Testimony of

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Chairwoman Stevens, Ranking Member Baird and Members of the Subcommittee, I am Theresa Mayer, Executive Vice President of Research and Partnerships and Professor of Electrical and Computer Engineering at Purdue University in Indiana. Thank you for the opportunity to testify to the subcommittee today, and for your efforts to ensure the CARES Act included funding to help universities cover the significant costs associated with our ongoing response to the COVID-19 pandemic. Addressing the needs of our undergraduate students was, and remains, absolutely critical. We also appreciate the flexibilities that federal agencies have offered researchers during this national and global emergency.

The U.S. University Research Enterprise and Our COVID-19 Response

America's university system is often called a crown jewel of our nation and an engine of innovation that has powered the U.S. as the world's largest economy. Our university-based advances have launched ideas, processes, and people to address daunting grand challenges that today range from cost competitive solar energy to artificial intelligence and understanding the human brain to feeding a growing world. A positive trajectory of economic prosperity and national security depends on this continued production of new knowledge and educated people, and the long-standing, strong support of government and partnership with industry are keys to sustaining a national innovation base that leads the world.

Research universities became critical national assets because of foresighted decisions by policy makers. Sponsored research to benefit society is in our academic DNA. For over 70 years, the strong federal-university partnership has brought our nation unparalleled success in basic research at the frontiers of science and transformative innovation in medicine and technology. Most importantly, it has built human capital. Universities have attracted and developed the best and brightest talent in a campus culture that stimulates and fosters innovation. The U.S. accounts for 70-80% of the world's top 50 research universities each year and is still the top choice of

international students. The U.S. has benefited tremendously from international talent remaining in the country after studying here, with many becoming STEM leaders throughout industry, universities and government.

Academic research, talent, and technology transfer will be key in emerging Industries of the Future (IoTF) such as artificial intelligence, quantum information science, 5G and beyond, advanced manufacturing, and biotechnology. Universities tend to operate as economic accelerators. Data show that just from 1996 to 2015, university innovation contributed about $1.3 trillion to the U.S. gross industrial output with new technology that supported 4.3 million jobs. In the past 25 years, our nation's university faculty and student researchers disclosed nearly 400,000 inventions that led to more than 11,000 startups including more than 200 new drugs and vaccines—which is timely news in this age of COVID-19.

The COVID-19 pandemic will continue to bring some of the greatest challenges along with new opportunities and beneficial change to our universities and their research enterprises. Today, I am pleased to share my experience and perspective from leading the COVID-19 response for the university-wide research enterprise at Purdue University. To provide context, Purdue is the state of Indiana's comprehensive land-grant university with over 1,900 tenure-line faculty, 850 research faculty and postdocs, 10,000 graduate and professional students, and 34,500 undergraduate students, with more than 2/3 graduating in STEM disciplines. Ranked the No. 6 Most Innovative University in the U.S., Purdue delivers world-changing research and out-of-this-world discovery. Committed to affordability and accessibility, the university has frozen tuition and most fees at 2012-13 levels, enabling more students than ever to graduate debt-free. Purdue reached a record $631.5 million in research expenditures in fiscal year 2018, ranking 39th in the NSF annual survey of higher education research expenditures out of over 600 private and public universities reporting, and 22nd among public research universities.

I would also like to recognize my colleagues in the Big Ten Academic Alliance for their strong partnership and regular sharing of best practices throughout the COVID-19 response. Together the universities in the Big Ten engage in over $10.5 B in academic research each year, providing talent, discoveries, and innovation to virtually all industry sectors, medical fields, and government organizations in the U.S. and across the world. This means our research enterprises include facilities and infrastructure that are both incredibly complex and diverse – from medical labs to agricultural fields to wind tunnels. Our ongoing collaboration, together with many others in the AAU and APLU, has been instrumental to the rapid and effective response that is minimizing the negative impacts of COVID-19 on our nation's university research enterprise.

University COVID-19 Response Timeline and Status

Last March, with limited scientific data on the SARS-CoV-2 virus and associated COVID-19 disease, Purdue University, along with peers across the country, acted swiftly and decisively to transition residential undergraduate and graduate course instruction to remote delivery over the week-long spring break recess. Faculty instructors quickly and creatively adapted their course content and delivery to maintain continuity and quality under unprecedented circumstances. This transition together with the evolving university plans for the fall semester has been followed

closely by local and national media. Today, Purdue University, with many new COVID-19 safety measures and cultural changes on campus and in the community, is in its third week of hybrid residential instruction for over 70% of its 45,000 undergraduate and graduate students. The remaining 30% selected Purdue's on-line option. This milestone means that our residential students once again have opportunities to participate in hands-on, project-based and research experiences, which are critical to their academic development and career trajectory. This is particularly important as our nation strives to increase the number of domestic students who continue at the university to pursue STEM-based graduate degrees.

