

DONALD DANFORTH PLANT SCIENCE CENTER DISCOVERY | COMMUNITY | IMPACT

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

2019 Annual Report

At the Donald Danforth Plant Science Center, we believe in the power of plants. By discovering and harnessing these powers, we will feed and fuel the world, heal the planet, and help our changing climate. We believe that human ingenuity, innovation, and determination can solve the greatest challenges of the 21st century. Our work is already benefiting people here at home and around the globe.

Yes, people and plants can do that.

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Letter from the Chair

This past year, 2019, has been one of great change and opportunity. Danforth Center scientists have made impressive advances toward growing more food and food with enhanced nutrition. They have embarked upon foundational research to help develop biofuels and agriculture that can heal the planet. In addition to advancing solutions to our most crucial problems, the Danforth Center has brought in new, exciting talent and strengthened our local economy.

Spin-out Benson Hill will now be headquartered on the Danforth Center campus, creating hundreds of new jobs for St. Louis. The Wells Fargo Innovation Incubator partnership (IN²) is bringing greater investment to our region. And the Center continues to invest in the future of innovation through STEM education and outreach in schools across our region, programs that we celebrated at Plantasia 2019. The Danforth Center's continued focus on discovery and innovation will have a substantial impact on our community and our world.

Our Founding Chair Bill Danforth once said, "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 sciencebased industry." Bill's comment still rings true today, and I am honored to succeed John McDonnell as the third chair of the Danforth Center Board as we work to bring Bill's vision to life.

The Danforth Center seeks to address the biggest challenges of the 21st century—hunger, malnutrition, environmental degradation. By working together with our many supporters, partners, and friends, we are making a difference. Thank you for your generosity.

Letter from the President

As we start 2020, the Danforth Center community and supporters should feel good about what we've achieved together during the past twelve months. Much like the prairie that embraces the front of our campus, the Danforth Center changes, grows, and builds strength each year.

The Center invested heavily in talented people and facilities in support of our mission to improve the human condition through plant science. We welcomed Kirk Czymmek, PhD, as principal investigator and the new director of the Advanced Bioimaging Laboratory (ABL). Kirk quickly transformed the ABL with new imaging technology and a collaboration-first approach to working with our scientific teams. We also welcomed Kristine Callis-Duehl, PhD, as principal investigator and the new Sally and Derick Driemeyer Director of Education Research and Outreach. Kris has established an ambitious, research-centered approach to bring plant science to the classroom and beyond.

This was a record-setting year of growth at the Danforth Center! Our scientific teams set high-water marks for number of scientific discoveries published and amount of competitive research funding awarded. These, of course, were enabled by a record number of generous donors who recognize the importance of investing in science to address grand challenges at the nexus of food and the environment. And we saw growth continue in the 39 North innovation community with the start of construction of the EDGE@BRDG building on campus.

Our Danforth Center community of scientists, staff, and supporters gets better every year. Thank you for joining us!



Lood R Solmer

Todd R. Schnuck



James C. Carrington

OUR PEOPLE

THE ENGINE THAT POWERS THE ENTERPRISE

Our principal investigators are the engine that powers the Danforth Center. Their discoveries lay the groundwork for new technologies. They attract the brightest minds in the field for their labs and land major national research grants. Fueled by a passion for changing the world through plant science, their labs make the critical discoveries that propel the plant science community forward.





Doug Allen, PhD

Associate Member and USDA Research Scientist The Allen lab uses isotopes combined with computational methods to assess plant growth and productivity at the molecular level that contribute to enhanced biomass production and valueadded seed compositions.



Rebecca Bart, PhD

Associate Member The Bart lab combines genetics with molecular and computational biology to study host – microbe interactions in important crops including, cassava, sorghum, and cotton.



Ivan Baxter, PhD

Associate Member The Baxter lab uses advanced technologies to understand the diverse ways plant genetics interacts with the environment to enable growth.



Kristine Callis-Duehl, PhD

Sally and Derick Driemeyer Director of Education Research and Outreach The Education Research & Outreach lab studies how to effectively engage students in authentic STEM research at all grade levels, K-16, in formal, informal, and virtual learning environments in an effort to recruit the next generation of diverse STEM and agtech scientists and leaders in St. Louis and around the world.



James Carrington, PhD President

The Carrington lab focuses on how plants respond to viruses, mechanisms of epigenetics, and how crops can be improved to increase productivity.



Bioimaging Laboratory The Czymmek lab uses advanced imaging approaches to understand the inner workings of plants, microbes, their interactions with each other and the environment.

Kirk Czymmek, PhD

Bradley Evans, PhD Director, Proteomics and

function of organisms.

