TIME CHANGE: THE IMPACT OF THE COVID–19 CRISIS ON UNIVERSITY RESEARCH

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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TIME CHANGE: THE IMPACT OF THE COVID–19 CRISIS ON UNIVERSITY RESEARCH

WEDNESDAY, SEPTEMBER 9, 2020

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Washington, D.C.

The Subcommittee met, pursuant to notice, at 11:30 a.m., via Webex, Hon. Haley Stevens [Chairwoman of the Subcommittee] presiding.

U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HEARING CHARTER

The Impact of the COVID-19 Crisis on University Research

Wednesday, September 9, 2020
11:30 am – 1:30 pm ET
Cisco WebEx

PURPOSE

On Wednesday, September 9, 2020, the Subcommittee on Research and Technology of the Committee on Science, Space, and Technology will hold a hearing to examine the near- and long-term impacts of the COVID-19 crisis on the U.S. academic research enterprise. The Committee will hear about the steps universities have taken to slow the spread of the virus and the impact such measures have had on the progress of research and the pipeline of STEM talent. The Committee will explore what is needed for universities to recover from these setbacks and safely ramp up research programs. This hearing is also an opportunity for the Committee to hear testimony on the *Research Investment to Spark the Economy (RISE) Act* and *the Supporting Early-Career Researchers Act.*

WITNESSES

- **Dr. Joseph Walsh**, Interim Vice President for Economic Development and Innovation, University of Illinois System
- **Dr. David Stone**, Vice President for Research, Oakland University
- **Dr. Theresa Mayer**, Executive Vice President for Research and Partnerships, Purdue University
- **Mr. Ryan Muzzio**, Physics Ph.D. Student, Carnegie Mellon University

KEY QUESTIONS

- What challenges have universities and researchers faced in maintaining research programs and providing guidance and support to undergraduate and graduate STEM students?
- How has the COVID-19 health crisis affected undergraduate students transitioning into STEM graduate programs and recent Ph.D. graduates entering the academic and private sector job market?
- In what ways, if any, are these challenges disproportionately affecting women and individuals from underrepresented minority groups?
- What are the implications of the potential loss of talent for the U.S. research and innovation ecosystem and U.S. economic competitiveness?
- What actions can the Federal government take to help universities recover from the losses incurred due to the COVID-19 crisis, restart their research programs, and mitigate the loss of STEM talent?
- In what ways has the COVID-19 health crisis helped to catalyze and accelerate research and innovation? What actions can the Federal government take to support these activities?

ACADEMIC RESEARCH AND DEVELOPMENT

American research universities are widely recognized as the best in the world and play a pivotal role in advancing U.S. economic prosperity, national security, health care, and other national priorities. In 2018, academic institutions carried out $79.4 billion in R&D, most of it funded by the federal government.[1] Although universities perform all types of R&D, they have long been the nation's largest performers of basic research.[2] Universities also provide education and training for the majority of the STEM workforce.[3] In the federal government, six agencies provide the most support for R&D conducted at colleges and universities:

- Department of Health and Human Services (55%, or $22.9 billion)
- Department of Defense (14%, or $5.9 billion)
- National Science Foundation (13%, or $5.3 billion)
- Department of Energy (4%, or $1.8 billion)
- National Aeronautics and Space Administration (4%, or $1.5 billion)
- Department of Agriculture (3%, or $1.2 billion)[4]

COVID IMPACT ON UNIVERSITY RESEARCH

Social Distancing

On March 16, 2020, the White House issued guidelines[5] restricting gatherings of more than 10 people. On March 19, California was the first state to issue a state-wide stay-at-home order. By early April, more than 300 million Americans were under directives to "shelter-in-place" or "stay-at-home".

Measures taken to comply with social distancing restrictions created major disruptions on college and university campuses across the country. On March 6, the University of Washington became the first major university to cancel in-person classes and exams. By the middle of March, institutions across the country had followed suit and more than 1,100 colleges and universities in all 50 states cancelled in-person classes or shifted to online-only instruction.[6] While there is extensive discussion in the news and among policymakers about the status of in-person education and the related challenges unfolding on university campuses across the country, this hearing is focused on impacts on the research enterprise.

Across the board, campus closures and social distancing requirements have significantly altered the way university research is conducted. Researchers forced to work remotely or under stringent social distancing requirements are experiencing significant delays in achieving their research aims. Students are also

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[1] Additional academic R&D sponsors include academic institutions, nonprofit organizations, industry, and state and local governments.
[2] Basic research is "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts." Source: OMB Circular A-11. Available at https://www.whitehouse.gov/wp-content/uploads/2018/06/a11.pdf
[3] https://www.pewresearch.org/fact-tank/2018/01/09/7-facts-about-the-stem-workforce/
[4] National Science Board, Science and Engineering Indicators 2020, Available at https://ncses.nsf.gov/pubs/nsb20202/.
[5] The White House, The President's Coronavirus Guidelines for America: 30 Days to Slow the Spread, Available at https://www.whitehouse.gov/wp-content/uploads/2020/03/03.16.20_coronavirus-guidance_8.5x11_315PM.pdf.
[6] National Conference of State Legislatures, Higher Education Responses to Coronavirus (COVID-19), Available at https://www.ncsl.org/research/education/higher-education-responses-to-coronavirus-covid-19.aspx

experiencing reduced access to professional development, networking, and hands-on training. For students, postdocs, and junior faculty, disruptions caused by the COVID crisis come at a critical juncture in their career and may have long-lasting impacts.

For example, many undergraduate students would normally have spent the past few months developing research skills through summer research internships. These programs offer students valuable research experience beyond their classroom studies and have a strong influence on student career aspirations. As a result of summer research internships being canceled, many students in their final year will not have the research experience necessary to prepare a competitive application to a graduate research program. The switch to remote classes has also made it difficult for students to fulfill their degree requirements, leading some students to consider switching majors due to the unavailability of required laboratory-based courses. Others are deciding to take a gap semester or year in the hopes of returning once campus is reopened and facing graduation delays as a result.

Graduate students are dealing with delays to their research due to limited access to their laboratories, which could compromise their ability to complete their projects on time and publish enough papers to be competitive for postdoctoral fellowships or research positions in industry. Graduate students are also learning how to carry out their teaching responsibilities remotely and missing out on important networking and collaboration opportunities as conferences have gone all virtual. The cumulative effect of these challenges is taking its toll on graduate student mental health. A recent survey of undergraduate and graduate students at 10 U.S. research universities found that signs of depression doubled among graduate students when compared with a similar survey from last year. Indications of anxiety among graduate students increased by 50% during the same period. Rates of mental distress were particularly high among low-income, Latinx, and LGBTQ students and those working in physical and biomedical sciences.[7]

The ability of faculty researchers to continue to make progress on their research remotely depends, in part, on the nature of the project and their discipline. For example, researchers working remotely may be able to perform certain tasks like scientific computations, modeling and simulation, experimental hardware design, data analysis, and drafting journal articles. In contrast, handling physical and biological samples, caring for laboratory animals, and building or operating specialized equipment require a researcher to be present in the laboratory. Research involving human subjects may be interrupted if those subjects are unavailable because of social distancing. In some cases, the extent to which research activities can continue may depend on the duration of the disruption; many researchers may have pivoted toward analyzing data and writing up findings for publication – tasks they can do from home - but eventually they will have run out of new data to analyze.

Another key factor in the ability of a researcher to be productive in carrying out their research remotely is childcare. Early analyses of submissions of draft research papers to pre-print servers suggest that the pandemic is disproportionately affecting female academics, because women often do more caregiving than men.[8,9]

A recent survey of approximately 4,500 Principal Investigators (PIs) at U.S. and European research institutions found that "scientists report a sharp decline in time spent on research on average, but there is substantial heterogeneity with a significant share reporting no change or even increases. Some of this

[7] https://escholarship.org/uc/item/80k5d5hw
[8] https://www.nature.com/articles/d41586-020-01294-9
[9] https://www.nature.com/articles/d41586-020-02183-x

heterogeneity is due to field-specific differences, with laboratory-based fields being the most negatively affected, and some is due to gender, with female scientists reporting larger declines. However, among the individuals' characteristics examined, the largest disruptions are connected to a usually unobserved dimension: childcare. Reporting a young dependent is associated with declines similar in magnitude to those reported by the laboratory-based fields and can account for a significant fraction of gender differences."[10]

Travel Restrictions

Travel restrictions have impeded research across all disciplines for scientists who engage in field observation work. Data sets that require months or even years of regular observations now have an irreversible break in continuity. For example, observations of the atmosphere taken routinely from passenger and cargo planes are transmitted to weather services and used in worldwide weather forecasts as well as atmosphere and climate research. The World Meteorological Organization recently released a statement expressing increasing concern over the loss of this data stream and the potential for degraded forecast accuracy.[11]

Travel restrictions and social distancing concerns have forced scientific societies to cancel or move conferences online. A scientific conference is not just an avenue for a scientist to present their research to the wider community, it is also an important venue for brainstorming, networking, and developing new collaborations. Conference cancellations also cut off a major source revenue for scientific societies, putting the societies and the vital role they play at risk. While some are optimistic that virtual conferences could add value in the long run, such a radically new model will take time to perfect.

The impact of travel restrictions has been particularly severe for students from other countries. U.S. Immigration and Customs Enforcement (ICE) issued guidance for the Fall 2020 term that prohibits new students from entering the U.S. on an F or M student visa unless they are registered for at least one in-person course.[12] According to a recent analysis by the Chronicle for Higher Education and Davidson College's College Crisis Initiative, about one-third of universities and colleges have opted for fully online or primarily online instruction.[13] Foreign students play a critical role in university research labs, and many remain in the United States and continue to contribute to our leadership in science and technology after graduation.[14]

Hiring Freezes and Layoffs

The impacts of the COVID crisis on academic employment may be long-lasting. Faced with reduced enrollment and unanticipated costs for cleaning, personal protective equipment, testing, and contact-tracing, many institutions have been forced to withdraw job offers, furlough and lay off workers, and implement hiring freezes.

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[10] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3608302
[11] https://public.wmo.int/en/media/press-release/covid-19-impacts-observing-system
[12] https://www.ice.gov/doclib/sevis/pdf/bcmFall2020guidance.pdf
[13] https://www.chronicle.com/article/heres-a-list-of-colleges-plans-for-reopening-in-the-fall/
[14] https://www.nsf.gov/nsb/sei/one-pagers/Foreign-Born.pdf

Hiring freezes in academia have substantially reduced the job prospects for early-career scientists. Many graduate students and postdocs who had academic job offers at the start of the pandemic have since had those offers rescinded or delayed. Those failing to find an academic position are faced with the difficult decision to abandon their career goals in order to support themselves and their families. This potentially irreversible loss of talent from the research pipeline could have lasting negative consequences for U.S. innovation and economic competitiveness.