The impact of COVID-19 on the university research enterprise has received less wide-spread attention despite its critical importance to the U.S. scientific base, economic prosperity and national security. Given this, I believe the information shared in this testimony will be particularly beneficial to increase awareness of the process, outcomes and status as well as to assist in informing the proposed legislation currently under consideration before your subcommittee. As an example of similar efforts that are underway across the country, I will summarize the key aspects of Purdue's COVID-19 research response, current status, quantitative data on financial loss, and other short and longer-term impacts.

On-Campus and Field Research Ramp-Down

At universities across the country, the ramp-down of campus research proceeded on a different timeline and schedule than the transition from residential to remote course instruction. At Purdue University, as with many of its peers, on-campus access for research and field work began a gradual ramp-down beginning the second week of March 2020, with nearly all universities completing the transition to allowing only critical campus research efforts by the last full week of March. Both the timeline and the extent of critical research that remained operational at each university were largely determined by restrictions state-specific Executive Orders (EOs). For the most part, universities in regions with more rapid spread of COVID-19 ramped-down earlier and more completely than in other parts of the country, including the Midwest.

Purdue University continued safe campus operations following CDC guidance with progressive de-densification of research spaces and activities by transitioning to remote work whenever possible until the critical campus research restrictions took effect on March 25, 2020, which was among the last in the Big 10. During this three-week period, research leaders were given detailed guidelines to prepare their campus research spaces for reduced operation up to full ramp-down for at least one month, and possibly longer. Research involving face-to-face interaction with human subjects was suspended on March 16, 2020, and limitations were placed on beginning new experiments with research animals unless the work supported the COVID-19 response, ongoing clinical studies, and other studies that would result in significant loss of data. During the ramp-down at Purdue, more than 1,200 faculty investigators and 500 staff members who support 4,500 active sponsored programs with research in over 100 buildings and Agriculture Centers and field-sites in all 92 counties of Indiana were involved in the transition. At the same time, travel restrictions placed significant limitations on in-person field work and collaborative programs with other universities, national labs, and industry across the country and the world.

Because EOs across the Midwest had similar exemptions for higher education, the Purdue University, Indiana University in Indiana together with University of Illinois and others in the region adopted similar on-campus critical research guidance and continuity of operation plans, including: Work directly related to preventing, containing, or treating COVID-19; Longitudinal and field work that if discontinued would result in significant data or sample loss; Clinical trials or human subject research that if discontinued would result in significant negative impact on patient care or human health; Seasonally dependent agricultural research that would have critical implications for human and animal health as well as food security; Work that is directly related to national security.

A university-level process was established to review investigator requests to retain limited campus access to conduct critical research with enhanced safety measures that met or exceeded the CDC guidance at the time. This flexibility allowed critical experimental research to continue, which has been instrumental in advancing the global understanding and response to the ongoing COVID-19 pandemic, maintaining continuity of critical cell lines, multi-year longitudinal clinical, once-yearly agricultural field work, among many others.

> *Critical research on COVID-19 continued during the ramp-down*: Profs. Mesecar and Ghosh have been working together for years to develop therapeutics to fight various coronaviruses, including SARS and MERS. Their current work is progressing to test their potent drug molecules on SARS-CoV-2 virus in the BSL-3 in collaboration with Prof. Kuhn and through contract with National Institute for Allergy and Infectious Diseases (NIAID) for preclinical trials.

It is important to emphasize that, like the academic enterprise, university researchers adapted to their new reality by prioritizing work that could be done remotely. During the Purdue COVID-19 Impact Study below, we learned that most investigators with computational and theoretical programs were able to continue their work through remote access to computing and software resources with minimal loss in time or continuity to the program goals. In contrast, researchers that rely on access to on-campus experimental facilities, human subjects, and field sites suffered the greatest disruption and impact during the ramp-down. However, even for many of these researchers, the two-to-three weeks of advance notice prior to the EO-directed campus restrictions allowed them to ramp-down lab-based experiments with minimal loss of samples or data, enabling a transition to data analysis and other tasks that advanced the program. This, together with the relatively short two to three-month duration of restricted facility access for most universities, has mitigated an even more devasting disruption from lengthy closures.

> *Experimental researchers shared feedback:* "Fortunately we shifted to non-experimental work with the data we had in place," and "Any additional delays or shut downs will have an exponential (negative) effect on the research progress."