Director, Advanced





Andrea Eveland, PhD Assistant Member The Eveland lab uses experimental and computational approaches to investigate the regulation of architecture traits and yield potential in cereal crops.

Noah Fahlgren, PhD

Director, Data Science Facility The Data Science team is a computing and data analytics hub that develops and deploys technologies in computational biology, computer science, mathematics, and statistics to accelerate discoveries from data and models in plant science.



Malia Gehan, PhD Assistant Member The Gehan lab develops highthroughput phenotyping approaches to study mechanis



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Elizabeth Kellogg, PhD

Member and Robert E. King Distinguished Investigator The Kellogg lab studies genomes, growth, and development of sorghum, maize, and their wild relatives, using biodiversity research to make ecosystems and agriculture more sustainable.

Toni Kutchan, PhD

Member, Oliver M. Langenberg Distinguished Investigator, VP for Research The Kutchan lab studies the production of the anticancer compound cyclopamine in cor

compound cyclopamine in corn lily, the modification of plant medicinals by the soil microbiome, and the oilseed crop camelina as a source of renewable fuel.

Mao Li, PhD



Senior Research Scientist & Principal Investigator The Li lab develops mathematical methods, models, and computational tools to extract and analyze comprehensive plant morphological features from 2D and 3D imaging data to fully utilize new technologies and accelerate biological discoveries.

Donald MacKenzie, PhD









Blake Meyers, PhD

Member and Professor, Division of Plant Sciences, University of Missouri – Columbia The Meyers lab uses experimental and computational approaches to study plant reproduction and fertility to enhance yield gains in crop plants.



Allison Miller, PhD

Member and Professor of Biology, Saint Louis University The Miller lab explores how longlived plants respond to dynamic environments, with the goal of developing perennial crops that support ecologically sustainable agricultural systems.



Todd Mockler, PhD

Member and Geraldine and Robert Virgil Distinguished Investigator The Mockler lab uses genomics, high-resolution phenotyping, and computational biology to understand plant responses to environmental stresses to improve productivity in food and energy crops.



Dmitri Nusinow, PhD

Assistant Member The Nusinow lab focuses on finding new genes that have the potential to increase productivity in response to daily and seasonal changes in light and temperature.



Sona Pandey, PhD

Associate Member The Pandey lab uses molecular, biochemical, and functional studies to understand the mechanisms of stress tolerance and yield improvement in plants by heterotrimeric G-proteins.



Dilip Shah, PhD Associate Member

The Shah lab investigates modes of action of antifungal plant defensins and defensin-like peptides to enable development of fungal disease resistant crops for yield protection.

R. Keith Slotkin, PhD

Associate Member and Associate Professor, Division of Biological Sciences, University of Missouri – Columbia The Slotkin lab seeks to uncover how plants determine which regions of their genomes should be expressed, which regions should not be expressed, and to create new technologies in plant biology.

Nigel Taylor, PhD

Associate Member and Dorothy J. King Distinguished Investigator The Taylor lab has advanced virusresistant cassava into regulatory field trials in East Africa as a critical step toward delivering enhanced planting materials to farmers.



Christopher Topp, PhD Associate Member

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

James Umen, PhD



Member, Enterprise Rent-a-Car Institute for Renewable Fuels and Joseph Varner Distinguished Investigator

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



Veena Veena, PhD

Director, Plant Transformation Facility The Veena lab explores novel approaches for plant genetic engineering and genome modification technologies to enable plant biology research for crop improvement.

Professor, University of Missouri – St. Louis



Ru Zhang, PhD

crops.



Sam Wang, PhD Member and E. Desmond Lee The Wang lab focuses on lipid

metabolism and signaling in plant response to nitrogen/phosphorus/ water deficiency and seed oil production.

Bing Yang, PhD



FOOD SECURITY FOR A CHANGING PLANET

Danforth Center scientists conduct fundamental research about how plants work – how they grow, how they capture the energy of the sun, how they resist disease, how they take up nutrients. But we do not stop there. Through cutting-edge research, critical partnerships, and groundbreaking innovation, we are helping bring food security to the people who need it most.

The Institute for International Crop Improvement applies discoveries and leads regulatory efforts to bring improved crops to people who need them most.

IMPROVED BLACK-EYED PEAS WILL:
Prevent losses of up to 80% from pod borer insect.
Reduce the dangerous use of spray pesticide.
Improve food security for 200 million people in Africa.

A Historic Milestone

New Pest-Resistant Cowpea Bringing Food Security to Nigeria

We know them as black-eyed peas in the U.S., but cowpeas (*Vigna unguiculata*), or simply "beans" as they are called by most Nigerians, are an important food crop throughout much of Africa. More than 200 million people depend on them for their daily dietary protein. Nigeria is the world's largest producer, growing more than sixty percent of the world's output.