Facility Closures

While skeleton staff who can maintain social distancing may be an option at some research facilities—such as telescopes or environmental sensor networks that share data with researchers remotely—other facilities require intensive on-site personnel for maintenance and operation. Closures of R&D facilities depend on the independent decisions of individual agencies, universities, and other institutions. For example, the National Aeronautics and Space Administration decides the status of each of its centers separately, based on local conditions, according to a four-stage response framework.[15] Actions by state or local governments also factor into the decisions of some facilities. For example, shutdowns at Department of Energy laboratories in California and Illinois followed statewide social distancing orders issued by the governors of those states.[16] Managing organizations and contractors operating National Science Foundation facilities also consider local conditions and statewide orders in making operational decisions.[17]

COVID RECOVERY NEEDS

Suspending research has resulted in additional costs for activities such as animal care, maintenance of cell cultures and biological samples, and safe storage of hazardous materials. Moreover, restarting research, when conditions permit, will likely incur costs for staff time and supplies to bring experimental equipment back to operational status, reestablish laboratory animal populations, or replace masks and other personal protective equipment that was donated to hospitals and first responders during the pandemic. The extent to which these costs may be covered out of existing federal research awards is not yet clear.

The Office of Management and Budget, in collaboration with federal science agencies, has provided temporary administrative and salary charging flexibilities to protect against furloughs and layoffs. Agencies have provided guidance for universities and offered no-cost extensions[18] to the term of current research grants to make up for time lost. Some agencies have also extended the deadline dates for a few solicitations to give PIs more time to submit proposals or have been lenient with PIs who miss a deadline.

The Council on Governmental Relations, an association of almost 200 U.S. universities and research institutes, recently released a report presenting a model for estimating research output loss and quantifying the financial impacts of the COVID-19 pandemic on research activities. The model is designed to account for factors such as reduced work, lost laboratory supplies, and inability to travel under differing impact and recovery scenarios. The report uses five case studies to illustrate the state of research under what it terms the new "pandemic normal," and projects research output losses between March 2020 and February 2021 at individual institutions ranging between 20% and 40% and financial impact in the hundreds of millions of

[15] https://nasapeople.nasa.gov/coronavirus/nasa_response_framework.pdf
[16] https://www.aip.org/fyi/2020/pandemic-impacts-escalating-across-federal-labs
[17] https://www.nsf.gov/news/special_reports/coronavirus/NSF%20Guidance%20for%20Major%20Facilities%20and%20Contracts%20Regarding%20COVID-19.pdf
[18] A no-cost extension extends the end date of the award without increasing funding.

dollars. The report also projects a potential impact in the tens of billions of dollars across the U.S. research enterprise.[19]

NIH Director Francis Collins, while testifying before Congress on May 7, 2020 stated, "The estimates are something like $10 billion of NIH funded-research that is going to disappear because of the way in which this virus has affected everybody requiring this kind of distancing and sending people home."[20]

Significant additional federal support (through supplements and full-cost extensions[21] to existing grants, administrative flexibility, or other mechanisms) is needed to enable the U.S. research enterprise to recover after a prolonged period of profound disruption. Additional funding to support graduate students and post-doctoral researchers whose research and training have been interrupted or otherwise delayed due to the pandemic is also critical to prevent a significant loss of talent from the STEM pipeline.

In March, organizations representing research universities, medical schools, and teaching hospitals asked Congress to take a number of steps to address these needs, including giving research institutions additional flexibility to cover researcher salaries and benefits while their institutions are affected, to provide $13 billion in additional extramural research funding, and to allow agencies to reprogram any supplemental funds that are not spent within a year for new awards.[22]

LEGISLATION

RISE Act

The *Research Investment to Spark the Economy (RISE) Act* (H.R. 7308) authorizes approximately $26 billion in emergency relief across federal science agencies to award to universities and national laboratories to continue working on federally-funded research projects and ensure that years of research – and the researchers that makes it possible - are not lost forever due to the pandemic.

Supporting Early-Career Researchers Act

The *Supporting Early-Career Researchers Act* (H.R. 8044) creates a new $250 million postdoctoral fellowship program at the National Science Foundation to support career development for early-career researchers whose employment opportunities have been impacted by the COVID-19 crisis. NSF estimates that a program established under this Act would support about 1,600 fellows.[23, 24]

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[19] https://www.cogr.edu/sites/default/files/Research_COVID_August2020_COGR_FINAL.pdf
[20] https://news.bloomberglaw.com/pharma-and-life-sciences/virus-will-cost-nih-10-billion-in-lost-research-director-warns
[21] A full-cost extension extends the end date of the award and provides additional funding to cover the costs to complete the activities.
[22] https://www.aplu.org/members/councils/governmental-affairs/CGA-library/association-letter-covid-19-research-relief-letter/file
[23] https://science.house.gov/imo/media/doc/Fellowships_forINTRO.pdf
[24] In fiscal year 2019, NSF supported 5,320 postdoctoral associates through funds included in research projects, centers, or facilities awards, as well as by postdoctoral fellowships. https://www.nsf.gov/about/budget/fy2021/pdf/fy2021budget.pdf

Chairwoman STEVENS. Well, this hearing will come to order. Without objection, the Chair is authorized to declare recess at any time. And, before I deliver my opening remarks, I do want to note the circumstances that we find ourselves in today, in which we are meeting pursuant to House Resolution 965 today, the Subcommittee on Research and Technology on the House Science, Space, and Technology Committee is meeting virtually, and I want to announce a couple of reminders to the Members, our House Members, about the conduct of today's remote hearing. First, Members should keep their video feed on for as long as they are present in the hearing, and Members are also responsible for their own microphones, just as if we were in the room together, and so please keep your microphones muted unless you're speaking. And, finally, if Members have documents they wish to submit for the record, please e-mail them to the Committee Clerk, whose e-mail address was circulated to your offices prior to today's hearing.

It certainly is nice to see everyone here today, and so good morning, and welcome to our distinguished panelists. Certainly want to give a special welcome to Dr. David Stone from Oakland University (OU), one of the prides of Michigan's 11th District, and, you know, the university's certainly a special place, but all of represent and come from special institutions and jurisdictions which are critical to this country's research fabric. We're here today to discuss the impact of COVID–19 on innovation as it relates to our academic system. We're here to discuss the disruptions brought on by COVID–19 into our research efforts.

As we all know, federally funded research conducted on university campuses across the Nation is certainly a critical driver of our country's innovation, economic development, pairing with the private sector and government partners to jump start new technology and scientific breakthroughs. The COVID–19 crisis sent shockwaves through this ecosystem very early on, particularly given some of the disruptions that were brought on from needing to social distance, and also end school years early. University administrators, research facility managers, faculty, post-docs, and students are still reeling from some of the profound disruptions to their work, and still making their way to adapt amid persistent uncertainty, and the duration of how long this pandemic will go on.

In the early days of the COVID–19 pandemic—we're now saying early days—universities stepped up in a big way to help us combat the disease. Many institutions reconfigured their laboratories for COVID–19 related research, and donated masks, gloves, and other personal protective equipment (PPE) to hospitals and first responders, part of the remarkable supply chain recovery efforts that we saw take place throughout this great Nation. I remain concerned and alarmed that our Federal Government is just not stepping up to its end of the bargain, and that's part of what we're here to discuss today.

In the absence of, you know, a complete and holistic national strategy to mitigate the spread of the virus, universities have been faced with difficult decisions about the fall semester. Many institutions find themselves in danger of incredible financial disruption, and even, in some cases, ruin, which is things that we are, you know, starting to hear from stakeholders across the country. Uni-

versities are being squeezed on both sides with a significant loss of revenue, and unanticipated costs of cleaning up their campuses, providing that PPE, developing their own testing and contact tracing technologies, and ramping down and restarting their research programs, as well as the virtual learning environment. And, boy, wouldn't it be nice to have some financial assistance or grant dollars made available to all of you, because you're certainly best in class examples. Many universities, for instance, had to implement hiring freezes, and the near-term impact on the research workforce is worrying, and will be long lasting if we don't find solutions.

The impacts to our wider STEM (science, technology, engineering, and mathematics) pipeline could also be quite devastating, and it's certainly troubling from the place which we're sitting right now. Undergraduate students are missing out on critical hands-on training. Graduate students are worried that there won't be funding for them to finish their research projects, I can't even imagine, and even raising some questions about graduating. So post-docs and other early career researchers are also searching for jobs in a severely contracted academic job market when we want those bright research minds on the forefront of innovation, and in high demand for their talents and research abilities at universities across the United States. Early data indicate that the impacts of these challenges are more pronounced for women and other groups historically underrepresented in STEM, which in and of itself is quite unfortunate, and troubling, and something I hope that today's hearing also touches on.

So, Chairwoman Johnson, and Ranking Member Lucas, and several Members of this Committee have been a part of championing two bipartisan bills which propose a great approach, a bold approach, to meeting the urgent needs to help universities and academic researchers recover from this crisis. The *RISE Act*, which authorizes $26 billion in emergency relief funding for science agencies to support full cost extension of research grants so that we don't literally lose years of research. This goes beyond just a general disruption. This is a sustained period that we're operating in, and the *RISE Act* certainly gives us a lot of hope and potential. We're really proud of that legislation. And then the *Supporting Early Career Researchers Act* creates a $250 million fellowship program at the National Science Foundation (NSF). I'm so proud of the NSF, and the work that they have been doing, and we want to, obviously, continue to support that. So with the *Supporting Early Careers Researchers Act*, the National Science Foundation will be able to keep recent Ph.D. recipients in the STEM pipeline.

And I certainly look forward to hearing from our panelists about their experiences navigating these new challenges that have been thrown their way, and the challenges posed to innovation presented by the COVID–19 crisis, and the need for getting back to the research enterprise, and getting back on track.

[The prepared statement of Chairwoman Stevens follows:]

Good morning and welcome to our distinguished panelists. I'd like to give a special welcome to Dr. David Stone from Oakland University, the pride of Michigan's 11th district.

We are here to discuss the impact of the COVID-19 crisis on innovation as it relates to our academic research system. We all know that federally funded research conducted on university campuses across the nation is a critical driver of U.S. inno-

vation and economic development, pairing with private sector and government partners to jumpstart new technology and scientific breakthroughs.

The COVID-19 crisis sent shock waves through this critical ecosystem. University administrators, research facility managers, faculty, postdocs, and students are all reeling from the profound disruptions to their work and struggling to adapt amid persistent uncertainty about how long this crisis will last.

In the early days of the pandemic, universities stepped up in a big way to help us combat the disease. Many institutions reconfigured their laboratories for COVID-related research and donated masks, gloves, and other personal protective equipment to hospitals and first responders.

I am deeply concerned that the federal government has yet to hold up its end of the bargain. In the absence of a national strategy to mitigate the spread of the virus, universities are faced with difficult decisions about the Fall semester.

