



Predictive Plant Phenomics Program

2020

Annual Report

August 2019-
August 2020



Predictive Plant Phenomics Program
we build things to grow green stuff better

IOWA STATE UNIVERSITY



Research Traineeship

Program Overview

The Predictive Plant Phenomics (P3) Program, a National Science Foundation Research Traineeship (NRT), serves as a model for the future of transdisciplinary education, notably in the field of Plant Sciences.

We have formed a community of practice here at Iowa State University, in synergy with the Plant Sciences Institute. The P3 model has been used in new plant science-based NRTs at Cornell, Michigan State University, University of California-Riverside and North Carolina State University.

Our vision of the P3 NRT project is realized through three goals:

- 1. Utilize transdisciplinary research bridging engineering, plant sciences and data sciences to improve the understanding of crop and agricultural production.**
- 2. Develop scientists and engineers with broad skillsets to address the research needs of Goal 1, and who have an appreciation of the abilities and limitations of other disciplines and the confidence and communication skills to interact with them.**
- 3. Implement and assess the ASPBT-training model at ISU to create a community of practice at ISU and across other plant sciences programs for effective transdisciplinary training.**

Since 2016, this specialization has matriculated 29 doctoral students, including twenty-six (26) NSF NRT funded doctoral students (scholarship recipients), and two (2) non-funded doctoral students. Twenty-five students have completed the program or will complete it this year, and are now endowed with the understanding and tools to develop methods to predict plant growth and productivity based on information about their genome and environment.

P3 Leadership Team



Julie Dickerson
Principal Investigator
Professor, Electrical and Computer Engineering



Ted Heindel
Co-Principal Investigator
Bergles Professor of Thermal Science,
Mechanical Engineering

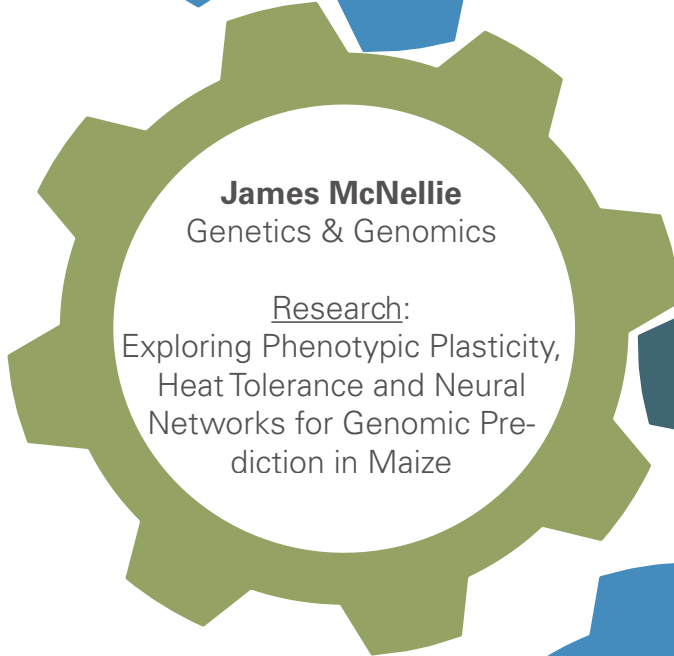
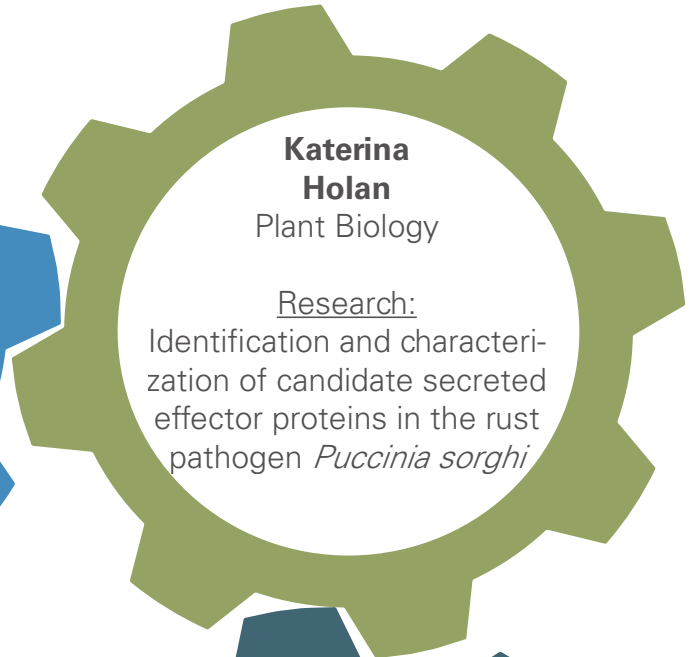
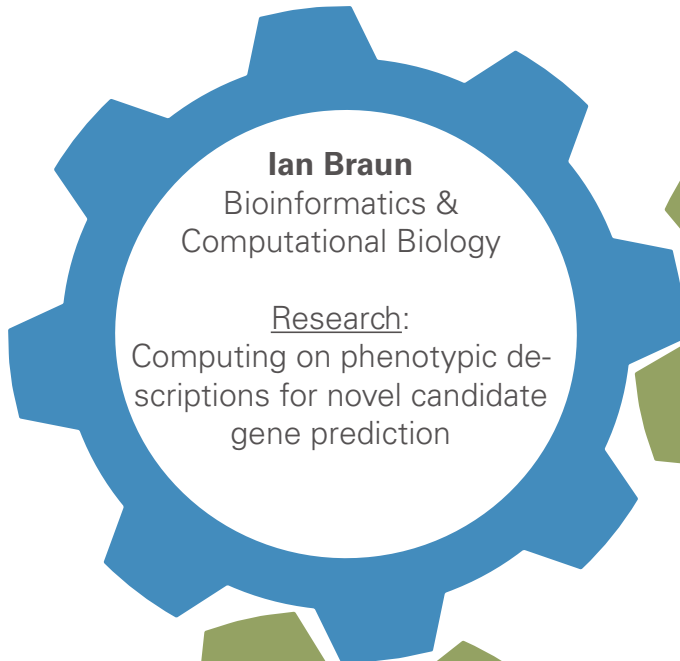


