

Annual Report of Research Activity

OFFICE OF THE SENIOR VICE PRESIDENT FOR RESEARCH

Surpassing a milestone

Wow! What a year we have had. We persevered through a pandemic, experienced social unrest, and weathered national political divisions. Yet, through all of this, we have remained resilient. We attained record research expenditures, maintained a healthy research workforce, and cultivated personal and professional relationships in ways we had never envisioned.

Our research portfolio exceeded a significant milestone in FY2019-20, with expenditures surpassing **\$1 billion**. This achievement places us among a select group of research universities, and reflects the breadth and depth of our research expertise.

Attaining this milestone is especially remarkable given the added challenges of rapidly developing wide-ranging responses to a worldwide pandemic. Our research community mobilized to meet the global crisis (see facing page) and developed approaches to safely sustain our vast research enterprise while ensuring and prioritizing the health of our community. This involved developing contingency plans, initially curtailing on-campus activities, and developing approaches to gradually increase on-campus research while supporting new approaches to conducting research remotely.



In spite of these obstacles, our expenditures increased by **\$40 million**, with a record **\$633 million** in federal funding and **\$375 million** from a combination of private funders, the Commonwealth of Pennsylvania, and University sources. It is a testament to the **world-class quality** and **teamwork** of our dedicated faculty, staff, and students. It reflects the **extraordinary expertise** within our research portfolio, the **talent** of our researchers, and the continued **confidence** of our sponsors.

Our perseverance under these challenging circumstances demonstrates our resilience and readiness to fulfill our land-grant mission in Pennsylvania and around the world. The unyielding dedication and devotion of our team have been exceptional. The cordiality and collegiality have been admirable, and the events we have experienced will remain with us for a lifetime. **As researchers, colleagues, parents, neighbors, community partners, and friends, we will emerge even stronger.** Thank you for your resilience.

Senior Vice President

for Research

READY TO RESPOND

When challenged with an unprecedented global crisis, Penn State's research enterprise was ready to respond. In February, we moved into action, signing the Wellcome Trust commitment to open access of COVID-19 research. By March, we seeded **48 research teams**. Our grassroots MASC (Manufacturing and Sterilization for COVID-19) group **grew from 20 individuals to more than 300**, supporting the immediate needs of our frontline healthcare workers. In doing so, we partnered with local businesses to **scale production** of our innovations.

More than **100 researchers** across three campuses, **10 colleges**, and more than **25 departments** rapidly transitioned their research programs. Our investigators studied plasma therapy, antivirals, and vaccine candidates to complement first-generation solutions. Those who study flu, Zika, and dengue pivoted to research on SARS-CoV-2. We joined colleagues around the world to track the outbreak's origins, and made more than **50 videos** informing the public about this pandemic. Our facilities were positioned to support investigations in genomics, metabolomics, fermentation, and cryogenic electron microscopy. Our research support offices put in incredible efforts, processing more than **9,000 submissions involving research with human subjects** and more than **900 no-cost extensions** to grants and contracts, and filing more than **70 new patents**.

Many of our researchers have been able to leverage external support as they work toward solutions that will benefit society both during the current pandemic and in facing challenges yet to come.

These are just some examples of the spirit of collaboration that distinguishes our researchers and interdisciplinary research institutes. The following pages offer brief updates on some of the institutes' activities and provide a glimpse into the scope of the world-class research that Penn State has to offer. MANY OF OUR RESEARCHERS HAVE BEEN ABLE TO LEVERAGE EXTERNAL SUPPORT AS THEY WORK TOWARD SOLUTIONS THAT WILL BENEFIT SOCIETY BOTH DURING THE CURRENT PANDEMIC AND IN FACING CHALLENGES YET TO COME.



CANCER INSTITUTE

The Penn State Cancer Institute (PSCI) is focused on fighting cancer nationally and in central Pennsylvania through education and prevention, early detection and diagnosis, effective treatment, and survivorship programs. All of these efforts benefit from the Cancer Institute's rigorous research programs which engage clinicians, laboratory scientists, and community members. For example, researchers have launched a human clinical trial that combines targeted chemotherapies for leukemia patients with an omega-3 fatty acid supplement. This translational research was based on a novel discovery that dietary substances, such as fish oils, activate a cellular pathway that targets and kills leukemia stem cells.