Many institutions find themselves in real danger of financial ruin. Universities are being squeezed from both sides, with a significant loss of revenue and unanticipated costs of cleaning their campuses, providing PPE, developing their own testing and contact tracing technologies, and ramping down and restarting their research programs as well as the virtual learning environments.

Many universities have had to implement hiring freezes. The near-term impact on the research workforce is worrying and will be long-lasting if we don't find solutions.

The impacts to our wider STEM pipeline could be devastating. Undergraduate students are missing out on critical hands-on training. Graduate students are worried there won't be funding for them to finish their research projects and graduate. Post-docs and other early-career researchers are desperately searching for jobs in a severely contracted academic job market.

Early data indicate that the impacts of these challenges are more pronounced for women and other groups historically underrepresented in STEM.

Chairwoman Johnson, Ranking Member Lucas, and several Members of this Committee have championed two bipartisan bills which propose a bold approach to meeting the urgent needs to help universities and academic researchers recover from this crisis.

The *RISE Act* authorizes $26 billion in emergency relief funding for science agencies to support full-cost extensions of research grants so that we don't lose literally years of critical research.

The *Supporting Early-Career Researchers Act* creates a new $250 million fellowship program at the National Science Foundation to help keep recent Ph.D. recipients in the STEM pipeline.

I look forward to hearing from our panelists about their experiences navigating the unprecedented challenges to innovation presented by this crisis and the needs for getting our research enterprise back on track.

Chairwoman STEVENS. So, with that, the Chair, myself, I'm going to recognize Dr. Baird now, our Ranking Member, for an opening statement. Dr. Baird, I'll pass it over to you.

Mr. BAIRD. Thank you, Chairwoman Stevens, and thank you for holding today's hearing. All of us here on this Committee, I think, recognize the critical role that the universities play in America's research enterprise, and they really are the largest performer of basic research, which drives scientific and technological discovery, in this country. They play a significant role in regional and national economic development by spurring countless startups and patent grants in a number of industry. And they educate and train our STEM workforce of tomorrow that will be critical for our future, and to stay competitive.

So, over the last six months, our research universities have faced one of the greatest disruptions they have ever experienced due to the COVID–19 pandemic, and yet they have played a critical role in addressing the pandemic by conducting research and development to detect, defend, and eventually defeat this COVID–19. For example, Purdue University, my alma mater, researchers are working on developing a handheld paper diagnostic device that will make COVID–19 detection fast, easy to use, and portable.

While COVID–19 related research has permitted us to continue, tens of thousands of other labs across the country have been forced to close or severely reduce their operations. Throughout this summer research institutions have been taking the tremendous task of planning for how to safely reopen and operate their research facilities, and adhering to the proper social distancing practices is challenging in general, but it's especially challenging when you consider the tight, confined spaces laboratory work is traditionally conducted in. So I look forward to hearing from our witnesses today on how their campuses are dealing with these challenges and creating a "new normal" that allows the research enterprise on their campuses to rev back up.

The restarting of the university research enterprise is particularly important to our future domestic STEM talent pipeline, especially early career researchers and post-docs. The limited access to laboratories has restricted the research that post-docs can complete, and, in some cases, causing their trajectories to change, and an uncertainty of when or if they would be able to complete their research and their degree on time. Additionally, because many universities have instituted hiring freezes, there's a great concern that many post-docs will have to leave academia to find a job in the near term, which will be extremely damaging to the U.S.'s domestic STEM talent and U.S. competitiveness. It is critical Congress takes steps to fight the threat of such a loss of STEM talent and brain drain.

I would like to thank all of our witnesses, and I would make a special welcome to Dr. Mayer from Purdue University to taking the time to join us today, especially given it is the start of the school year, and I expect much more demanding than the start of a normal school year. So I look forward to hearing our testimonies, and having a productive session. I yield back.

[The prepared statement of Mr. Baird follows:]

Thank you, Chairwoman Stevens, for holding today's hearing. All of us on this Committee know the critical role our universities play in America's research enterprise.

They are the largest performers of basic research, which drives scientific and technological discovery in this country. They play a significant role in regional and national economic development, spurring countless start-ups and patent grants in a number of industries. And they educate and train our STEM workforce of tomorrow, which will be critical to our future competitiveness.

Over the last six months, our research universities have faced one of the greatest disruptions they have ever experienced due to the COVID-19 pandemic. And yet, they have played a critical role in addressing the pandemic by conducting research and development to detect, defend, and eventually defeat COVID-19.

For example, at Purdue University, researchers are working on developing a handheld paper diagnostic device that will make COVID-19 detection fast, easy-to-use, and portable thanks to the inherent properties of paper. While COVID-19 related research was permitted to continue, tens of thousands of other labs across the country were forced to close or severely reduce their operations.

Throughout this summer, research institutions have been taking on the tremendous task of planning for how they can safely reopen and operate their research facilities. Adhering to proper social distancing practices is challenging in general, but especially when you consider the tight, confined spaces laboratory work is traditionally conducted in. I look forward to hearing from our witnesses today on how their campuses are dealing with these challenges and creating a "new normal" that allows the research enterprise on their campuses to rev back up.

Restarting the university research enterprise is particularly important to our future domestic STEM talent pipeline, especially early-career researchers and postdocs. The limited access to laboratories has restricted the research that postdocs

can complete, in some cases causing their trajectories to change and creating uncertainty of when or if they will be able to complete their research and degree on time. Additionally, because many universities have instituted hiring freezes, there are great concerns that many postdocs will have to leave academia to find a job in the near term, which will be extremely damaging to the US's domestic STEM talent and U.S. competitiveness. It is critical Congress takes steps to fight the threat of such a loss of STEM talent and "brain drain."

I would like to thank all of our witnesses for taking the time to join us today, especially given it is the start of the school year and I expect, much more demanding than the start of a normal school year. I look forward to hearing your testimonies and a productive discussion.

I yield back the balance of my time.

Chairwoman STEVENS. Thank you, Dr. Baird. And, with that, the Chair now recognizes our Chairwoman of the Full Committee, Chairwoman Johnson, for an opening statement.

Chairwoman JOHNSON. Thank you very much, Chairwoman Stevens, and thanks to Ranking Member Baird for holding this hearing, and thanks to all of our distinguished panelists for joining us today. The Nation is in a crisis on many fronts. Due to the unprecedented lack of firm guidance, nearly 200,000 Americans have died from the COVID–19 pandemic. Millions of American children are hungry. Countless Americans have no safe place to live, and our very democracy is at stake.

In the midst of all these crises, it may be hard to think about our future, and it may be even harder to convince our colleagues, and the American people, of the urgent need to help rescue our universities, and, by doing so, help to rescue our future. And yet, that is what we are here today to discuss, for even now we cannot afford to ignore it. Even as China looms large as a competitor, and many other nations have strong science and technology capacity, U.S. universities continue to lead the world in cultivating the next generation of STEM talent, and serving as an engine for our economy. I believe that our universities can do more to recruit and nurture all talent, no matter their gender, race, disability, or other background, and I'm pleased that Ranking Member Lucas has joined me in pursuing many efforts to address diversity and inclusion in STEM education and research. While I will continue my own efforts to address these disparities, I remain confident that the American universities have the essential ingredients to carry our Nation into a healthy, secure, and prosperous future.

More than that, I believe we cannot have a healthy, secure, and prosperous future without our universities. This Nation is blessed with hundreds of excellent research universities that collectively serve the very diverse needs of our population and underpin our innovation economy. I am not suggesting that all—that even most of our universities' research is going to collapse due to the COVID–19 pandemic. I am, however, deeply concerned that many institutions may not survive, that years of important research will be lost, and that we will suffer irreparable harm to our talent pipeline. I'm especially concerned about the fallout from this pandemic undercutting the gains that we have made in diversity, and diversifying our STEM pipeline, including the geographic diversity that will help communities across the Nation revitalize their economies in the coming years. We cannot allow that long term damage to happen. The stakes for our Nation are simply too high.

For those reasons, I did not hesitate to join my bipartisan colleagues in the House co-sponsoring the *RISE Act*, despite the hefty price tag. I was also pleased to be joined by many colleagues on the Science, Space, and Technology Committee in introducing *Supporting Early Career Researchers Act*, which is focused specifically on keeping the best and brightest in research careers that they already worked so hard for. I hope my colleagues on both sides of the aisle will continue to join me in advocating for real funding for these two bills, and I thank you, and yield back.

[The prepared statement of Chairwoman Johnson follows:]

Thank you Chairwoman Stevens and Ranking Member Baird for holding this hearing, and thank you to our distinguished panel for joining us today. This nation is in crisis on many fronts. Due to an unprecedented lack of leadership, nearly 200,000 Americans have died from the COVID19 pandemic, millions of American children are hungry, countless Americans have no safe place to live, and our very democracy is at risk.

In the midst of all of these crises, it may be hard to think about our future. And it may be even harder to convince our colleagues and the American people of the urgent need to help rescue our universities, and by doing so, help rescue our future. And yet, that is what we are here today to discuss, for even now, we cannot afford to ignore it.

Even as China looms large as a competitor, and many other nations have strong science and innovation capacity, U.S. universities continue to lead the world in cultivating the next generation of STEM talent and serving as an engine for our economy. I believe that our universities can do more to recruit and nurture all talent, no matter their gender, race, disability, or other background. And I am pleased that Ranking Member Lucas has joined me in pursuing many efforts to address diversity and inclusion in STEM education and research. While I will continue my own efforts to address these disparities, I remain confident that American universities have the essential ingredients to help carry our nation into a healthy, secure, and prosperous future. More than that, I believe we cannot have a healthy, secure, and prosperous future without our universities.

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Thank you and I yield back.

Chairwoman STEVENS. Thank you, Madam Chair. And now the Chair recognizes Ranking Member Lucas for an opening statement.

Mr. LUCAS. Thank you, Chairwoman Stevens, for holding today's hearing to examine the challenges our academic research enterprise has faced during the COVID–19 pandemic. When the pandemic reached our shores, many researchers immediately pivoted to apply the knowledge and resources to fight this virus. Universities have devoted engineering departments to 3D printing personal protective equipment for front line workers. They've engineered inexpensive ventilators and self-sterilizing equipment for

hospitals, and they've even repurposed the veterinarian labs to process COVID–19 tests.

Unfortunately, even while doing this exceptional work, universities have also had to slow down, or entirely stop, other research that is non-essential to fighting COVID–19. Social distancing, travel restrictions, campus closures have forced many researchers to stop their work. There are tremendous costs to halt in research. First, we lose the scientific knowledge and technology development that would've been gained from this work. Second, we face economic consequences. According to the IRS data, American universities used research funds to pay more than 560,000 people on campuses across the country Fiscal Year 2018 to 2019. And, third, we could slow our scientific progress for years to come because of the damage being done to our STEM pipeline. We know it will take time and financial resources to get the research enterprise back up on its feet, but if we do not provide the resources now, we'll be limiting our ability to support new and innovative research, and forced to play catch-up to our foreign competitors, like China.