Carolyn Lawrence-Dill
Co-Principal Investigator
Professor, Genetics, Development and Cell Biology



Patrick Schnable
Co-Principal Investigator
C. F. Curtiss Distinguished Professor, Agronomy and
Genetics, Development and Cell Biology
Iowa Corn Endowed Chair in Genetics
Baker Scholar of Agricultural Entrepreneurship
Director, Plant Sciences Institute
Director, Center for Plant Genomics

P3 2016 Trainees



P3 2017 Trainees



Clayton Carley

Agronomy-Plant Breeding

Research:

Breeding below ground:
phenomics and genomics for
advancing soybean root
traits



Zachary Lozier

Bioinformatics &
Computational Biology

Research:

Functional analysis of
subgenomic RNAs produced
by autonomously replicat-
ing small RNA species



Ashley Paulsen

Genetics & Genomics

Research:

Microbiomes in transparent soil
as a means of phenotyping
root-environment
interactions



Lyle Sisson

Genetics & Genomics

Research:

Modeling and optimization of
single and multi-allele
introgression in cannabis



Schuyler Smith

Bioinformatics &
Computational Biology

Research:

Analyses of microbiomes and
their impact within their
environmental systems



Paul Villanueva

Bioinformatics &
Computational Biology

Research:

Persistent homology of
microbial community
assemblages

P3 2018 Trainees



Matthew Carroll

Agronomy-Plant Breeding

Research:

Optimization and machine learning for plant breeding



Tanner Cook

Plant Biology

Research:

Tool to detect meiosis induction in high-throughput genotyping



Samantha Snodgrass

Plant Biology

Research:

Genomic sequence evolutionary consequences in *Zea*: form follows functions?