CLINICAL AND TRANSLATIONAL SCIENCE INSTITUTE

In 2020, the Clinical and Translational Science Institute collaborated with Highmark Health Enterprise Analytics to investigate the incidence of diseases of despair in Pennsylvania. By analyzing claims data of more than 12 million people, the team determined that diagnoses involving alcohol-related disorders, substance-related disorders, and suicidal thoughts and behaviors—all associated with diseases of despair increased in Pennsylvania between 2007 and 2018. Nearly one in 20 people in the study was diagnosed with a disease of despair. Between 2009 and 2018, the rates of alcohol-, substance-, and suicide-related diagnoses increased by 37 percent, 94 percent, and 170 percent, respectively. The Institute provides tools, services, and education to make health research more efficient, and it engages in science that can transition to society, with a special focus on rural health.

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INSTITUTE FOR COMPUTATIONAL AND DATA SCIENCES

Navigating the complex world of data and computational science can be a challenge for research teams with varied skill sets and experience levels. Penn State's expertise in all aspects of massive analytics ranges from fundamental algorithm conception to medical applications and meteorological discoveries. To enable these advances, in 2020 the Institute for Computational and Data Sciences, with a \$1.3 million grant from the National Science Foundation, began scale-up of a team known as Research Innovations with Scientists and Engineers (RISE). The RISE team partners with research groups at all Penn State campuses to develop tools, hardware, and software; optimize code; build workflows; and set up collaborative environments. This foundation then enables sophisticated computational approaches such as machine learning, science gateways, predictive analysis, and more.



INSTITUTES OF ENERGY AND THE ENVIRONMENT

Through the Institutes of Energy and the Environment and the new Consortium for Integrated Energy Systems, the University is facilitating interdisciplinary, solutions-focused research and innovative programs to create the next-generation of energy scientists, scholars, researchers, and workforce. Goals include minimizing environmental footprints of energy generation systems, leveraging computational and data sciences to tackle complex energy challenges, and delivering energy services efficiently and affordably. One example of Penn State's interdisciplinary approach is Energy 2100, a strategic initiative focusing on renewable energy research, outreach, and education. Energy 2100 has organized clusters of faculty, students, and external stakeholders who work together on solar, biofuels, wind, hydrogen, batteries, and the support systems required for a renewable energy transition. Complementary energy-related activities include the Center for Energy Law and Policy, the Global Building Network, and the Drawdown Scholars program.



HUCK INSTITUTES OF THE LIFE SCIENCES

COVID profoundly impacted this interdisciplinary institute's focus, spurring a great deal of research. A rapid-fire seedgrant effort awarded \$2.4 million to 48 research teams, spanning 10 Penn State colleges. Projects cover diagnostics and detection, therapeutics and vaccines, transmissionblocking interventions, predictive modeling, and cohort studies. Additionally, Huck labs provided testing for the University Park campus and the surrounding community, enabling antibody testing of Centre County residents and Penn State students through the Data4Action project, a partnership with the Social Science Research Institute and the Clinical and Translational Sciences Institute, as well as wastewater testing through a collaboration with the Institutes of Energy and the Environment. Finally, Huck informed the public about coronavirus and Penn State's research response though AskCIDD videos and The Symbiotic Podcast.



SOCIAL SCIENCE RESEARCH INSTITUTE

Researchers in Penn State's Child Maltreatment Solutions Network, an interdisciplinary group of faculty affiliated with the Social Science Research Institute, have published new research showing how a new child sexual abuse prevention program, Smart Parents–Safe and Healthy Kids (SPSHK), can be successfully integrated into evidence-based parenteducation programs. SPSHK teaches parents how to recognize sexual abuse as well as behavioral skills for protecting children. This approach was designed to leverage existing parent education infrastructures and thus boosts sustainability and engagement. Child sexual abuse is estimated to affect more than one in four women and one in five men in the U.S., with more than 63,000 new cases each year.

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MATERIALS RESEARCH INSTITUTE

Founded in 1992, the Materials Research Institute (MRI) drives multidisciplinary materials research at Penn State through the operation of core facilities, leadership, inclusive partnerships, and creative technological innovations to address complex problems at both the local and global levels. To help meet its mission, MRI recently partnered with industry and government to establish several new centers that address specific areas requiring interdisciplinary research. Two centers created in 2020 include the Penn State Convergence Center for Living Multifunctional Material Systems (in partnership with the University of Freiburg) and the Energy Frontier Research Center (funded by the Department of Energy), which is focused on 3-D ferroelectric microelectronics.