That's why I'm a proud co-sponsor of "the *Research Investment to Security the Economy Act."* It will help ensure that our research sector recovers from the current challenges, and continues to thrive even after the pandemic subsides. The *"RISE Act*" authorizes approximately $26 billion in emergency relief that Federal science agencies will award to research universities, independent institutions, and national laboratories to continue working on federally funded research projects. This funding will allow us to continue to support the critical research we need to keep progressing as a nation.

Along with the "*RISE Act*," we have "the *Supporting Early Career Researchers Act*," a bipartisan bill led by Chairwoman Johnson and Congressman Mike Garcia. This bill creates a fellowship program at the National Science Foundation for post-doc researchers who are unable to continue their research at universities due to COVID–19. By allowing graduate students and post-docs to stay in research, rather than leaving to find other employment, these bills will help preserve our STEM workforce so we don't lose out on years of discoveries. As we fight to keep America safe, healthy, and economically stable during this pandemic, there's one certainty, our success depends on science. I look forward to hearing from our witnesses today about their experiences, the lessons they've learned, and the recommendations they have for how Congress can invest in American research and technology to overcome future pandemics and scientific challenges. Thank you, and I yield back the balance of my time.

[The prepared statement of Mr. Lucas follows:]

Thank you, Chairwoman Stevens, for holding today's hearing to examine the challenges our academic research enterprise has faced during the COVID-19 pandemic.

When the pandemic reached our shores, many researchers immediately pivoted to apply their knowledge and resources to fight this virus. Universities have devoted engineering departments to 3D printing personal protective equipment (PPE) for frontline workers. They have engineered inexpensive ventilators and self-sterilizing equipment for hospitals. And they have even repurposed veterinary labs to process COVID-19 tests.

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19. Social distancing, travel restrictions, and campus closures have forced many researchers to stop their work.

There are tremendous costs to this halt in research:

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Second, we face economic consequences. According to IRS data, American universities used research funds to pay more than 560,000 people on campuses across the country in fiscal year 2018-2019.

And third, we could slow our scientific progress for years to come because of the damage being done to our STEM pipeline.

We know it will take time and financial resources to get the research enterprise back up on its feet. But if we do not provide the resources now, we will be limiting our ability to support new and innovative research, and forced to play catch up to our foreign competitors like China.

That's why I am a proud cosponsor of the *Research Investment to Secure the Economy (RISE) Act*. It will help ensure that our research sector recovers from the current challenges and continues to thrive even after the pandemic subsides. The *RISE Act* authorizes approximately $26 billion in emergency relief that federal science agencieswill award to research universities, independent institutions, and national laboratories to continue working on federally funded research projects. This funding will allow us to continue to support the critical research we need to keep progressing as a nation.

Along with the *RISE Act*, we have the *Supporting Early Career Researchers Act*—a bipartisan bill led by Chairwoman Johnson and Congressman Mike Garcia. This bill creates a fellowship program at the National Science Foundation for postdoctoral researchers who are unable to continue their research at universities due to COVID-19.

By allowing graduate students and post-docs to stay in research rather than leaving to find other employment, these bills will help us preserve our STEM workforce, so we don't lose out on years of discoveries.

As we fight to keep America safe, healthy, and economically stable during this pandemic, there is one certainty: our success depends on science.

I look forward to hearing from our witnesses today about their experiences, the lessons they've learned, and the recommendations they have for how Congress can invest in American research and technology to overcome future pandemics and scientific challenges

Chairwoman STEVENS. Thank you, Ranking Member Lucas, and if there are any other Members who wish to submit additional opening statements, your statements will be added to the record at this point. And, at this time, I'd like to introduce our witnesses.

Our first witness is Dr. Joseph Jay Walsh. Dr. Walsh is the Interim Vice President for Economic Development and Innovation for the University of Illinois System, a position he has held since May of this year. Prior to his position in the University of Illinois System, Dr. Walsh was a faculty member and administrator for more than 30 years at Northwestern University. Dr. Walsh currently serves on the Board of Directors at MxD (Manufacturing x Digital), and the Board of Governors at Argonne National Laboratory, among others, and previously served on the Board of Directors at Fermi National Laboratory, the Illinois Governor's Innovation Council, the Naval Research Advisory Committee, and the U.S. Secretary of Navy Advisory Panel.

Following from Dr. Walsh is Dr. David Stone. Dr. Stone is the Vice President for Research at Oakland University in Michigan, where he is also a Professor of Public Health, and a Professor of Philosophy. Dr. Stone has previously taught and conducted research at Harvard Schools of Medicine and Public Health, Tufts University School of Medicine, Sheffield University in the U.K., and Northern Illinois University. Dr. Stone's recent scholarship focuses on the nature of interdisciplinarity, and takes a transdisciplinary approach to public health, education, and re-

search development. He has also served as an American Council on Education Fellow, as President of the National Organization of Research Development Fellows, and is a member of the charter class of NORDP Fellows.

Our third witness is Dr. Theresa Mayer. Dr. Mayer is the Executive Vice President for Research and Partnerships at Purdue University. In this role she oversees the University's research enterprise, and supports engagements with Federal, industry, and global strategic partnerships. Prior to her role at Purdue, she served as Vice President for Research and Innovation at Virginia Tech, and in a number of roles at Penn State University, including Associate Dean for Research and Innovation and Engineering, the Site Director of the NSF National Nanotechnology Infrastructure Network, and Director of the Materials Research Institute Nanofabrication Laboratory. Dr. Mayer is also a member of the U.S. President's Council of Advisors on Science and Technology, otherwise known as PCAST, and a Fellow of the Institute for Electrical and Electronics Engineers.

Our final witness is Mr. Ryan Muzzio. Mr. Muzzio is currently pursuing a Ph.D. in Physics at Carnegie Mellon University, where his research focuses on the electronic properties of novel materials and devices in the 2D regime by utilizing nano-scaled angle resolved photoemissions and device fabrication. Mr. Muzzio is also serving as a student volunteer on Carnegie Mellon's Equity, Diversity, and Inclusion Committee. This is just an amazing panel. I feel like we could spend—witnesses, I feel like we could have testimonies individually, and hearings about what each of you have dedicated your careers to, so thank you so much for your time today with this Science Committee.

Our witnesses should know you're each going to get 5 minutes for spoken testimony, and your written testimony—which these testimonies, folks, are fabulous, OK? I mean, there's addendums, they're graphs. They're doing research on the research. It's—this is an amazing moment in time. So your written testimonies are going to be included in the record for the hearing, and when you've completed your spoken testimonies, we're going to begin with questions, and each Member is going to have 5 minutes to question the panel. And I know we've got a lot of fabulous Members of Congress here. We're all chomping at the bit to have this conversation, have this hearing, talk about our legislation. And we're going to begin with our first 5-minute testimony, we've got the clock buzzing in the background here, with—we're going to hear from Dr. Walsh. And so, with that, Dr. Walsh, we'll begin with you.

TESTIMONY OF DR. JOSEPH WALSH,
INTERIM VICE PRESIDENT FOR ECONOMIC DEVELOPMENT AND INNOVATION, UNIVERSITY OF ILLINOIS SYSTEM

Dr. WALSH. Thank you, Chairwoman Stevens, Ranking Member Baird, and Members of the Subcommittee. Thank you for inviting me to testify, and for holding this timely and important hearing. You asked about the impacts of the COVID–19 crisis on the research enterprise, and steps Congress can take in response. In brief, the impacts have been, and could continue to be, significant, disrupting productivity, the careers of students and post-docs, and

the development of new technologies that drive the economy. Strong Federal assistance, including passage of the *RISE Act*, is needed to help prepare—repair the damage to America's research universities and researchers. In my written testimony I documented the challenges we face and the actions to take. Here I will focus on the pandemic's harmful impact on research, the consequences to the Nation's research infrastructure, the effects on our students and researchers, and the role the Federal Government can take going forward.

Research universities train students, produce graduates, and conduct research that leads to new knowledge. They also provide the infrastructure that serves as the backbone for the Nation's research and development enterprise. The resulting outputs drive U.S. economic prosperity, and are the foundation for the country's health, well-being, and national security. In their role as researchers, every faculty member at a research university should be viewed as the sole proprietor of a small business, a research group. Each is an entrepreneur striving to produce two key products, new knowledge and graduates.

The impact of the pandemic for these small business owners, the researchers, has been significant. In March, to protect health and safety, most universities shut down on-campus operations. By most estimates, in the early spring of 2020, approximately 80 percent of all research was significantly slowed or stopped. One key exception was research into solutions to address COVID–19. As the pandemic raged, our faculty and staff developed new diagnostics, manufactured PPE, and developed models and systems to understand and mitigate the spread of the virus. In late spring university researchers cautiously started returning to campus, and, as we entered late summer, most on-campus labs are operational, but with social distancing limiting the number of researchers in a lab space, vital person-to-person exchanges are disrupted, as is the research training of students and post-docs in the discovery of new knowledge.

The pandemic's disruptions have also extended to essential research infrastructure. Nearly every researcher uses core university research facilities with shared scientific instrumentation. This is an efficient and effective aspect of the U.S. research enterprise. The financing of these core facilities comes from fees paid from grants by users. For example, when a grad student uses an electron microscope to study the spiky surface of a virus, grant funds are used to pay the costs of using that microscope. During the pandemic, researchers are not using these facilities at pace, user fees are not being collected, and thus university funds must be used to maintain facilities. This is not sustainable, particularly at universities that are already struggling to cover the many other costs associated with the pandemic.

While its impact has been broad, the pandemic has been particularly harmful to certain categories of researchers. In a study I coauthored recently in *Nature*, we found that scientists with young children experienced a substantial decline in productivity. This burden falls on early career researchers, and disproportionately on women.

Today, maintaining the momentum of research, indeed accelerating our activities, when we are in a war against the disease,

is our challenge and our opportunity. Strong and timely Federal actions are needed to ensure that the U.S. maintains its prominent global position in research, and that research universities can continue to provide answers and opportunities for citizens at this crucial time in history. Without supplemental funding from Congress for relief, Federal research agencies will be forced to choose between abandoning new research opportunities of national importance, or discontinuing research projects that are not yet completed, thus failing to maximize the return of Federal dollars already invested. Either approach will slow discovery and innovation, and jeopardize a generation of scientists and engineers crucial to America's innovation capacity and economic competitiveness for years to come. Passage of the *RISE Act* and *Supporting Early Career Researchers Act* will help propel our researchers and our Nation forward. I thank you for your time, and look forward to your questions.