Cowpea tolerates drought and poor soils, and as a legume, supplies its own nitrogen. However, the crop is susceptible to pod borer insects, with losses up to 80 percent when attacked. To keep the insects at bay, Nigerian farmers spray pesticides six to ten times throughout the growing season, often with no protective gear, at substantial expense and risk to their health.

In 2019, a historic milestone was reached when Nigeria approved a new pod-borer resistant (PBR) cowpea. It was approved following a decade-long safety review by local scientists and will be in farmers' hands in the coming year. The variety was developed by an international team with the Danforth Center's Institute for International Crop Improvement providing regulatory support. "In the Hausa language, the name of this bean is literally 'meat for the poor.' Black-eyed peas are a crucial source of dietary protein and a pest-resistant variety is a vital step toward food security."



-DONALD MACKENZIE, PhD, Danforth Center IICI director

OUR WORK

Children holding cassava. Even when enough calories are consumed, malnutrition is a pervasive problem in Africa. Enriched cassava is being developed by scientists at the Danforth Center to help.

"Enriched cassava has the potential to improve the nutrition and health of millions of people throughout Africa."



 ANDREW KIGGUNDU, PhD, Danforth Center VIRCA Plus
 Project Manager

Fighting The Hidden Hunger

New Progress in Danforth Center's Cassava Enrichment Project

Cassava (*Manihot esculenta*) is drought-tolerant crop and staple food for more than 500 million people in Africa. It is abundant in calories, but not essential nutrients.

Micronutrient deficiency, especially of iron and zinc, is widespread in Africa. In Nigeria, for example, 75 percent of preschool children and 67 percent of pregnant women are irondeficiency anemic. When children lack vitamins and minerals, even if adequate calories are consumed, the resulting malnutrition can cause illness, stunted growth, and impaired cognitive development. Public health workers call this "the hidden hunger."

The Danforth Center's **Nigel Taylor, PhD**, Dorothy J. King Distinguished Investigator, and **Andrew Kiggundu, PhD**, Danforth Center project manager, are fighting this hidden hunger. Their project, VIRCA Plus, is an international collaboration to develop cassava with significantly higher levels of iron and zinc.

In 2019, a new study published in *Nature Biotechnology* demonstrated that it is possible to raise the iron and zinc content of cassava roots while maintaining yield and other plant characteristics that are important to farmers and consumers. The VIRCA Plus team also confirmed that the higher mineral levels are preserved during cooking, so that improved nutrition will actually reach the dinner plate and the digestive tract. Field evaluations are now underway.



Abundant in calories Tolerant of drought

- A staple food for 500 million people in Africa
- Lacking in essential minerals

Foundational Science for Food

Plant Evolution and Reproduction Better Understood through Danforth Center Research

Danforth Center scientists participate in broad research to better understand the origins and functions of plants and their genes. Their findings provide new and often crucial knowledge that can help improve food crop breeding. The findings can also help scientists and breeders better prepare for the unexpected in a changing climate.

In 2019, the Danforth Center's Oliver M. Langenberg Distinguished Investigator **Toni Kutchan, PhD**, vice president for research, along with a team of nearly 200 scientists, published a broad study in *Nature* of the RNA expressions of the genes of one thousand plants. Nicknamed "One Billion Years of Green Evolution," the study reveals insights into how and when plants first grew tall, and how and when plants learned to make seeds.

Also in 2019, an international team of scientists led by **Blake Meyers**, **PhD**, Danforth Center principal investigator and professor at the University of Missouri, has overturned one element of previous understanding of reproductive evolution. As published in *Nature Communications*, one of the pathways for small RNA production critical to reproductive success that was previously believed specific to grasses has now been demonstrated to be widely present in the flowering plants.



Distant relations? Danforth Center Distinguished Investigator Toni Kutchan, PhD, participated in a broad study of one thousand different species that sheds light on important details of green plant evolution.



"Understanding the genetic mechanisms by which flowers develop is important for improving crop yields and breeding better varieties."



–BLAKE MEYERS, PhD, Danforth Center principal investigator and professor, University of Missouri — Columbia

SUSTAINABLE SOLUTIONS FOR ENVIRONMENTAL HEALTH

The Danforth Center has a mission to feed the hungry and improve human health while preserving and renewing the environment. Our work is bringing sustainability to agriculture as never before. We are helping to harness the power of nature to restore soil health and fertility—and even fix carbon while feeding and powering the world. It's plant science in service to the planet.