2020

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APPLIED RESEARCH LABORATORY

The Applied Research Laboratory (ARL), established at Penn State in 1945 at the request of the U.S. Navy, celebrated 75 years of innovation and discovery in 2020. Originally focused on undersea weapons technology development, ARL now includes a broad research portfolio. Innovative solutions are being developed to address challenging national problems in sea, land, air, space, and cyber domains through basic and applied research, rapid prototyping, and demonstration and fielding of technologies. Advanced physics modeling uses high performance computing for design and analysis. Advanced manufacturing addresses issues related to materials design, materials processing, component design, manufacturing systems, logistics, and sustainment. Excellence in undersea weapons, unmanned undersea vehicles, and advanced sonars supports undersea warfare through development and demonstration of science and technology. The combined expertise, tools, and processes provide for an innovative and aggressive approach to assuring national security.





SOURCES OF RESEARCH FUNDING

1 Federal \$633,105,000

2 University \$205,496,000

3 Industry and other \$100,973,000

4 Commonwealth of Pennsylvania \$68,355,000

Total \$1,007,929,000





EXPENDITURES FROM FEDERAL AGENCIES

EXPENDITURES BY PERFORMING UNIT

1 Department of Defense \$293,762,000

- 2 Department of Health and Human Services \$142,408,000
- 3 National Science Foundation \$66,576,000

4 Other \$50,880,000

Commerce \$2,353,000 Education \$2,483,000 Interior \$1,201,000 Transportation \$6,949,000 Other Federal \$37,894,000

5 USDA \$32,991,000

6 DOE \$30,864,000

7 NASA \$15,624,000

Total \$633,105,000



1 Agricultural Sciences \$114,786,000

- 2 Defense Related Research Units \$309,452,000
- 3 Earth and Mineral Sciences \$70,790,000
- 4 Eberly College of Science \$122,558,000
- 5 Engineering \$153,153,000
- 6 Health and Human Development \$53,633,000
- 7 Information Sciences and Technology \$11,430,000
- 8 Liberal Arts \$37,567,000
- 9 Medicine \$103,344,000

10 Other Campuses \$10,206,000

Altoona College \$1,449,000 Behrend College \$3,398,000 Berks College \$666,000 Capital College \$2,466,000 Great Valley \$545,000 Other Commonwealth Campuses \$1,682,000

11 Other Colleges \$21,010,000

Arts and Architecture \$2,402,000 Communications \$971,000 Education \$9,554,000 Dickinson School of Law \$277,000 International Programs \$4,000 Nursing \$3,337,000 Penn State Law \$494,000 Smeal College of Business \$3,971,000

Total \$1,007,929,000



PENN STATE TECHNOLOGY TRANSFER AT A GLANCE Total revenue: \$2.2 million



Technology transfer data are for the period January–December 2019.

\$3.16B

TOTAL

AMOUNT OF

PROPOSALS

4,726

PROPOSALS

SUBMITTED

NEW & COMPETING

CONTINUATION AWARDS

RECEIVED

1.91

20 20

A SAMPLING OF MAJOR AWARDS

INVASIVE PEST

The United States Department of Agriculture awarded \$7.3 million to fund efforts to understand the biology of the Spotted Lanternfly and advance efforts to manage the spread of this invasive pest and reduce its impact on specialty crops in the Eastern United States.

STREAMLINING SCIENCE

The National Science Foundation awarded \$3.5 million to fund efforts to increase the speed and improve the functionality of Galaxy, a scientific workflow-management system that is used to share, integrate and analyze research across many disciplines. The main focus will be improving the speed and functionality of Galaxy by making the system compatible with graphics processing units (GPUs).

FOOD RESILIENCE

The Open Philanthropy project awarded \$3 million for the interdisciplinary study of food resilience in the face of a major global catastrophe, to test and optimize strategies for emergency food resilience, and to produce recommendations for prudent planning for post-catastrophic food resilience.

STEM SUCCESS

The National Science Foundation awarded \$1.98 million to improve the preparation of future elementary teachers. The project will investigate the use of a small-group, teacher-facilitated discussion approach by teacher educators in STEM methods courses and classroom-based field experiences to improve the quality of elementary mathematics instruction.

OPIOID TREATMENT

The National Institutes of Health awarded \$2.36 million to further study of whether a GLP-1 receptor agonist drug already approved to treat obesity and Type 2 diabetes can be used to reduce cravings and prevent relapse in those struggling with opioid addiction.

SUMMARY OF RESEARCH PROPOSALS AND AWARDS

SPONSORS

\$**722**м

TOTAL

AMOUNT OF

AWARDS

3,232

AWARDS

RECEIVED

2,150

INVESTIGATORS

RECEIVING

AWARDS

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FOR MORE INFORMATION, VISIT OUR WEBSITE:

research.psu.edu

FOR THE LATEST NEWS ABOUT PENN STATE RESEARCH, VISIT:

news.psu.edu/topic/research

IMAGE CREDITS:

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PAGE 5 IEE: Tyler Henderson/Penn State

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