[The prepared statement of Dr. Walsh follows:]

Statement of Joseph T. Walsh, Jr.
Interim Vice President for Economic Development and Innovation, University of Illinois System
Senior Fellow, Association of American Universities

before the

Committee on Science, Space, and Technology
Subcommittee on Research and Technology
U.S. House of Representatives
September 9, 2020

The Impact of the COVID-19 Crisis on University Research

Chairwoman Stevens, Ranking Member Baird, and members of the subcommittee — thank you for inviting me to address the devastating impacts of the pandemic on the university research enterprise, and ways in which Congress can redress that impact. This committee has provided tremendous, bipartisan leadership on these issues and includes many of the leading voices in Congress on the importance of basic research to our country's future.

I serve as the Interim Vice President for Economic Development and Innovation of the University of Illinois System, which is the state's largest system of higher education, with more than 89,000 students at three universities in Urbana-Champaign, Chicago, and Springfield. I am also a Senior Fellow at the Association of American Universities (AAU), which is composed of the nation's leading research universities. Since the pandemic started, AAU has worked to assess research impacts, challenges, and opportunities, and to illuminate the need and advocate for a strong federal response.

As I will discuss in my testimony that response should include passage of the Research Investment to Spark the Economy (RISE) Act (H.R. 7308), which authorizes research relief funds for the federal research agencies, as well as the Early Career Researchers Act (H.R. 8044) which addresses the unequal impacts the pandemic has had on researchers at the start of their careers. I thank the members of this committee who are spearheading these important legislative efforts and for explicitly including these bills in the charter of today's hearing. It is critical that Congress act soon to implement the provisions of the RISE Act and Early Career Researcher Act by approving supplemental funding to federal research agencies to ameliorate the harmful disruptions to research and the research workforce that I discuss below.

In my testimony, I will discuss: (1) the impact of the pandemic on research activities; (2) current challenges facing universities and research laboratories; (3) general impacts of delays on researchers; (4) the unequal impact on certain categories of researchers including students and trainees; and (5) the need to take federal action to maintain the position of the U.S. research enterprise and the economic and workforce benefits it provides.

Impact on Research Activities

In March, to protect the health and safety of their students, employees, and surrounding communities, universities across the United States shut down on-campus operations. Students departed and classes for the remainder of the academic year were conducted remotely at nearly

all universities. The shutdown of research was similarly significant. The institutional change was well-described by Wigginton *et al*[1], detailing how extensively and rapidly research operations were transformed. By most estimates, in the early spring of 2020, approximately 80 percent of all research was significantly slowed or stopped. Researchers could analyze previously collected data, write reports and manuscripts, and plan for next steps; but then productivity dropped significantly. Nearly all lab-based research, social science, education-related, and health-related research as well as almost all field-based research was seriously impacted. Typically, the only on-campus research that continued was that which was considered essential, such as research associated with the pandemic. Activity also continued where it was critical to maintain equipment, vital cell and animal lines, as well as some long-term studies, and some patient-related research.

It is worth highlighting the significant ways in which universities have helped provide solutions specific to the pandemic. Researchers published thousands of papers and posted preprints on-line on a timeline that defied the usual pace of academic publications. In this way, academic researchers provided the public with vital information in an impressively rapid fashion. This information was critical to our nation's response to the pandemic during the initial wave of transmission and continues to be vital as we mitigate spread, respond to flare-ups, and better diagnose and treat COVID-19. Researchers also developed innovative and cost-effective means to manufacture personal protective equipment (PPE), such as faceguards, and lifesaving equipment, such as ventilators. They also developed new diagnostics and therapeutics in record time.

At all universities, there was an immediate pivot to find a path to fulfilling the tripartite mission of teaching, research, and service. Faculty and staff efforts were tremendous. New modes of teaching and new educational technologies were implemented with speed and at scale. Service activities pivoted to online modes. And researchers nationwide engaged in means to use their expertise to bring teaching and research back to campus. Much of that effort was local, e.g., bringing a laboratory or department back toward fuller activity; however, some of the activity was broader. At the University of Illinois Urbana-Champaign, a convergence of faculty from numerous disciplines developed a sensitive and specific saliva-based test for SARS-CoV-2 that is now being used at high frequency (everyone on-campus, approximately 35,000 people, is being tested twice per week) with actionable turnaround times as part of an entire program of mitigation that is founded on epidemiologic modeling and technology-driven communications. All of this is scalable at entities beyond academia. This is but one example of how universities have used the multidisciplinary resources uniquely embedded in their faculty and staff to focus on fulfilling their mission as an institution of higher education. We are also witnessing how research activities initiated on-campus are being extended beyond the campus to help institutions and companies navigate the pandemic, thereby advancing the economy and the health of the nation.

For more examples of work done by universities to respond to the pandemic, please see Appendix A.

In late spring, university researchers cautiously started returning to campuses. They did so while implementing now well-accepted principles: wearing masks to mitigate the spread of the virus borne within respiratory droplets and aerosols, socially distancing by limiting the number of people in a building or a research space, implementing around the clock scheduling, increasing hygiene such as hand washing, and checking regularly for signs and symptoms of COVID-19.

[1] See Appendix B

The return to campus by researchers was a huge effort for the faculty, staff, and students. It required changes in practices by all involved – from the faculty and students, to the support staff and facilities personnel. It required serious introspection regarding safety and risk tolerance by all who have returned to campus – everyone needed to feel that they would be safe. But universities felt that it was important for researchers to be able to ramp up the activity that is vital to the creation of new knowledge and is undisputedly an engine for the U.S. economy. Anecdotal evidence indicates that the transmission of SARS-CoV-2 in the research environment is rare, which is unsurprising given the safety culture that pervades research.

As we enter late summer, most on-campus research laboratories are operational, but with social distancing limiting the number of researchers in a lab space at any time – each aware of their distance relative to others. Working multiple shifts and coordinating carefully, most laboratories can make progress, but not at the usual pace. Some field work has restarted; most international collaborations remain remote. Human-subjects research in the medical sciences is returning; but in-person human-subjects work in the social sciences remains largely stagnant.

COVID-19 has disrupted all social activities, and that includes research, which, despite popular misconceptions, depends on social interactions. Researchers continually learn from one another in formal settings such as at lab group meetings, seminars, and conference presentations as well as during informal interactions in the laboratory or hallway, or at coffee breaks during conferences. Collaborations and regular discussions are vital to the creation of new knowledge. The mitigation activities, especially the social distancing, disrupt these exchanges, slow the progress of research, and have significant near- and long-term impacts.

While the evidence indicates that by implementing mitigation strategies (masking, distancing, etc.) there is little spread of SAR-CoV-2 in research environments, there are significant challenges that universities and researchers are facing.[2]

Current Challenges Facing Universities and Researcher Labs

University financial and personnel resources are strained at this time. Beyond the strain that is visible to the public due to changes in undergraduate education, the late spring ramp-up of research required investment by every university: from PPE to hand sanitizer, from increased access to information technology (IT) services to new computer systems for remote workers, from one-way hallways to more regular and deeper cleaning of nearly every space on campus. The list of new processes is long; the costs are significant and are being borne by internal university funds.

One set of costs of particular importance to research are those associated with core university research facilities with shared scientific instrumentation. Nearly every researcher uses such core facilities, which include high performance computers, specialized microscopes, nanofabrication labs, and vivariums. Research often cannot be conducted without these facilities. Core university research facilities are critical to innovation, our economic vitality, and our national security. The financing of "core facilities" is from fees paid from grant funds by users; e.g., when a graduate student research assistant uses an electron microscope to study the surface of a virus, grant funds are used to pay the costs of using that microscope. During the shutdown and even now when activity is less than 100%, researchers are not using these

[2] See Appendix C

facilities fully, user fees are not being collected as they were before the pandemic, and thus university funds must be used to maintain the existence of the core facilities. If a university is unable to maintain a core facility, then part of the cornerstone of the nation's research infrastructure is lost.

Many research universities have committed resources to maintain their world-class research facilities through the time of the pandemic. This is unsustainable. While the federal government and many private sponsors modified grant conditions to allow continued support of personnel paid from a grant during the early stages of the pandemic when research was paused, funds for core facilities did not continue to flow. Recovery from the pandemic should include federal funds that allow for the sustainability of university core facilities and other key components of the research infrastructure of the United States that are operated by research universities.

General Impacts of Research Delays

The progress toward completion of funded research has been slowed or halted for most researchers in the U.S. Every faculty member conducting research can be considered an entrepreneur. Effectively they are the sole proprietor of a small business: their research group. They all have a vision for their work and drive forward on that vision. They produce two key products: new knowledge and graduates. That new knowledge expands our understanding of the world in which we live and, periodically, results in new products or processes that are the basis for new companies, an expanded economy, and enhanced national security. Those new graduates go on to produce discoveries or propel companies for a lifetime and thus are an incredible return on the research investment. During the pandemic, however, most of these "small business owners" – the researchers – have had their activity seriously derailed, often being at least temporarily halted in their regular operations. Some actually regressed. A few proceeded unaffected. And others started a new line of activity related to COVID-19.

Those who faced pauses in regular activities, i.e., the vast majority, will be challenged to reach the expected research milestones in the timeframe that was proposed to their federal research sponsors. No-cost extensions to their grants will help these researchers, but unforeseen new delays due to the pandemic will limit their ability to reach their goals – unless supplemented, their funds could be expended before their research is complete. All research that leads to societal impact, such as the discovery of a new treatment for cancer or of new methods in artificial intelligence, involves a series of steps. It requires funding over many years, sometimes decades. The disruption of the pandemic, without supplemental support from the federal research sponsors, will break this continuum and at best delay results; in many cases, it can indefinitely halt otherwise productive lines of work.

Some researchers have experienced regression in their research. If a researcher was doing a longitudinal study that was stopped during the pandemic, then not only does that study need to restart, it may need to restart at the beginning of the study so there is continuity of data collection. Some researchers were preparing for seasonal field work, e.g. in agricultural areas or environmental sciences; for these researchers, a year has been lost and hole in the data will be harmful in most cases. The graduate students and post-doctoral fellows in these areas have experienced a halt to their career progress; for some, the path forward is not clear since their salary funding is available only for a defined period of time, which may no longer be sufficient to complete their research.

A few researchers barely paused during the pandemic. As an example, some computational scientists continued their work unabated. Indeed, with less travel to conferences and invited

seminars, they may have been able to focus more on creation of new knowledge and less on dissemination of that knowledge. Such has been the heterogeneity of the impact of COVID-19.

In a related way, the strain of the pandemic and the delays this strain is causing on our pursuit of new and impactful knowledge is impacting our global competitiveness.