On-Campus and Field Research Return-to-Operation

For universities across the country, the work to support the transition to remote research as well as to plan the return-to-operation for the campus research enterprise began immediately after the ramp-down to critical research ended. At Purdue, this involved forming a Research Task Team

within the larger university-wide Protect Purdue Task Team, which was charged with developing and implementing a fully integrated response to support all missions of the university. In addition to research leaders, the Research Task Team included members from environmental health and safety, IT and data management, human resources, procurement, finance, and legal counsel. Beginning on May 4, 2020, when the state EO restrictions were lifted, Purdue began to implement a three-pronged research return-to-operations plan predicated on enhanced COVID-19 safety measures, including testing and contacting tracing, for:

(1) **Safe Buildings**: COVID-19 compliant public spaces;

(2) **Safe Research Spaces**: COVID-19 compliant campus labs and field-sites;

(3) **Safe People**: Protecting vulnerable individuals at highest risk for serious illness or complications from COVID-19.

The COVID-19 safety plans and responses have continued to evolve to integrate the latest data and modeling on best practices to mitigate transmission and protect high-risk individuals at the university and in the community. Purdue implemented this comprehensive set of actions on an ambitious timeline and schedule, beginning with a professionally trained team completing 100+ "Safe Building" walkthroughs and approvals of public spaces by June 1, 2020. Given the significant variability in the function and operation of campus research facilities, the "Safe Research Spaces" approach and fillable template allows research leaders to submit and update research-space specific COVID-19 Standard Operating Procedures (SOPs) for university review and approval. This provided a harmonized approach across campus, and documented approved research personnel, enhanced PPE and disinfecting requirements, space dedensification and reconfiguration plans, including shifts and remote work, among others for future planning and use in contact tracing. **Over 95% of the 1,200 campus research spaces and core labs, including individual investigator, multi-investigator, and shared user/core labs, were online under COVID-19 modified operation by June 30, 2020 target. This translated to access for 7,000 researchers, including 500 research faculty and scholars, 370 postdocs, 3,100 graduate students, and 400 undergraduates.** Professionally staffed core labs that house sophisticated and expensive shared use scientific instruments were also brought back online after recalibration and service by the staff and vendors.

Protecting vulnerable individuals with increased risk, including faculty supervisors and staff that are central to educating and training our future STEM workforce, has been a central priority through the return to operation process. The "Safe People" initiative is centered on an individualized approach to identify enhanced safety measures, e.g., N95 masks, face shields, etc., or other accommodations for campus research activities, and assistance with remote options when this is not an option. Another important aspect of this strategy is the campus-wide surveillance testing and contact tracing, which incorporates daily updates from the Research Space SOP approved personnel lists. To date, fewer than ten out of 7,000 approved researchers have tested COVID-19 positive, and there has not been evidence of transmission within the campus facilities due to strict enforcement of additional PPE in these facilities.

In addition to the lost effort and salary on sponsored programs due to reduced access to campus facilities and other COVID-19 related factors (see COVID-19 Sponsored Program Impact Study), the *institutional* costs associated with the research response are large, measured in the $10's millions for Purdue alone. Several of the highest cost items that can be attributed to the research response include: (1) employee time (and salary) realigned to the COVID-19 ramp-down and return to operation; (2) lost revenue associated with professionally staffed shared and core user labs and added costs to ramp-down and back up; (3) cost of enhanced PPE, cleaning and disinfecting supplies, retrofitting labs with barriers; (4) COVID-19 testing, contact tracing, and medical teams; (5) COVID-19 related family and medical leave. While the first two costs are expected to diminish over time, the others will continue for the foreseeable future, until a vaccine is widely available. This estimate does *not* include other institutional costs related to the broader academic response, which are significantly higher than those attributed to research here.

Importance of the OMB Guidance on Charging to Federal Awards

The OMB Guidance from March 2020, which provided agencies with the flexibility to allow institutions to continue to charge salary to federal awards at the pre-COVID-19 amount even when employees were unable to contribute to the project goals because of COVID-19 related absence or loss in productivity due to facility closure, has been critical to maintaining continuity of programs and personnel during this challenging time. The salary charges were only allowable as long as the university continued to offer pre-COVID salary and benefits to all university employees; Purdue and many other universities made this commitment through June 30, 2020. This guarantee of continued salary support at pre-COVID levels has been essential for post-docs and graduate students that require regular pay to cover monthly expenses. It has also been important for early-career researchers, particularly women and other underrepresented groups in STEM, who have been disproportionally negatively impacted by COVID-19. Although quantitative data is limited, informal feedback indicates that the flexibility afforded by the OMB guidance has stemmed the potential loss of these students and trainees from these federally funded research programs and academia more broadly.