Perennial Power

Nearly 70 percent of cropland is dedicated to annual plants, such as wheat, corn, and soy. But perennial crops offer many advantages, such as decreased water use and diminished soil erosion. That's why **Allison Miller**, **PhD**, principal investigator at the Danforth Center, is leading the Global Inventory Project. This Danforth Center collaboration with The Land Institute, Missouri Botanical Garden, and Saint Louis University, seeks to identify wild perennial plant species that are strong candidates for potential development as food crops. In 2019, the Miller lab identified and grew twelve perennial crop candidates for evaluation. They automated seedling data collection with the Bellwether Phenotyper and then planted in an experimental field at the Shaw Nature Reserve, where plants are being monitored for overwintering capacity and yield.

The Hidden Half of Plants

Roots are the foundation of plant health. In the past, studies of roots growing in soil required killing the plant, and so were unable to capture the dynamic nature of root growth and soil interaction. Danforth Center principal investigator **Chris Topp, PhD**, has created a unique method to study roots combining cutting-edge X-ray microscopy with 3D computerized tomography. Already the work is yielding results in "rhizo-economics," the study of the microbial ecology fostered by plant root systems, including symbiotic interactions of mycorrhizal fungi. In 2019, the Topp lab deployed their technology to analyze the roots of corn, rice, and other plants in order to develop more robust, sustainable crops.

"Perennial crops allow us to harness the power of plants to nourish both humanity and the planet."



-ALLISON MILLER, PhD, Danforth Center principal investigator and professor, Saint Louis University





Danforth Center Distinguished Investigator James Umen, PhD, (left) is an internationally renowned algae expert. He was chosen by the U.S. Department of Energy in 2019 to lead the hunt for the meaning of Deep Green genes, which are believed to be key to unlocking stress tolerance in bioenergy crops.

Sorghum growing beneath the TERRA-REF field scanner gantry in Maricopa, AZ. Danforth Center Principal Investigator Andrea Eveland, PhD, is leading a DOE initiative to deepen the understanding of bioenergy sorghum's spectacular drought-tolerance.



Blueprint for Bioenergy

Replacing fossil fuels with sustainable sources of energy is imperative for our future. Solar and wind power are part of the solution, but not a complete answer. Current sources of biofuels compete with food crops and cannot be scaled to provide the sustainable sources of energy the world's growing population needs. At the Danforth Center's Enterprise Rent-a-Car Institute for Renewable Fuels, scientists are exploring solutions.

Deep Green Genes

In 2019, the U.S. Department of Energy (DOE) launched a major initiative for the development of bioenergy crops. DOE tapped **James Umen, PhD**, the Danforth Center's Joseph Varner Distinguished Investigator and an internationally renowned expert on algae, to lead the multi-institutional collaboration. The goal? To predict functions for hundreds of uncharacterized plant genes, the so-called "Deep Green" genes.



"While genome sequences for plants and algae are being produced in evergrowing numbers," said Umen, "our knowledge of what most plant and algal genes do remains remarkably limited. These genes hold untapped potential for improving bioenergy crops."

Deliverance from Drought

What if you could grow your own fuel? And grow it where it's too hot and dry for any other crops? Sorghum is the fifth most widely grown cereal crop worldwide, but it's number one when it comes to natural resilience to heat and drought. In 2019, the DOE tapped Danforth Center Principal Investigator **Andrea Eveland, PhD**, to lead a new multi-institutional project to improve sorghum's potential as a bioenergy crop. Eveland and her team hope to do this by uncovering the genes responsible for the crop's resistance to drought, as many aspects of what makes sorghum so stress-resilient are unknown.

 A crop domesticated in Africa 5,000-8,000 years ago

• A drought-and heattolerant plant that grows where other crops can't A super-converter of solar energy to biomass, thus a leading bioenergy candidate



Innovation for Sustainability

Processing of the opium poppy is chemical-ridden and creates toxic waste byproducts. In 2019, as published in the journal Nature Sustainability, Danforth Center scientist Megan Augustin, a research associate in the Kutchan lab, identified a new process that harnesses the naturally occurring enzymes of a microorganism. This green chemistry has the potential to generate lifesaving antidotes more sustainably and at reduced cost.

When Plants Breathe In

Danforth Center scientists are joining with Washington University in St. Louis to predict the effects of rising carbon dioxide levels on crops. The project harnesses the Danforth Center's expertise in controlled plant growth, cutting-edge 3D imaging, and mathematical modeling. The effort is supported by a 2019 grant from the National Science Foundation. Danforth Center principal investigators involved include Noah Fahlgren, PhD; Keith Slotkin, PhD; and Malia Gehan, PhD (pictured at left), as well as Chris Topp, PhD; Mao Li, PhD; Blake Meyers, PhD; and Sona Pandey, PhD.

