member of the Kenyan parliament, she is the 2017 recipient of the Africa Food Prize and has dedicated her life to fighting hunger and malnutrition.

Oniang'o cited improved crops as being central to African food security. "The work of Danforth Center scientists in cassava, teff, millet—African food crops— is so important! I want scientists to speak up more. You don't have to be a politician, but you need to lobby them."

Following her presentation, Natalie DiNicola, vice chair of the Danforth Leadership Council, moderated a discussion, describing Dr. Oniang'o as a trailblazer, one of only 18 women to serve in the Kenyan parliament in the mid-2000s, and one of only a few women to earn a Ph.D. in a traditional society.

Oniang'o explained how her passion for food security led to her equally passionate involvement with women's rights: "I wanted to make sure Africa no longer has hunger, so I was an advocate for food security. I found that in my country, the women were the ones caring for the crops so then I became an advocate for the women."

2018 Danforth Leadership Council

The Danforth Leadership Council is a group of prominent St. Louisans interested in the role of plant science in the future of the region.

EXECUTIVE COMMITTEE

Chip Lerwick, *chair*
Natalie DiNicola, *vice-chair*
Wesley Jones, *chair emeritus*
Christopher B. Danforth
James L. Johnson, III
Julie Lilly
Michael Scully

MEMBERS

Benjamin O. Akande
Kathy Bader
R.D. Todd Baur
Eleanor Peters Bergquist
Robert Brandt
Beau Brauer
Jason Brauer
Lee Broughton
Juan Carlos Buitrago-Suarez
Johannes Burlin
J. Powell Carman
Vijay Chauhan
Charles K. Cohn
Charles H. Fendell
J. Spencer Finney
Blair L. Fortner
Steven M. Fox
Marc D. Goldstein
Ted A. Guhr, Jr.
Jason Hall
A. Charles Hiemenz, IV
Clifford Holekamp
Richard C. Holton, Jr.
Harold Rockwell Kroeger
David Lemkemeier
Jason Logsdon
Aditya Malhotra
Toby Martin
Anna McKelvey
Saad Naseer
Ted Noel
Dennis Plummer
William L. Polk, Jr.
Steven Ponciroli
Ryan Rippel
Pat Tracy
Carter Williams
Jay A. Williamson, IV
Heather Wood
Nancy Ylvisaker
Jackie Yoon

"The Danforth Leadership Council is proud to bring world-renowned thought leaders like Dr. Oniang'o to the St. Louis public. This is one small part we can play in spreading the word about the Danforth Center's vital research that has global impact while enhancing St. Louis as a world center for plant science."

- CHIP LERWICK, Chair,
Danforth Leadership Council

"Young Friends continues to grow in service to the Danforth Center mission. This year's Party with the Plants event set a record for attendance and raised more than $25,000 for STEM education and outreach."

- STEPHANIE REGAGNON, Chair, Young Friends

2018 Young Friends

The Young Friends is a group of professionals, 40 and under, who support the mission of the Danforth Center.

Party with the Plants: A Night to Support STEM Education

On Friday, June 8, the Young Friends of the Danforth Center hosted the second annual Party with the Plants. More than 300 young professionals enjoyed an evening of music, magic and fun and generated $25,000 to benefit the Innovation Fund, which supports STEM education, outreach, internships and more.

2018 YOUNG FRIENDS STEERING COMMITTEE

Stephanie Regagnon, *chair*
Logan O'Connor, *vice-chair*
Erica Agnew
Tony Aiazzi
Melanie Bernds
Stephen Brauer, Jr.
Will Brown
David Culver, Jr.
Mary Fuller
Lyle Gulley
Anne Haudrich
Bartow Hawes
Kyra Hjelle
Michael Hollo, Jr.
Erin Jones
Anna Krane
Kevin Maher
Chip Mallin
Will McHargue
Davey Oetting
Molly Ortwerth
Nick Pass
Harsha Paul
Harry Pettey
Matt Plummer
Teddy Potter
Tim Rodgers, Jr.
Andrew Rzonca
Dan Schindler
Carter Schmid
Justin Scholz
Casey Sears
Tyler Short
Scott Smithson, Jr.
Joy Straney
Sloan Stuart
John Wahl
Michael Williams
Irene Yu

2018 Corporate Partners

Corporations are more than donors. They are valued partners. Companies that support the Danforth Center empower people everywhere to enjoy better health and a higher quality of life. An investment in the Center is an investment in creating economic growth and security in the St. Louis region and beyond. With gratitude for the generous support of the following companies in 2018.