The renewal of the guidance in August 2020 continued the same flexibility through September 30, 2020 and has reopened the door to no-cost time extensions on impacted awards, which is greatly appreciated by the university research community. Because of growing revenue losses and increasing costs, universities are beginning to turn to furloughs and reductions in force, particularly in non-research related positions. This may limit the effectiveness of this flexibility for some of the students, post-docs, and other researchers who are still being impacted by restricting salary charges to the award. In terms of no-cost time extensions on federal awards, Purdue and its university peers have found that program managers across the federal agencies have been supportive of these requests, and have worked with principal investigators on modified timelines for milestones and deliverables.

> *Researchers shared feedback:* "Sponsors were very open to shifting deliverables and scope because they understand our situation," "We worked with program managers to shift

priorities and project scope," and "A large amount of my work shifted to the COVID-19 response. NIH has been very supportive throughout."

With the current trends in COVID-19 positive cases across the country, it is reasonable to expect that federally funded researchers will continue to experience declines in productivity due to COVID-19 related issues such as absences due to illness, quarantine, gaps in childcare and school, and other factors. Therefore, ongoing flexibility in these areas, with additional flexibility granted for commitments to institutionally funded positions, particularly for graduate students and other early-career researchers, would mitigate the potential loss of our best and brightest STEM talent at this critical time for the nation.

Quantitative Data on the COVID-19-Related Financial Impact on Federal Awards

The time and resources committed to the institutional response is only one aspect of the research impact. COGR recently reported an excellent study that qualitatively analyzes and predicts the effect of different "pandemic normal" scenarios on short- and long-term financial impact to sponsored program research. It is also important to quantitatively measure and document the level of disruption and financial impact on individual sponsored programs to overall university portfolios to feed these models and to inform federal agencies of actual COVID-19 related losses due to factors including: lost access to facilities, travel restrictions preventing state, national, and international collaborations and field work, illness and family leave, and others.

To address this goal, during the ramp-down in March 2020, Purdue University collaborated with Microsoft to create a "COVID-19 Sponsored Program Impact Application." Each principal investigator with a sponsored program is presented with a custom dashboard that includes their portfolio of sponsored programs pre-populated with program data such as level-of-effort and payroll information. For each project, the researcher can indicate the financial impact of lost progress toward project goals and deliverables for each member of the research team. This information is aggregated to measure the financial impact at the grant, investigator, college, and agency level. Microsoft is collaborating with universities across the country to deploy a similar tool that will allow a greater understanding of the scientific and financial losses on sponsored program grants and contracts from the COVID-19 pandemic.*

Table 1. Impact on federal funds – an example.

Agency	COVID Period Total Expenses ($ millions)	COVID Period Reported Loss ($ millions)	COVID Impact
NSF	$ 23.77	$ 2.52	11%
DHHS	$ 22.37	$ 2.90	13%
DOD	$ 14.92	$ 1.21	8%
DOE	$ 9.18	$ 1.01	11%
DOA	$ 4.20	$ 1.17	28%
NASA	$ 3.60	$ 0.26	7%
USAID	$ 2.75	$ 0.12	4%
DOEd	$ 2.34	$ 0.14	6%
DOC	$ 2.12	$ 0.29	14%
Other	$ 1.90	$ 0.15	8%
DOT	$ 0.79	$ 0.03	4%
EPA	$ 0.51	$ 0.03	6%
DOI	$ 0.36	$ 0.01	3%
Grand Total	$ 88.81	$ 9.84	11%

At Purdue, over 70% of the 1,300 investigators who are responsible for 86% of the total $137 million sponsored program expenditure base from March 1, 2020 through June 30, 2020 have reported the percentage loss, if any, on salary, travel and other allowable costs. A high-level summary of the

aggregate financial loss for the entire portfolio is 11%, or a $15 million loss, on total expenditures. Of this, there was a 20%, or $11 million loss, on total salaries and benefits alone. For reference, the breakdown for federal agencies is provided in Table 1.* It is notable that the data collected showed that 50% of the 4,200 researchers funded on these programs reported little to no impact or financial loss over this period, which is consistent with return to operation information that shows a similar number of researchers can continue to work remotely on computation and analysis. Of the impacted researchers, 70% stated restricted access to facilities as the primary reason for the loss, 10% reporting restricted travel, and the remaining 20% a combination of factors, including COVID-19 related leave.