BUT I

CATALYZING INNOVATION FOR THE WORLD

In our mission to improve the human condition through plant science, the Danforth Center combines world-class talent with cutting-edge infrastructure and technology. This combination in the thriving 39 North innovation community is inspiring agtech companies to choose St. Louis, attracting investors, and creating economic growth and jobs.



The Speed of Change



Just over 30 years from now, in the year 2050, Earth will be home to some 10 billion people. To feed everyone, we will need to double the amount of food we currently produce—and do so with less land, less water, and subject to an unpredictable climate. To meet the challenge will take sound science and transformative thinking. Promising technologies need testing and validation to make it to market.

That's why the Danforth Center has partnered with the Wells Fargo Innovation Incubator (IN²) to provide facilities, equipment, and expertise to speed promising agtech startups addressing critical sustainability challenges. In 2019, the first cohort of early-stage companies was announced. From 36 invited participants, five were selected. Danforth Center principal investigators have been paired with each company for development and validation, in order to speed promising agtech to market.

The founders. From 36 submissions, IN² selected five startups for an intensive partnership aimed at speeding promising agtech to market. From left: Tyler Sickels and Sunil Sahi of SolGro. Bala Venkata of RNAissance Ag. Cris Handel of CoverCress. John Freeman and Ahsan Ali of IntrinsyxBio. Orlando Saez of Aker Technologies. Tim Ulmasov of CoverCress. Brad Fabbri of RNAissance Ag/ TechAccel.



A Leading Collaboration

In 2019, the Danforth Center partnership with IN² was selected as one of only four "lead collaborators" with the Bloomberg New Economy Forum. Other lead collaborators include Bill + Melinda Gates Foundation, MasterCard's Humanitarian Group, and Global Trade Professionals Alliance.



CLAIRE KINLAW

New Director of Innovation Commercialization Claire Kinlaw, PhD, joined the Danforth Center in 2019 as director of innovation commercialization. She holds a PhD from Rice University in biochemistry and molecular plant genetics and an MBA from University of California – Berkeley. She has extensive experience in early-stage commercialization through her previous work for the Larta Institute and TerViva.

_ 39°Nj

39 North is the 600-acre innovation community anchored by the Danforth Center, BRDG Park, Helix Center Incubator, the Yield Lab, Bayer Crop Science, and soon the headquarters of Benson Hill. In 2019, 39 North completed the redesigned plans for the Old **Olive Street and** Interchange projects. Visit the new website 39northstl.com for the latest developments.



"I have witnessed firsthand how technology can profoundly improve the lives of farmers. RNAissance Ag aims to do just that."



BALA VENKATA, PhD,
 Danforth Center research
 scientist and RNAissance Ag
 co-founder

Another St. Louis HQ **BENSON** • **HILL**

Benson Hill is a crop improvement company co-founded by Danforth Center Principal Investigator **Todd Mockler, PhD**. After obtaining venture capital from GV (Google Ventures), the startup officially named St. Louis its headquarters in 2019, closing an office at Research Triangle Park and bringing more than 300 jobs to the St. Louis region. Their offices will anchor the new EDGE@BRDG building under construction on the Danforth Center campus in the 39 North innovation community. "We chose to expand our presence in St. Louis because of its leadership in plant science and commitment to innovation," said Matthew Crisp, Benson Hill CEO and co-founder.

Breakthrough Discovery Sparks New Company



While many insects are beneficial to our environment, others are not. Billions of dollars are spent each year in control measures and yet nearly twenty percent of crops are lost to insect damage. Danforth Center Research Scientist **Bala Venkata, PhD,** has a solution—one that does not harm the environment, humans, or beneficial insects, like bees. His company, RNAissance Ag, offers targeted pest control using a novel method of RNA interference. The company spun out of the Danforth Center in 2019 and was selected as part of the first IN² agtech cohort.





INSPIRING TOMORROW'S SCIENTISTS

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

OUR FUTURE

Next Gen STEM

The Danforth Center provides dynamic, hands-on, inquiry-based STEM education—and involvement in actual Danforth Center research—to students throughout the St. Louis region and beyond. By sharing our science, the Center hopes to inspire a scientifically informed citizenry and the scientific leaders of tomorrow.



The Danforth Center's **Green Means Grow** program is an agtech design/build challenge for grades K-5. Students construct and test functional hydroponic gardens to grow fresh food. The curriculum emphasizes real-life problem solving in plant biology, nutrition, and crop agronomy—and decreases barriers to accessing nutritious foods in food deserts. In 2019, Green Means Grow reached 400 students in the classroom and another 700 students in full-day immersive **STEM Splash Days** held at Meadows and Danforth elementary schools, Riverview Gardens district. These programs are supported by a grant from Boeing.