Cassandra Winn

Agronomy-Plant Breeding

Research:

Evaluating use of crop-growth models in genotype x environment interactions; and implementation in plant breeding



Colleen Yanarella

Bioinformatics & Computational Biology

Research:

Speech-to-text for building phenotyping data for ontologies analysis




Jacob Zobrist

Genetics & Genomics

Research:

de novo domestication of teosinte

P3 2019 Trainees



Kevin Chiteri
Genetics & Genomics
non-funded trainee

Henri Chung
Bioinformatics &
Computational Biology

Colin Finnegan
Bioinformatics &
Computational Biology

Tyler Foster
Agronomy-Plant Breeding

Brianna Griffin
Plant Biology

Research:
Rel2-acetylation in plant
pathogen interactions

Kaitlin Higgins
Genetics & Genomics

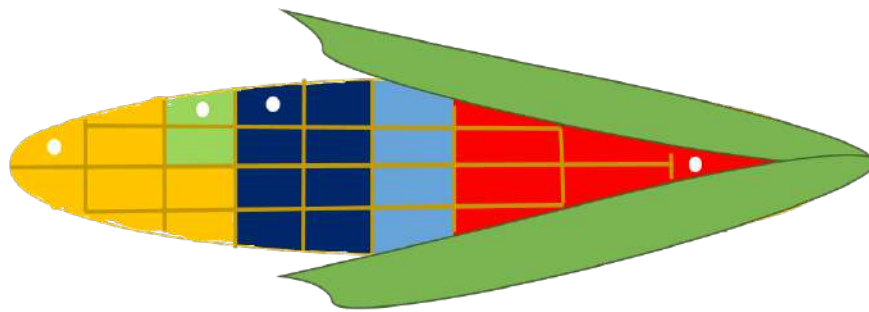
Juan Panelo
Agronomy-Plant Breeding
non-funded trainee

Ashlyn Rairdin
Agronomy-Plant Breeding

Trainee Demographics



Major Programs



28%
Genetics &
Genomics

28%
Bioinformatics &
Computational
Biology

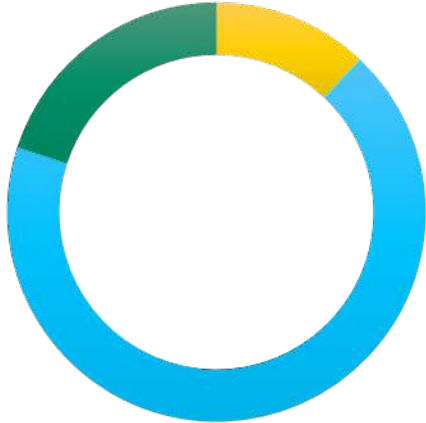
24%
Agronomy-Plant
Breeding

13%
Plant Biology

7%
Mechanical
Engineering

○ Dot denotes trainee who exited program

Professional Aspirations



■ Government ■ Industry ■ Academe

Internships



Mentorships



Professional Programs



(Convion Scholars Program)



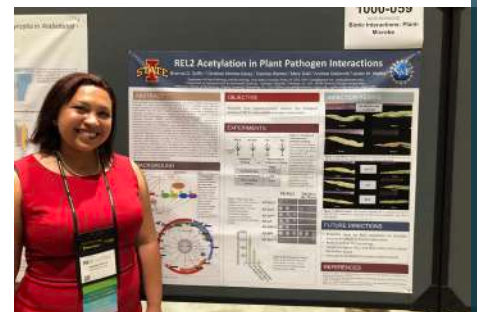
(Ambassadors Program)

Top Achievers



P3 students have had an award-winning year. Ten students received awards, fellowships or other accolades during the 2019-2020 academic year.

- **Samantha Snodgrass** is a 2020 Conviron fellow through ASPB.
- **Clayton Carley** and **Cassandra Winn** each received 2020 National Association of Plant Breeders' (NAPB) Borlaug Scholarships for outstanding contributions to agronomy.
- **Colleen Yanarella** and **Kevin Chiteri** each began Science Communication Fellowships from Reiman Gardens, a partner in the Portal to the Public program, to hone their communication skills.
- **Ashley Paulsen** was awarded a second Iowa Space Grant Consortium Fellowship and won third place in the American Society for Gravitational and Space Research for her poster presentation.
- **Tanner Cook** was awarded the agronomy department's Josef F. Schuler Graduate Fellowship and a university Brown Graduate Fellowship.
- **Brianna Griffin** is currently acting as Ambassador, American Society of Plant Biologists through spring 2021.
- Finally, **Katerina Holan** and **Ian Braun** both received National Institute of Food and Agriculture (NIFA) pre-doctoral fellowships which they each will use to complete their research and wrap up their graduate experience.