** Purdue has a balanced portfolio of federal funding with 27% NSF, 21% NIH, 17% DOD, 10% DOE, 11% USDA, 3% NASA and 10% other. Therefore, the trends presented here may be helpful in informing the larger national picture. However, it is important to point out that variations in the COVID-19 response timeline and makeup of the research portfolio at each university will translate into differences in the impact on scientific productivity, financial losses at the institution and on sponsored programs, progress toward grant goals and deliverables, delays in graduate student and post-doc completion, and other factors.*

The quantitative data compiled by the tool allows principal investigators and sponsored programs staff to understand the project-by-project impact so they are in a better position to respond to federal agencies' specific questions in requesting no-cost time extensions and/or modifications to program goals and deliverables (see OMB Guidance below). For many grants, the quantitative data shows that no-cost time extensions will not be sufficient to allow the original program goals to be met with the effort and financial losses that have been sustained due to COVID-19 disruptions. This is particularly harmful for graduate students, post-docs, and early-career faculty who may miss the opportunity to complete the research required to publish meaningful articles or translate their work to commercial outcomes. In addition, the sudden reduction in available positions in academia and industry due to hiring freezes at most universities and many companies is leaving many graduate students and post-docs without career opportunities in their chosen field. When taken together, these factors are leading to even greater challenges for future of the U.S. STEM workforce at a time when global competition for talent continues to increase.

Federal Support for Immediate Impact of COVID-19 and Long-Term Growth in Research and Technology Development

It is important to look at ways to support both the immediate needs of the university research community and the long-term needs to stimulate technology development and domestic high-tech capabilities through education, research, and workforce development partnerships in critical areas. To this end, the proposed bipartisan **Research Investment to Secure the Economy (RISE) Act** would provide critical support to address short-term needs with funding for basic and applied supplemental grants and funding to cover the increased costs of research facilities and equipment resulting from the COVID-19 pandemic. For longer-term sustained investment, the Big Ten senior research officers have provided a letter in support for the **Endless Frontiers Act**, which would establish a new Directorate for Technology in the redesignated National

Science and Technology Foundation and establish a regional technology hub. These investments in regional technology development would be critical to helping the research community recover and create a more resilient tech sector following COVID-19. Finally, the **Creating Helpful Incentives to Produce Semiconductors for America (CHIPS) Act** would establish investments and incentives to secure the U.S. semiconductor, research, and development, and supply chain that underpins all of the IoTFs. In particular, universities and their regional ecosystems would help carry out a program of research and development to accelerate the design, development, and manufacturability of next generation microelectronics, and ensure the creation of a domestic workforce trained in these skills.

Protecting our researchers already in the pipeline is of utmost importance to maintain our technological superiority in the face of increasing global competition. A combination of investments in research and talent development is required for the U.S. to maintain its position in science and technology and be better prepared for the next pandemic, major disaster, or disruptive event. This includes ensuring the next generation of university faculty and researchers are not lost to the COVID-19 crisis due to the large financial losses being sustained by universities across the country. The **Supporting Early-Career Researchers Act** would provide critical emergency support for post-doctoral fellowships to prevent the loss of research talent due to job market disruptions caused by the pandemic.

Closing Remarks

I wish to thank you again for the opportunity to testify to the subcommittee. My colleagues and I appreciate you holding this hearing to gain a thorough understanding of the impacts of the COVID-19 pandemic on the university research enterprise. As you have heard, the pandemic is impacting university research immediately and directly. However, we are all concerned that if we don't protect and adequately fund research today, our future technical superiority, economic prosperity, and national security will be at greater risk.

Theresa S. Mayer is the executive vice president for research and partnerships at Purdue University, where she oversees the $670 million research enterprise of the university and supports holistic engagements with federal, industry, and global strategic partners. Prior to this role, she was the vice president for research and innovation at Virginia Tech. During her 22-years at Penn State University, she served as the associate dean for research and innovation in engineering, the site director of the NSF National Nanotechnology Infrastructure Network and director of the Materials Research Institute Nanofabrication Laboratory, which enabled cutting-edge materials and techniques to be shared among researchers in academia and industry. She is widely recognized for her work in advanced manufacturing of nanoscale electronic, optical, and biomedical devices, which has been supported by the NSF, DOD, DOE, NIH, and industry. Mayer has over 350 technical publications, invited presentations and tutorials, and holds ten patents in these areas. Several of her inventions have been transitioned into commercial and military systems. She is actively engaged in service to her profession and the nation, including the U.S. President's Council of Advisors on Science and Technology, PCAST. She is a fellow of the Institute for Electrical and Electronics Engineers, and has received numerous awards for her teaching and research, including the NSF CAREER award. Mayer received a B.S. in electrical engineering from Virginia Tech, and a M.S. and Ph.D. in electrical engineering from Purdue University. Throughout her career, she has supported the advancement of women in science and engineering.