Authentic research experiences are the focus of STEM outreach for middle school and high school students. Danforth Center educators also conduct teacher professional development workshops, introducing cutting-edge technologies, like **augmented and virtual reality** (image far right) to improve access for all.



- BRITTANY DOUGLAS, Boeing Community Investor, St. Louis

"Boeing supports the Danforth Center's STEM education and outreach because we believe that STEM learning benefits us all."

On January 26, more than 900 people attended the fourth annual Raspberry Pi Jam at the Danforth Center. Kids and adults learned about DIY computing through hands-on demonstrations with microcomputers, soldering, robotics, 3-D printers, and more. Sponsored by Boeing, National Science Foundation, Outside Inside Thinking, Paycom, and Young Friends of the Danforth Center.







A Pipeline of Plant Scientists

The Research Experience for Undergraduates is an 11-week intensive summer program with generous support from the National Science Foundation. In 2019, the Danforth Center again took part in our 16th year as an REU institution. More than 230 students competed for 19 spaces at the Danforth Center in this competitive and rigorous training program. Students receive hands-on research experiences with mentoring from top-tier scientists, helping to create a pipeline of plant scientists prepared to address both current and future global challenges. The 2019 REU was organized by Principal Investigators **Sona Pandey, PhD**, and **Ru Zhang, PhD**, Grant Manager Cathy Kromer, and Administrative Assistant Shannon Rapp.

Over 16 years, the Danforth Center has hosted 322 interns from 41 states, Puerto Rico, and Washington DC.



KRISTINE CALLIS-DUEHL

New Director of Education Research and Outreach

Kristine Callis-Duehl, PhD, joined the Danforth Center in 2019 as principal investigator and the Sally and Derick Driemeyer Director of Education Research and Outreach. She has a PhD in biology/ecology from the University of Florida and was previously an assistant professor of biology education at East Carolina University. Callis-Duehl succeeds Terry Woodford-Thomas, PhD, who retired after nearly 19 years at the Center.



KEVIN COX Danforth Center Post-Doc Named a Hanna Gray Fellow

In 2019, Howard Hughes Medical Institute named **Kevin Cox, PhD**, one of 15 national recipients of the prestigious Hanna H. Gray Fellowship, which provides \$1.4M over four years of postdoctoral support and training. A post-doctoral associate in the Meyers lab, Cox has a background in plant pathology. His research seeks to understand how plants fight infection by developing a cellularlevel view of the battles between plants and microbes.





SURESH POKHREL Mizzou Grad Student Named WHD Fellow

Suresh Pokhrel, a third-year PhD student at the University of Missouri – Columbia, was named the 2019 William H. Danforth Plant Science Fellow. The fellowship was endowed in honor of Dr. Danforth by Dr. P. Roy and Diana Vagelos and supports outstanding PhD students whose research demonstrates great promise for advancing plant science. Pokhrel is a member of the Meyers lab and is studying male fertility in eudicots.





A Microscopy Discovery

As published in Nature Plants in 2019, researchers have discovered a previously unknown mycorrhizal compartment believed important for nutrient exchange and molecular communication between the symbiotic partners. **Howard Berg, PhD**, former microscopy director at the Danforth Center, led the multi-institutional team in pairing high-pressure freezing techniques with electron microscopy and tomography to reveal the structure.

Spotlight on Advanced Bioimaging Lab

World-class facilities attract world-class talent and partnership. Danforth Center core facilities equip our scientists and partners with state-of-the-art instrumentation, cutting-edge technology, and the expert guidance to do innovative groundbreaking research. In 2019, the Danforth Center expanded the capacity of its Integrated Microscopy Facility to include high-resolution 3D imaging at the nanoscale, single-molecule approaches, as well as automation and machine learning, to enhance and accelerate research and discovery. The expansion was led by the new Director, Kirk Czymmek, PhD, who joined the Center in June. A new name, the Advanced Bioimaging Laboratory, reflects the new technologies and research capabilities.

"Remarkable technological advances in imaging allow us to visualize unprecedented views of the inner workings of plants as well as their interactions with other organisms and the environment," said Czymmek. "Scientists can leverage these imaging advances to make new discoveries in plant science for the benefit of humankind."



KIRK CZYMMEK

New Director of Advanced Bioimaging

Kirk Czymmek, PhD, was named the new director of the Advanced Bioimaging Laboratory (formerly the Integrated Microscopy Facility) in 2019. He succeeded R. Howard Berg, PhD, who retired after 19 years in the role. Czymmek is a renowned expert in the microscopy field with 30 years of experience and 95 refereed publications. Prior to joining the Danforth Center, he served as vice president of Global ZEISS Microscopy Customer Centers and was an associate professor at the University of Delaware, where he helped found the Delaware Biotechnology Institute Bio-Imaging Center.