Unequal Impacts on Certain Researchers

The pandemic has been particularly harmful to some researchers, independent of their research specialties. For example, early career faculty are on a tenure track that has a limited time frame. Most universities have provided an additional year to all those who are in their pre-tenure, probationary period. This is absolutely the right decision, but we can expect that there are differential impacts of such measures. A study I coauthored recently on Unequal effects of the COVID-19 pandemic on scientists, attached as Appendix C, found that researchers with children at home have had larger barriers to their productivity, especially when daycare availability has been limited and when primary and secondary schools are delivering education online. This impact falls disproportionately on women. Further, with most universities severely limiting faculty hiring this year, career advancement for post-doctoral fellows is slowed. One can foretell the cascade of negative impacts: graduating graduate students see fewer post-doctoral position openings and delay moving on, and thus new graduate students face laboratories with fewer funded positions that are open.

Data from the University of Michigan's Institute for Research on Innovation and Science indicate the majority (53%) of the scientific workforce at universities who receive funding from federal research funds are students or trainees, including post-doctorates.[3] With research grants depleted by productivity drops during the pandemic, it is critical to provide additional support for this vulnerable group of researchers, i.e. those early in their career. Support for graduate students and post-doctoral fellows can have a multiplier effect throughout the ecosystem and propel a generation of young researchers into long careers of consequence. That is why it is so important that we provide graduate students and post-docs with additional support now and seek to mitigate the adverse consequences of the pandemic on their careers. I am pleased that members of this Committee recently introduced the Supporting Early-Career Researchers Act, H.R. 8044, to help address the unequal impacts the pandemic has had on researchers at the start of their careers.

Further, researchers who would be susceptible to COVID-19, such as those with health risks and those sharing living or working spaces with vulnerable people, could find it difficult to return to research activities. Also, researchers who are socio-economically disadvantaged may be differentially impacted by the pandemic because they do not have the resources that allow them to work effectively away from campus or respond promptly to the challenges encountered during a pandemic.

Lack of support for specific groups could differentially impede researchers who are in a vulnerable stage of their careers and have long-term impact on efforts to diversify the academy.

Federal Action Needed

It is for these reasons that the federal government needs to act now to address the pandemic's harmful impacts on research. Research relief funding for the nation's science agencies is

[3] https://iris.isr.umich.edu/wp-content/uploads/2020/04/IRISresearchspendingfactsheet4-20_final.pdf

needed to maintain the vital continuity of the research across a breadth of disciplines, to maintain the flow of talent from within the U.S. and to the U.S., and to continue to fuel the engine of innovation vital to national prosperity and security. Foreign government investment in research has not abated. In fact, in many countries the investment continues to increase greatly. In addition to the Supporting Early-Career Researchers Act, Congress should take up and pass the RISE Act, H.R. 7308. As AAU, the Association of Public and Land-grant Universities, the Association of American Medical Colleges, and the American Council on Education wrote to Congress in May, "COVID-19 has caused enormous disruptions to federally supported research and inflicted serious and detrimental impacts on our nation's research enterprise." The bipartisan and bicameral (S. 4286) RISE Act authorizes approximately $26 billion in supplemental funding for federal research agencies to ameliorate the tremendous disruption to federally funded research, while also providing temporary regulatory relief. I am encouraged by the support of 126 House Members so far and more than 300 organizations that have cosponsored or endorsed the RISE Act, including the University of Illinois System and AAU.

As researchers and universities face challenges to their operations incurred by the pandemic[4], it is crucial to provide support so the U.S. can maintain its prominent position in research. Without supplemental funding from Congress for research relief, the consequences for our nation's university research and scientific enterprise will be dire. In the coming months, federal agencies will be forced to choose between abandoning new research opportunities of national importance or discontinuing existing research projects that are not yet completed. The latter would undermine investments the public has already made in research and either approach will slow discovery and innovation, while at the same time jeopardizing a generation of scientists and engineers critical to America's innovation capacity and economic competitiveness for years to come.

The near-term impacts of the COVID-19 crisis on the U.S. academic research enterprise are clear, as indicated above. We can foresee that the long-term impacts are likely to be serious and harmful. That is why I urge members of this subcommittee to help ensure that their congressional colleagues understand the need for urgent action. U.S. research universities and, very importantly, the visionary researchers within those universities are assets that the American public has leveraged for generations. The federal government recognized these assets decades ago when forging the modern government-university research partnership to advance our nation's health, economic, and national security. The universities and their researchers have stepped forward during the pandemic to help us understand the virus and the disease it causes. They prudently shut down operations, and then as soon as feasible they deliberately, safely, and successfully ramped up their research activities. The universities and their researchers are working to weather the setbacks caused by the pandemic. But they cannot do it alone. With the support of Congress, federal research conducted at America's universities and by the researchers who innovate there will emerge from the pandemic with the strength and vigor that has been the hallmark of the U.S. research enterprise for decades.

Thank you again for the opportunity to testify, and I look forward to your questions.

[4] See Appendix D

Appendices:

Appendix A: Examples of university efforts to advance COVID-19 research

Appendix B: Wigginton NS, Cunningham RM, Katz RH, Lidstrom ME, Moler KA, Wirtz D, Zuber MT: Moving academic research forward during COVID-19. Science Vol 368, pp.1190-1992, 12 June 2020.

Appendix C: Myers KR, Tham WY, Yin Y, Cohodes N, Thursby JG, Thursby MC, Schiffer P, Walsh JT, Lakhani KR, and Wang D: Unequal effects of the COVID-19 pandemic on scientists. Nature Human Behavior, 2020. https://doi.org/10.1038/s41562-020-0921-y

Appendix D: Schiffer P, Walsh J: The research ecosystem has undergone a complex transformation, necessitating a multifaceted response. Inside Higher Ed 5 Aug 2020.

Appendix A

Examples of university efforts to advance COVID-19 research (https://www.aau.edu/research/featured-research/battling-covid-19)

Institution	Title	Summary	Link
Boston University	Tiny, Decoy "Sponges" Attract Coronavirus Away from Lung Cells	New nanotechnology tested at BU's NEIDL stops SARS-CoV-2 from infecting cells and replicating	https://www.aau.edu/research-scholarship/featured-research-topics/tiny-decoy-sponges-attract-coronavirus-away-lung
Rutgers University	Asthma Does Not Seem to Increase the Severity of COVID-19	Rutgers researchers say further study is needed but those with the chronic respiratory disease don't appear to be at a higher risk of getting extremely ill or dying from coronavirus	https://www.aau.edu/research-scholarship/featured-research-topics/asthma-does-not-seem-increase-severity-covid-19
University of Illinois	Scientists develop rapid saliva test	The University of Illinois Urbana-Champaign is testing up to 20,000 students and staff daily using a saliva test it developed that typically provides results within hours.	https://emails.illinois.edu/newsletter/250894814.html
University of Oregon	New research examines the societal effects of COVID-19	UO researchers trying to learn more about how the coronavirus pandemic has affected daily life are teaming up to explore how people get groceries and household provisions and how that is changing travel and transportation.	https://www.aau.edu/research-scholarship/featured-research-topics/new-research-examines-societal-effects-covid-19
Iowa State University	Chemists at Iowa State University are developing a paper-strip urine test to detect infection by the coronavirus that causes COVID-19.	Chemists developing paper-strip urine test for at-home/office/clinic COVID-19 evaluation	https://www.aau.edu/research-scholarship/featured-research-topics/chemists-developing-paper-strip-urine-test
University of Southern California	USC researchers bioengineer first-line defense against COVID-19	Researchers at the USC Dr. Allen and Charlotte Ginsburg Institute for Biomedical Therapeutics, the USC Institute for Technology and Medical Systems and the USC School of Pharmacy are developing an antimicrobial fluid to bolster the body's first-line defenses against COVID-19.	https://www.aau.edu/research-scholarship/featured-research-topics/usc-researchers-bioengineer-first-line-defense
University of Utah	COVID-19 causes 'hyperactivity' in blood-clotting cells	Changes in blood platelets triggered by COVID-19 could contribute to the onset of heart attacks, strokes and other serious complications in some patients who have the disease, according to University of Utah Health scientists.	https://www.aau.edu/research-scholarship/featured-research-topics/covid-19-causes-hyperactivity-blood-clotting-cells

Stony Brook University	Machine Learning Can Identify Areas Most at Risk from Pandemic	Areas most at risk from the COVID-19 pandemic can be identified by a new machine learning tool developed by researchers at startup company Akai Kaeru LLC, which is affiliated with Stony Brook University's Department of Computer Science and the Institute for Advanced Computational Science.	https://www.aau.edu/research-scholarship/featured-research-topics/machine-learning-can-identify-areas-most-risk
Pennsylvania State University	Online dashboard enables COVID-19 tracking by Pennsylvania county	Residents of Pennsylvania can monitor the spread of COVID-19 across the commonwealth with an online dashboard created by researchers at Penn State. The dashboard, which has been available since March 12, provides a map of the state with the number of confirmed COVID-19 cases represented by county	https://www.aau.edu/research-scholarship/featured-research-topics/online-dashboard-enables-covid-19-tracking
University of Washington	UW launches online training for contact tracing to help fight COVID-19	University of Washington created the free, online course Every Contact Counts to support public health agencies in their contact tracing efforts	https://www.aau.edu/research-scholarship/featured-research-topics/uw-launches-online-training-contact-tracing-help
Northwestern University	Northwestern team develops new antibody test for COVID-19	Northwestern University researchers have developed a new method for testing for SARS-CoV-2 (the virus that causes COVID-19) antibodies. The method requires only a single drop of blood collected from a simple finger prick.	https://www.aau.edu/research-scholarship/featured-research-topics/northwestern-team-develops-new-antibody-test-covid-19
University at Buffalo	In three languages, Berry Bunny teaches kids about coronavirus	How should children learn about COVID-19? Two University at Buffalo medical students created an adorable, original character named Berry Bunny to explain coronavirus to kids in a clear, colorful and easy-to-understand story, complete with illustrations and activities.	https://www.aau.edu/research-scholarship/featured-research-topics/three-languages-berry-bunny-teaches-kids-about
Michigan State University	Study: How To Identify Patients Most At Risk From COVID-19 Through Nanotechnology	A Michigan State University professor proposed a point-of-care diagnostic platform that uses either nanoparticles or magnetic levitation to diagnose infection and assess future risk.	https://www.aau.edu/research-scholarship/featured-research-topics/study-how-identify-patients-most-risk-covid-19
The Ohio State University	Glacial ice will likely hold records of the COVID-19 pandemic, researchers say	Ice from glaciers around the world, undisturbed for centuries, show changes in how societies functioned throughout history – and will likely hold a record of the current impact of the COVID-19 pandemic for future generations.	https://www.aau.edu/research-scholarship/featured-research-topics/glacial-ice-will-likely-hold-records-covid-19
University of Pittsburgh	Formula Developed to Combat HIV Could Work as Novel Coronavirus Preventive	A nasal spray derived from algae and a plant in the tobacco family could offer a preventive measure for COVID-19, per Pitt researchers.	https://www.aau.edu/research-scholarship/featured-research-topics/formula-developed-combat-hiv-could-work-novel