P3 Student Awards

This year, the Predictive Plant Phenomics (P3) program developed student awards to recognize some of the achievements of P3 graduate students.

Four categories of awards were developed to acknowledge the hard work, dedication and successes of P3 students. Each category, along with the winners, is described below. Winners received \$100 and a glass etched with the name of their award.

Nominations were submitted by P3 students and faculty.

Predictive Plant Phenomics student leadership award.

There are two awards available in this category. This award is to recognize two students who have engaged in outstanding service to the P3 program, fellow students, and the university. The services donated by these students have potentially impacted P3 and the university.

WINNERS: Colleen Yanarella & Tanner Cook

Predictive Plant Phenomics student engagement award.

This award is to acknowledge a P3 student's contribution to learning through an activity – including, but not limited to, a presentation or tour – that was both engaging and displayed a mastery of content that inspired further learning by those in attendance.

WINNER: Paul Villanueva

Predictive Plant Phenomics peer mentor award.

This award is to recognize exceptional peer mentoring by a P3 student to another P3 student. The nominee should have a demonstrated commitment to sharing their knowledge, abilities, and experiences to help develop the capacities of others, in terms of professional or personal growth.

WINNER: Samantha Snodgrass

Predictive Plant Phenomics research excellence award.

This award is to recognize the high quality research, pursued by a P3 student, which advances the field of predictive plant phenomics. A student may be awarded based on the uniqueness or strength of their research project, including a project which embodies the collaborative spirit which is required for the interdisciplinary work inherent in predicting plant phenotypes.

WINNERS: Johnathon Shook & James McNellie

P3 in the News: Plant Cy-nce Toy Boxes



First-year graduate student Hyeon Chung works in the Roy J. Carver Co-Lab greenhouse as part of the "Fundamentals of Predictive Plant Phenomics" course. Photo by Caitlin Ware | Office of the Vice President for Research

10.29.2019

P3 PROGRAM INTRODUCING NEW TECHNOLOGY, TEAMWORK TO THE CLASSROOM

Plant Sensors Bringing Class Concepts to Life

By Caitlin Ware, Office of the Vice President for Research

Since its start in 2015, Iowa State University's Predictive Plant Phenomics (P3) graduate program has focused on changing the



The achievements and awards of Predictive Plant Phenomics faculty and trainees are chronicled on the P3 website (<https://www.predictivephenomicsinplants.iastate.edu/>), under the News tab. The program and its faculty affiliates has been highlighted by various Iowa State University news services over the years. For example, in October 2019, the Vice President for Research Office published a story on the P3 core course, "Fundamentals of Predictive Plant Phenomics," describing the implementation of Plant Cy-nce Toy Boxes. These boxes are designed to encourage experimentation and exploration with a variety of plant and environmental sensors. Also included in the boxes are cameras, processors and kits to build economical rovers.

Students have been quite committed to learning and utilizing the boxes both in terms of outreach and research. For example, members of the Predictive Plant Phenomics Graduate Student Organization (P3GSO) built three styles of rovers - of increasing sophistication - and put together three demonstrations for attendees of the Phenome 2020 conference in Tucson, AZ. This activity was part of the second annual P3 symposium, which is generously sponsored by Corteva Agrisciences. Prior to the conference, members of the P3GSO arranged a demonstration of their planned activity for P3 faculty so the trainees could practice their duties for the demonstrations and to work through any challenges that popped up. Non-P3 students have also enjoyed exploring the Plant Cy-nce Toy Boxes: one student from the *Fundamentals* course kept her group's kit so that she could incorporate some of the sensors into her graduate research project and two engineering students checked out spare kits for their projects.