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. We are grateful.

Plantasia

Plantasia is an opportunity to thank our Danforth Society supporters for their exceptional dedication and generosity—and to come together and just have fun. Plantasia 2019 was held on November 9 at the Four Seasons, accommodating a crowd of over 400. The theme was "Inspiring Tomorrow's Scientists," a celebration of the Danforth Center's science education and outreach. Long-term supporter and board director Brett Begemann was honored with the Danforth Distinguished Service Award.



2019 Plantasia Sponsors

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Party with the Plants

Organized by the Young Friends since 2017, Party with the Plants is a good time for a good cause. On June 7, the Young Friends of the Danforth Center hosted the third annual Party with the Plants. More than 300 young professionals enjoyed an evening of music, magic, and fun. The Event raised \$56,000 for the Danforth Center Innovation Fund, supporting STEM education, outreach, internships, and more.

> The Danforth Center is grateful to the sponsors, committees, and everyone who worked so hard to make **Plantasia** and **Party with the Plants** resounding successes in 2019.

2019 Party with the Plants Sponsors

Silver (\$2,500+)

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Bronze (\$1,000+)

Adama USA Advantage Capital Anders CPAs & Advisors Aon Blitz Bardgett & Deutsch LLC Carrollton Bank CMA Color Art Palette Inc. CoverCress Inc. **EWR Radar Systems** Hjelle Advisors LLC Merrill Lynch (Davey Oetting) MOgene **MWM Industries** Novus International Paulo

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4Hands, AB InBev, Alpha Brewing, Defiance Whiskey, Crushed Red, Mission Taco, Trademark Wines, White Claw Hard Seltzer

Danforth Society Membership Committee

Molly Cline, PhD, chair Tim Halls, vice-chair Cicardi Bruce Ann Case Ann Desloge **Steve Epner Glenn Fischer** George Fonyo Gary Halls Phil Hellwege Paul Kravitz David Rath Tim Rodgers John Rowe **Rich Schumacher** James R. von der Heydt

"The Friends Committee helps engage the public in the mission of the Danforth Center. In 2019, we achieved a record number of both new Danforth Society members and donors over all. If you're reading this, you are an integral part of the Danforth Center's success. Thank you."



- TIM RODGERS, Chair, Friends Committee

2019 Friends Committee

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

2019 FRIENDS COMMITTEE

Tim Rodgers, *chair* James R. von der Heydt, *chair emeritus* A. Van Brokaw, III Bruce Buckland Harold R. Burroughs Ann Case Molly Cline, PhD Joan Culver Maebelle Danforth Ann Desloge Adie Dietz George Fonyo Roberta (Robbye) Frank Jane Goldberg † Gary Halls Tim Halls Ruth E. Kim M. Paul Kravitz Ann Liberman Jay Nouss, Jr. Stephanie Regagnon John W. Rowe Jared Spader Matt S. Wolfe

Young Friends Steering Committee

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

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Logan O'Connor, *chair* Stephanie Regagnon, *chair emerita* Matt Plummer, *vice-chair* Davey Oetting, *vice-chair*

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2019 Conversations Series

Organized by the Friends Committee since 2003, Conversations is a series of free public events that provide 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.

In 2019, the Danforth Center hosted: BIG IDEAS 2.0: A BIG SUCCESS | MARCH 7

Three teams of junior scientists presented their best new ideas to address big challenges in agriculture and the environment. Chip Lerwick, managing director of Aon and chair of the Danforth Leadership Council (DLC), served as emcee. After each team's presentation, a panel asked questions, which included Julie Lilly, CEO of The St. Louis Trust Company and DLC member; Tim Rodgers, founder of Rodgers Townsend and chair of the Danforth Center Friends; and Stephanie Regagnon, CEO of FieldWatch and chair emerita of the Danforth Center Young Friends. After an audience vote, Team Jumping Gene from the Slotkin lab took home top honors—and a grant to pursue their idea at the Danforth Center.

CONNECTING SMALLHOLDERS TO SCIENCE | AUGUST 22

Smallholder farmers aren't small. In fact, their impact on the world's food supply is startlingly large. Farmers with land of less than 25 acres account for some 98% of the world's agriculture. Ruth Kaggwa, PhD, Danforth Center STEM education and outreach manager, and Donald MacKenzie, PhD, director of the Institute for International Crop Improvement at the Danforth Center, discussed the topic in a conversation moderated by Natalie DiNicola, chief communications officer of Benson Hill and vice-chair of the Danforth Leadership Council.