University of Florida	Developing a next-generation coronavirus test for home use	UF researchers are working on a simple, paper-based system that would make it possible to test for the novel coronavirus in your own home.	https://www.aau.edu/research-scholarship/featured-research-topics/developing-next-generation-coronavirus-test-home-use
University of California, Irvine	Chemistry faculty launch antiviral research project	Scientists combine their diverse skills in collaborative effort to hobble COVID-19	https://www.aau.edu/research-scholarship/featured-research-topics/chemistry-faculty-launch-antiviral-research-project
University of Rochester	Rochester researchers pursue quick ways to detect COVID-19 — and better understand it	Scientists at the University of Rochester are rapidly adapting previous research to develop tests to detect the fast-spreading disease.	https://www.aau.edu/research-scholarship/featured-research-topics/rochester-researchers-pursue-quick-ways-detect-covid
Emory University	Emory develops diagnostic antibody blood test to determine antibody-responses to COVID-20	Emory University has developed a sensitive and specific diagnostic antibody blood test that will help determine antibody responses in people who have been infected by COVID-19.	https://www.aau.edu/research-scholarship/featured-research-topics/emory-develops-diagnostic-antibody-blood-test
Duke University	Duke Creates Open-Source Protective Respirator	A protective respirator created by a Duke University medical and engineering task force is now being used by Duke Health doctors as they treat patients with suspected cases of COVID-19.	https://www.aau.edu/research-scholarship/featured-research-topics/duke-creates-open-source-protective-respirator
Brandeis University	Brandeis researchers tackle COVID-19	Virologist Tijana Ivanovic's lab is looking at how the virus infects cells. Computer scientists Pengyu Hong and Hongfu Liu are using machine learning to map its genetic code.	https://www.aau.edu/research-scholarship/featured-research-topics/brandeis-researchers-tackle-covid-19
Johns Hopkins University	Antibodies from COVID-19 survivors could be used to treat patients, protect those at risk	With a vaccine for COVID-19 still a long way from being realized, Johns Hopkins immunologist Arturo Casadevall is working to revive a century-old blood-derived treatment for use in the United States in hopes of slowing the spread of the disease.	https://www.aau.edu/research-scholarship/featured-research-topics/antibodies-covid-19-survivors-could-be-used-treat

POLICY FORUM

RESEARCH POLICY: COVID-19

Moving academic research forward during COVID-19

A gradual, stepwise approach to reopening, informed by public health expertise, will be essential

By N. S. Wigginton[1,2], R. M. Cunningham[1], R. H. Katz[3], M. E. Lidstrom[4], K. A. Moler[2], D. Wirtz[5], M. T. Zuber[6]

The coronavirus disease 2019 (COVID-19) pandemic has led to an unprecedented disruption of society. Institutions of higher education have been no exception. To preserve the safety of their communities and adhere to public health guidance, universities and colleges around the world have rapidly pivoted to fully online teaching and learning models, implemented remote work for the majority of employees, and shuttered countless public spaces and programs. Most "on-site" research activities—in laboratories, in clinics, or in the field—also ground to a halt. Many institutions are now planning or implementing a ramp-up of on-site research activities, which offers an opportunity to begin implementing policies and practices that will lay the groundwork for the eventual reopening of additional on-site academic programming, including teaching. To ramp up safely, institutions are working with stakeholder groups—such as public health experts, as well as faculty, staff, and students—to develop guiding principles that will help inform and drive decision-making over the coming months. We synthesized several risk and decision-making frameworks under development at our universities to develop a set of criteria informed by public health expertise that institutions should consider before and during the first stages of restoring research activities and less certain factors to consider for subsequent phases.

Ramping down academic research and development around the world will undoubtedly contribute to the long-term economic ramifications of COVID-19. In addition to supporting the teaching and service missions of higher education—and health care delivery within academic medical centers—academic research contributes greatly to global economic development. In the United States, for example, higher education institutions accounted for $74 billion, or ~13%, of the $580 billion spent nationally on research and development in 2018 (*1*). More critically, these same institutions accounted for nearly half of the $96 billion spent on basic research nationwide, often seen as the seed corn for innovation and industry. Moreover, academic research institutions are among the top five employers in 44 of 50 U.S. states, employing more than 560,000 people (and more than 300,000 trainees) directly on research funds (*2*), many of which cannot perform their work remotely.

Markings are placed on the floor of an empty lab to promote social distancing.

PHOTO: J. FELLOW/UNIVERSITY OF MICHIGAN

RAMPING DOWN

Public health mitigation strategies across the globe have affected on-site research to varying degrees. In China, university research was subject to strict control measures in Wuhan and elsewhere, which contributed to the mitigation of the spread of the virus across the country (*3*). In Australia, where COVID-19 remains under greater control owing to early mitigation efforts, universities moved classes online, but social distancing measures and encouraging nonessential work from home when possible were deemed sufficient to keep most research facilities at least partially open.

In countries and regions where community transmission has been most severe—including the United States, Europe, and China—most academic institutions implemented policies to cease all "nonessential" on-site research activities over a short time frame, in some cases just a few days. This included not only laboratory research in the physical and life sciences but also field-based activities involving travel or direct human contact, such as clinic-based health, social, or educational research. Exemptions for accessing facilities on campus were solely made for work required to maintain equipment, preserve specialized research materials or long-term experiments, perform research to address the ongoing pandemic or other research deemed essential, or ensure patient, animal, and laboratory safety. Although varying widely by discipline and region, we estimate that these restrictions have halted more than 80% of on-site research activity at our six institutions.

RAPID RESPONSE

Despite the myriad challenges associated with ramping down on-site activities, research institutions worked closely with state and federal governments, funders, private industry, and each other to maintain continuity of research operations. In the United States, universities and their associations have been working closely with federal agencies to clarify what activities are allowed under active grants (e.g., salary continuity for researchers who aren't able to work on-site). Other coordination efforts include commitments to open sharing of data and research findings during the pandemic (*4*), improving access to high-performance computing resources for COVID research (*5*), and licensing terms that prioritize access to potentially life-saving technologies (*6*).

Academic researchers have also greatly contributed to work that directly addresses the ongoing pandemic—from revealing the fundamental biology of severe acute respiratory syndrome–coronavirus 2 (SARS-CoV-2), to studying the vast social, behavioral, and

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Phased approach and possible mitigations for determining allowable on-site research

	COMMUNITY TRANSMISSION STATUS (1S)	ON-SITE ACTIVITIES PERMITTED	MITIGATIONS	RESEARCH WORKFORCE IMPLICATIONS
Phase 0 (current state)	Substantial	Only essential work to ensure laboratory, animal, or patient safety; maintenance of equipment, materials, or long-running experiments; COVID-related research	Strict building access; personal protective equipment required; all work done remotely, if possible	Only essential staff with considerable training allowed; travel disrupted; substantial absenteeism owing to illness, child care, or family care; high-risk workers restricted
Phase 1 (ramp-up)	Moderate	Gradual addition of laboratory and studio work and regional field research not involving human subjects; widely used shared facilities reopen	Control building and/or room access; require temperature and symptom checking, physical distancing, strict limits on occupancy in labs, use of masks, enhanced cleaning procedures, and closures of exposed work spaces and buildings; testing and contact tracing if and when available	Fraction of researchers allowed depending on need, training, and willingness to return
Later phases	Minimal to none	Continued gradual addition of more on-site research activities, use of office and shared spaces, and relaxation of travel prohibitions; research with human subjects will require the highest level of scrutiny	Gradual loosening of some control measures, depending on performance metrics	Phased introduction of researchers working in-person with human subjects; additional trainees; high-risk workers only when conditions allow

economic impacts felt across the world, to developing the tests, therapies, and vaccines that will help treat the disease and prevent its transmission. Researchers around the globe have published more than 13,700 papers on SARS-CoV-2 or COVID-19 (*7*) and posted more than 3700 preprints to the bioRxiv and medRxiv repositories as of 19 May 2020.

Institutions are also assisting with critical public health services such as testing and providing the public and decision-makers with real-time data about the pandemic. For example, Johns Hopkins University's international COVID-19 dashboard receives 1.5 billion views each day, providing invaluable data on total confirmed cases, deaths, recovery rates, bed occupancy, intensive care unit availability, and more (*8*). Overall, the collaborations and open sharing of data and knowledge across international borders have proven to be essential in the response to the pandemic and to the reopening of other economic sectors.

GUIDANCE FOR PHASED RAMP-UP

Months after most on-site research was shut down, institutions in China, Europe, and the United States have slowly started resuming on-site research. Institutions have developed principles and policies for resuming on-site research activities based on input from public health and biosecurity experts, faculty, staff, students, and other community members. Our six universities, which represent a range of public and private institutions under varying state and local mandates and levels of local virus transmission, have developed overlapping yet distinct guidance for our research communities (see https://doi.org/10.3886/E119503V1). Common themes within our plans and elsewhere center around the critical need to adhere to public health guidance, prioritize the health and safety of the workforce and participants, and implement fair and transparent processes for decision-making. However, our plans, as well as others around the United States and in other countries, also diverge in ways that may be determined by a host of other factors, from cultural norms on campuses to local and state regulations. Policies such as allowing on-site undergraduate researchers, deciding acceptable occupancy levels in facilities, deciding whether to prioritize certain buildings and activities at the expense of minimal access to everyone, permitting use of nonlaboratory on-site spaces—including libraries, offices, and studios—and allowing field research that does not involve human subjects are among the primary differences in institutional responses. Variations in ramp-down and ramp-up approaches often reflected differing local and state guidelines or mandates, where political and social pressures have the potential to conflict with the best public health recommendations.

Public health frameworks provide a critical and helpful risk-based assessment for when certain industries, governments, and the economy more broadly can reopen (e.g., (*9*)). Academic institutions represent a broad set of activities and associated risk where one size (and one policy) does not fit all; however, it is clear from public health expertise that a gradual, stepwise approach to reopening and operating will be essential [see the table; (*10*)]. Furthermore, the use of metrics both in the community and within institutions will help determine if and when it is suitable to move into the next phase. On-site testing, contact tracing, and determining immunity status will likely play important roles not just in institutional decision-making and risk mitigation but also for broader public health monitoring (*11*). To do so, institutions will also have to consider how these strategies for research complement strategies being discussed for their broader campus community, as well as weigh potential costs, resources, and privacy concerns. Other metrics that will help determine when institutions are prepared to move into the next phase include building and laboratory occupancy rates, rates of adherence to physical distancing guidelines, and the number of new cases and symptomatic individuals identified during screening (see the box).