2019-20 P3 Activities & Responding to COVID-19


Completed Activities	Postponed Activities
<p><u>P3 Learning Community</u>: includes student-led planning for P3 Symposium; virtual policy talk with Senator Quirmbach; virtual “how to balance commitments” with Dr. Lawrence-Dill (bottom left photo)</p>	<p>P3 <u>student-led outreach activity</u> with community organization or school to practice their science communication skills</p>
<p><u>Workshop</u> on training for the small unmanned aerial systems (sUAS) pilot license (bottom center photo, courtesy Carolyn Lawrence-Dill)</p>	<p><u>Workshop</u> for NRTs on how to organize boot camps for incoming trainees (may be held during virtual NRT annual meeting in January 2021)</p>
<p>P3-organized <u>Field Trip</u> to Zylstras’ farm in Central Iowa, in coordination with Iowa Corn (bottom right photo, courtesy of Rod Williamson/Iowa Corn)</p>	<p>P3 <u>student-led field trip</u> to local farm and businesses</p>
<p><u>P3 Graduate Student Organization (P3GSO)</u> visit to Corteva Agrisciences campus</p>	<p><u>P3 Symposium</u> - which is planned by the P3GSO beginning in the summer - will be postponed to spring 2021 or later</p>



Institutional Impact

The 2020-21 Academic Year will mark P3's first no-cost extension year. Although there is an option for a second no-cost extension, P3 Leadership is making plans for closing out the program and arranging for certain program elements to continue without any centralized P3 administrative support. Below is a list of program elements and an explanation of if and how it will continue to be offered at the university.

- **P3 Boot Camp** - A 10-day introduction to the emerging field of predictive plant phenomics that includes some workshops open to non-trainees. The open events have been popular with non-trainees, particularly the data skills training sessions. No boot camp is planned for 2020, but some elements - like the data skills sessions - could be institutionalized.
- **Fundamentals of Predictive Plant Phenomics** (course) - This course provides students with the necessary tools and vocabulary to tackle multidisciplinary predictive plant phenomics problems. It exposes students to engineering principles such as transport phenomena and sensor design, data science activities, and plant science fundamentals. Will continue to be offered in fall semesters.
- **Plant Cy-nce Toy Boxes** - Built for the Fundamentals course and exhibited at Phenome 2020 conference, these plant sensor kits include environmental sensors, mini processors, color card, cameras, and rover parts. Will continue to be available in the course and for individual check-out from Dr. Lawrence-Dill.
- **Entrepreneurship for Graduate Students in Science & Engineering** (course) - This course introduces students to key topics of starting a technology-based company, intrapreneurship and the entrepreneurial ecosystem at ISU and in Central Iowa. Local entrepreneurs share their stories in guest lectures and class culminates in five-minute business pitch competition. Included as core course in DataFEWision NRT. Will continue to be offered fall and spring semesters.



- **Experiential Learning** (course) - This one-credit summer semester course brings graduate students and advanced undergraduate students to farms, businesses, and other agricultural institutions across the United States to expose them to different agricultural, economic, and cultural environments in order to gain an understanding as to how these factors contribute to the food system. It is planned for Summer 2021 and includes overnight travel.

- **P3 Research Grants** - Available to all students conducting research related to predictive plant phenomics, until August 2021.

- **P3 Travel Grants** - Available to all students conducting research related to predictive plant phenomics, until August 2021. Limited to domestic flights and air carriers.

- **P3 Small Project Grants** - Available to all students conducting research related to predictive plant phenomics until, August 2021. Includes team-based projects.

- **P3 Graduate Student Organization** - Student-led group that plans events for professional development, including the P3 Symposium. Coordinates an annual visit with Corteva Agrisciences in Johnston. Continuance is dependent on student leadership.

- **P3 Symposium** - Student-led, two-day event that showcases work of P3 students and four invited speakers. Preceded by a workshop the previous day. Sponsored by Corteva Agrisciences. Continuance is dependent on student leadership and sponsorship.

- **P3 Learning Community** - Students in specialization meet at least once monthly to explore professional development opportunities, practice science communication skills, plan P3GSO events, or discuss any other topics of interest. This activity will not be continued.



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