INSIDE THE INNOVATION INCUBATOR (IN²) | OCTOBER 17

The Wells Fargo Innovation Incubator (IN²) connects promising start-up companies with cutting-edge scientists to help move breakthrough technologies faster to marketplace. This conversation about the program and the Danforth Center's role involved Mary Wenzel, Executive Vice President and Head of Sustainability and Corporate Responsibility for Wells Fargo Advisors, and Sam Fiorello, Chief Operating Officer of the Danforth Center and President of BRDG Park. It was followed by a deeper dive into the first agtech cohort with Aker Technologies and RNAissance Ag.











2019 Seeds of Change

Organized by the Danforth Leadership Council since 2010, Seeds of Change is a free annual lecture by a renowned thought-leader to inspire and unite people to make positive change. Seeds of Change 2019 took place on May 8 and featured Bob Chapman, chairman and CEO of St. Louisbased Barry-Wehmiller and author of the Wall Street Journal bestseller *Everybody Matters*. A Q&A with Penny Pennington, managing partner of Edward Jones, followed.

Media sponsorship by:

"We must have the courage to see past our differences to recognize a common goalhealthy food from a healthy planet."



- BRETT BEGEMANN, COO, Bayer Crop Science and Danforth Center board of directors, recipient of the 2019 Danforth Service Award

2019 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* Benjamin Ola Akande Kathy Bader Christopher B. Danforth Julie Lilly Dennis M. Plummer Michael Scully

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2019 Corporate Partners



"We wanted to know that we were leaving a legacy to the St. Louis region, and the Danforth Center was a natural choice."



– ANN CASE, Legacy Society Member

Legacy Society

The Danforth Center is grateful for members of the Legacy Society. These generous donors have provided for the future of the Center through planned gifts. Founding members include Dr. William H. Danforth, Mary† and Oliver † M. Langenberg, and Mrs.† Jefferson L. Miller.

LEGACY SOCIETY

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Tribute Gifts 📖

The Danforth Center is grateful for donors who honor or memorialize their friends, loved ones, and colleagues with a gift to the Center.

In Memory Of

Sue Bahle Frank & Mariann Baker Mr. & Mrs. Jack Bodine Mr. & Mrs. Bradley D. Ives Jane & Milton† Rand Mrs. Carol Rucker Dr. Susan A. Westcott & Dr. Michael L. Westcott

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2019 Volunteer Docents -----

The Danforth Center is grateful for our docents, highly trained volunteers who lead tours, engage the public, increase awareness, and build donor support in the St. Louis community and beyond.

Molly Cline, PhD Joan Culver Steve Epner Robbye Frank Glenn Fischer Rashmi Nair Rich Schumacher Merv Schrock Matthew Rubin Alice Wolfe Dylan Zielonko



A Brighter Tomorrow

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

Selected Financial Data

Fiscal Year Ended December 31, 2019

(Unaudited)

	_	2019 (\$000's)	
	UNRESTRICTED OPERATING REVENUES ¹	Revenue	Source %
	Donor Gifts	\$2,513	7.1%
	Research Grants and Contracts	\$16,695	47.1%
	• Core Facility Fees	\$1,944	5.5%
	Draw from Endowment Appropriated for Spending	\$12,975	36.6%
	Other Income	\$1,290	3.7%
	Total Operating Revenues	\$35,417	100.0%



OPERATING EXPENSES ²	Expenditures	Expenditure %
Total Research/Science	\$24,632	78.6%
Administration	\$4,722	15.1%
Development and Public Relations	\$1,991	6.3%
Total Expenses from Continuing Operations	\$31,345	100.0%

CAPITAL EXPENDITURES						
	Lab and Core Facility Equipment	\$474				
•	All Other	\$196				
	Total Capital Expenditures	\$670				
	NON-OPERATING EXPENDITURES					
	Debt Service Payments	\$558				
	DEPRECIATION EXPENSE					
	Depreciation of Fixed Assets	\$7,393				

Notes:

¹Cash basis and excludes income(loss) on Endowment investments and reimbursement for subcontracted research.

² Excludes subcontracted research on Grants and Contracts and Depreciation Expense.

2019 Board of Directors

TODD R. SCHNUCK Chair Chairman and Chief Executive Officer, Schnuck Markets, Inc.

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* Chancellor Martin assumed the office from Chancellor Wrighton in mid-2019.

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CHIP LERWICK Managing Director, Aon

TIM RODGERS Co-founder, Rodgers Townsend

Board Elects Two New Members

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KIERSTEN E. STEAD, PhD Managing Partner, DCVC Bio

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OUR VALUES

Collaboration • Diversity and Inclusion • Innovation • Integrity and Respect • Environmental Sustainability • Stewardship

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