$100,000 AND GREATER

WELLS FARGO
Edward Jones

$50,000 - $99,999

BOEING

25,000 - $99,999

BANK OF AMERICA
MilliporeSigma

$10,000 - $24,999
Ameren
Butler's Pantry
Maritz Inc.
US Bank

$5,000 - $9,999
Aon Risk Services Central Inc.
Bunge North America Foundation
Premier Party Rentals
Prolog Ventures, LLC

$1,000 - $4,999
Anders CPAs + Advisors
Argent Capital Management
Bayer CropScience
Benson Hill Biosystems
Clayco, Inc.
Color Art Palette Inc.
CSI Leasing, Inc.
FieldWatch, Inc.
Hjelle Advisors LLC
Monsanto Company
Novus International, Inc.
Paycom Payroll LLC
St. Louis Economic Development Partnership
Tarlton Corporation
The St. Louis Trust Company
Thompson Coburn LLP

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Oak Tree Products
RubinBrown LLP
S4 Agtech
Seven Pines Garden Club
St. Louis AgriBusiness Club
TechAccel LLC
Wednesday Club of St. Louis
The Yield Lab - AgTech Accelerator

"Learning about the Danforth Center made me want to be even more involved. The Danforth Center wants to feed the world. Talk about an aspirational vision! I'm proud of the role my fellow colleagues and partners at Edward Jones have played in supporting the Center."

- PENNY PENNINGTON, Managing Director, Edward Jones

"I chose to put the Danforth Center in my will because it is a world-class facility and by making a gift, I can be part of it."

- DR. KEN MARES, Member, Legacy Society

Creating a Legacy

The Legacy Society provides for the future of the Danforth Center through planned gifts. Founding members include Dr. William H. Danforth, Mary† and Oliver † M. Langenberg, and Mrs.† Jefferson L. Miller.

LEGACY SOCIETY

Anonymous
Mel† & Sue† Bahle
Senator & Mrs. Christopher S. Bond
William R. Boyle†
Ann Case
Dr. & Mrs.† William H. Danforth
Dr. Robert† & Lorene† Drews
Elizabeth Early
Mr. & Mrs.† David C. Farrell
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Mr. & Mrs. David P. Gast
Mrs. Charles Guggenheim
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Dr.† & Mrs. Wilfred R. Konneker
Mary† & Oliver† Langenberg
The Mares Family Endowment
Mr.† & Mrs.† Jefferson Miller
Mr. & Mrs. John W. Rowe
Carol & D.C.† Rucker
Mr. & Mrs. Austin Tao
Alice H. Vosburgh
Ambassador & Mrs. George Walker, III
Mr. Blanton J. Whitmire†
Mr. & Mrs. John J. Wolfe, Jr.
Aleene Schneider Zawada

† deceased

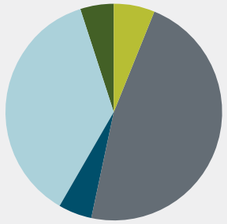
Legacy Advisory Council

Legal and financial estate planning experts who generously provide assistance with the promotion of planned gifts to the Danforth Center.

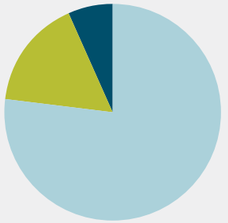
KENNETH J. BOWER, Clayton Financial Group
STEPHEN B. DAIKER, Bryan Cave LLP
MATTHEW G. PERLOW, Husch Blackwell LLP
BUD STRONG, Husch Blackwell LLP

Selected Financial Data

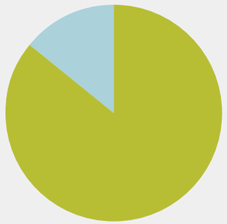
Fiscal year ended December 31, 2018
(Unaudited)



UNRESTRICTED OPERATING REVENUES [1]	2018 ($000's) Revenue	Source %
Donor Gifts	$2,173	6.4%
Research Grants and Contracts	$16,069	47.1%
Core Facility Fees	$1,707	5.0%
Draw from Endowment Appropriated for Spending	$12,561	36.8%
Other Income	$1,639	4.7%
Total Operating Revenues	$34,149	100.0%



OPERATING EXPENSES [2]	Expenditures	Expenditure %
Total Research/Science	$22,942	77.1%
Administration	$4,848	16.3%
Development and Public Relations	$1,954	6.6%
Total Expenses from Continuing Operations	$29,744	100.0%



CAPITAL EXPENDITURES	
Lab and Core Facility Equipment	$2,667
All Other	$431
Total Capital Expenditures	$3,098
NON-OPERATING EXPENDITURES	
Debt Service Payments	$551
DEPRECIATION EXPENSE	
Depreciation of Fixed Assets	$7,333

Notes:
[1] Cash basis and excludes income(loss) on Endowment investments and reimbursement for subcontracted research.
[2] Excludes subcontracted research on Grants and Contracts and Depreciation Expense.

A Brighter Tomorrow

The Danforth Center is building a brighter tomorrow for people and the planet. Support the mission today: **danforthcenter.org/give.**

OUR MISSION |

Improve the human condition through plant science

Feed the hungry and improve human health

Preserve and renew our environment

Enhance the St. Louis region as a world center for plant science

975 North Warson Road / Saint Louis, MO 63132 / danforthcenter.org

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