Future ramp-up and stabilization phases should be cautious and flexible enough that research activity can also ramp back down if metrics, public health guidance, or other external factors (e.g., local health care system capacity) dictates. Within institutions, this may also be required for certain laboratories, floors, or buildings if cases are identified and researchers are required to self-quarantine after possibly being exposed to a sick co-worker.

Further control measures will be required for months or more, such as continued physical distancing, engineering controls, requiring personal protective equipment, and administrative controls that include staggering access to spaces through shifts to minimize interactions between personnel (*9*). Although our suggestions are intended to prioritize caution and reversibility, we are concerned that other ramp-up plans might instead reopen too quickly or without proper safeguards out of a desire to return to prepandemic operations as soon as possible. As we are seeing in countries or other sectors that are prematurely reopening, undesired outcomes such as new transmission and outbreaks could lead to a whiplash effect of being fully open and then back to fully closed. Gradually and carefully resuming on-site research, and demonstrating that mitigations are effective, provides an ideal opportunity for institutions to implement lessons learned to inform the potential arrival of thousands of undergraduate students when terms resume. It will also help inform when other higher-risk activities, such as in-person work with human subjects, can safely resume.

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LOOKING AHEAD

Given the length of time that may be required to continue practicing social distancing, it may be years before academic research institutions reach a new normal. Although some beneficial practices may become more routinized (e.g., more alternative work arrangements and virtual meetings), there will undoubtedly be far more deleterious impacts across higher education. Anticipated budget shortfalls from multiple revenue streams suggest that the ongoing pandemic will hamstring institutions financially for years to come. Regarding research specifically, institutions will have fewer internal resources to perform research, invest in research infrastructure, and maintain its workforce. This presents challenges not only for individual institutions but also for the global research enterprise as a whole. In the United States, for example, institutional investments in research comprised ~25% of total higher education R&D spending in 2018 (*12*), a proportion that has increased considerably over the past decade as the percentage of federal investment in research has declined. For countries in which a large percentage of its research workforce consists of international students, such as Australia, travel and visa restrictions could lead to a substantial loss in revenue to support operations and a considerable reduction of the national scientific workforce (*13*).

The response to COVID-19 has highlighted how the lack of scenario planning and disaster preparedness is a systemic problem spanning virtually all sectors of society. Despite clear guidance and recommendations based on lessons learned from other disasters (*14*), the research community has much work to do to improve disaster resiliency. The experience of COVID-19 should make it clear that resilience planning should be a priority going forward, but even the best laid plans fail without effective leadership and coordination. Global coordinating bodies like the World Health Organization, or national agencies, must not be sidelined in their ability to advise governments and guide policies.

In the absence of strong national leadership, most institutions had to quickly develop their own plans for ramping down research, supplemented by ad hoc communication between institutions. Coordinating bodies like the Association of American Universities, which represents 63 major research universities in the United States and Canada, are playing much more prominent roles in facilitating ramp-up and other long-range planning. Improved coordination across academia, government, health systems, and industry during crises will also help identify early roles that institutions could play to address critical needs. For example, institutions could deploy expertise, resources, or facilities when there is insufficient incentive or capacity for the private or public sectors to refocus production or facilities rapidly, or when they lack capacity to scale up services such as testing. Considering a broader subset of the R&D workforce among essential workers, as in Washington state's "Stay Home, Stay Healthy" order, would help facilitate these cross-sector collaborations more effectively while also maintaining other potential life-saving research unrelated to the pandemic.

Should we ramp up?

Checklist for assessing when more research activity is permissible on-site

- Does local or regional public health guidance permit a gradual increase in research activity?
- Do individual labs and the institution have reliable access to supplies such as personal protective equipment and disinfectants?
- Does the institution have the ability to track symptoms, conduct testing, and/or trace and inform contacts?
- Have ramp-up procedures and plans been communicated to researchers?
- Are departments and individual labs ready to work safely?
- Are the support units (facilities, environmental health, security, custodial, transportation) prepared to support more on-site activity?

Finally, COVID-19 has exacerbated multiple equity issues in the research enterprise that institutions will grapple with in the months and years ahead. This broad-scale disruption of research operations has led to an incalculable number of setbacks for researchers, many of which disproportionately affect early-career researchers and their career advancement. These include the cancellation of long-running experiments, the loss of opportunities to collect critical data (e.g., in field and clinical studies), and lack of access to specialized major instrumentation, among many others. Furthermore, longstanding affordability and child- and family-care disparities across the research workforce—which disproportionally affect women, lower-income support staff, and trainees—are more clear than ever given the sudden and asynchronous sector closures and cost-saving measures implemented at many institutions. Researchers that fall into higher-risk categories on the basis of preexisting health concerns, age, or other immunocompromising conditions face long-term uncertainties around when it is safe to return to work. Systemic solutions such as extensions to promotion and tenure clocks, further deployment of alternative work arrangements, additional fellowship support for trainees, and policies to allow for extended paid and unpaid leave will be essential to stabilize the research workforce.

Moving forward, it will be up to academic institutions, governments, and funding agencies to develop practices and policies that encourage a more resilient, nimble, and equitable research ecosystem during the COVID-19 pandemic and beyond. Deeper investments in the research workforce and infrastructure will surely help; however, governments should also incentivize stronger ties between public health agencies and academic research institutions to ensure that decision-making at institutions and across communities is guided by the best available research. If not, it is unlikely that the research enterprise or society as a whole will be any better positioned to help generate solutions, or recover itself, when the next disaster arrives. ■

REFERENCES AND NOTES

1. National Center for Science and Engineering Statistics, "National patterns of R&D resources: 2017–18 data update" (NSF 20-307, National Science Foundation, 2019); https://ncses.nsf.gov/pubs/nsf20307
2. The institute for Research on innovation & Science, Summary documentation for the IRIS.UMETRICS 2019 data release. IRIS (2020); https://doi.org/10.21987/a07t-1c72
3. H. Tian *et al.*, *Science* **368**, 638 (2020).
4. Wellcome, Sharing research data and findings relevant to the novel coronavirus (COVID-19) outbreak (2020); https://wellcome.ac.uk/coronavirus-covid-19/open-data.
5. The COVID-19 High Performance Computing Consortium; https://covid19-hpc-consortium.org
6. AUTM, COVID-19 licensing guidelines; https://autm.net/about-tech-transfer/covid19/covid-19-licensing-guidelines
7. Q. Chen, A. Allot, Z. Lu, *Nature* **579**, 193 (2020).
8. E. Dong, H. Du, L. Gardner, *Lancet Infect. Dis.* **20**, 533 (2020).
9. C. Rivers *et al.*, "Public health principles for a phased reopening during COVID-19: Guidance for governors" (Johns Hopkins University, 2020); www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2020/reopening-guidance-governors.pdf
10. American College Health Association (ACHA), "Considerations for reopening institutions of higher education in the COVID-19 era" (ACHA, 2020); www.acha.org/documents/resources/guidelines/ACHA_Considerations_for_Reopening_IHEs_in_the_COVID-19_Era_May2020.pdf
11. D. M. Altmann, D. C. Douek, R. J. Boyton, *Lancet* **395**, 1527 (2020).
12. National Center for Science and Engineering Statistics (NCSES), Higher education research and development survey: Fiscal year 2018 (National Science Foundation, 2018); https://ncsesdata.nsf.gov/herd/2018/html/herd18-dt-tab001.html
13. F. Larkins *et al.*, "Impact of the pandemic on Australia's research workforce," 6 May 2020, p. 14; www.science.org.au/sites/default/files/rnif-covid19-research-workforce.pdf
14. National Academies of Sciences, Engineering, and Medicine, "Strengthening the disaster resilience of the academic biomedical research community: Protecting the nation's investment" (Consensus Study Report, National Academies Press, 2017); https://doi.org/10.17226/24827
15. U.S. Centers for Disease Control and Prevention (CDC), "Interim guidance for administrators of US institutions of higher education" (CDC, 2020); www.cdc.gov/coronavirus/2019-ncov/community/guidance-ihe-response.html

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Science

Moving academic research forward during COVID-19

N. S. Wigginton, R. M. Cunningham, R. H. Katz, M. E. Lidstrom, K. A. Moler, D. Wirtz and M. T. Zuber

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Check for updates comment

Unequal effects of the COVID-19 pandemic on scientists

COVID-19 has not affected all scientists equally. A survey of principal investigators indicates that female scientists, those in the 'bench sciences' and, especially, scientists with young children experienced a substantial decline in time devoted to research. This could have important short- and longer-term effects on their careers, which institution leaders and funders need to address carefully.

Kyle R. Myers, Wei Yang Tham, Yian Yin, Nina Cohodes, Jerry G. Thursby, Marie C. Thursby, Peter Schiffer, Joseph T. Walsh, Karim R. Lakhani and Dashun Wang

The COVID-19 pandemic has undoubtedly disrupted the scientific enterprise. Policymakers and institutional leaders have already begun to respond to mitigate the impacts of the pandemic on researchers. For instance, many universities are making accommodations for their researchers, and the US government has allowed temporary flexibility in grant conditions[1]. However, we lack evidence on the nature and magnitude of the disruptions scientists are experiencing.

To gain some insight into the extent of disruptions scientists are experiencing, we conducted a preliminary survey, which was distributed on 13 April 2020, approximately 1 month after the World Health Organization declared COVID-19 a pandemic. We reached out to US- and Europe-based scientists across a wide range of institutions, career stages and demographic backgrounds. Within a week, we received full responses from 4,535 faculty or Principal Investigators (detailed information on our survey is included in Supplementary Methods 1–3). Motivated by prior research on scientific productivity[2], we solicited information about scientists' working hours and how their time allocations have changed since the onset of the pandemic. We also asked scientists to report a wide range of individual and family characteristics (for example, field of study, career stage, demographic information, presence of partners or dependents), as these features may moderate the effects of the pandemic[3,4].

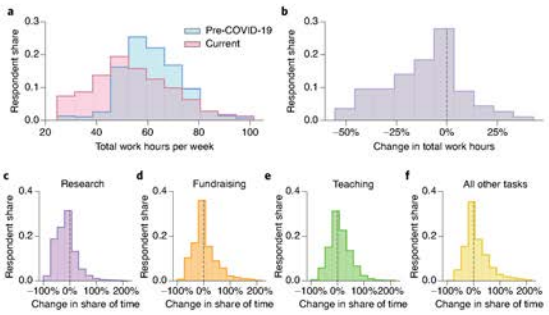

Fig. 1 | Changes in levels and allocations of work time. a, Distribution of total hours spent on work pre-pandemic and at the time of the survey. **b**, Distribution of changes in total work hours from pre-pandemic to time of survey. **c**–**f**, Distribution of percent changes in the share of work time allocated to research (**c**), fundraising (**d**), teaching (**e**) and all other tasks (**f**).

Varied effects of the pandemic

Overall, we found a decline in total working hours, with the average dropping from 61 h per week pre-pandemic to 54 h at the time of the survey (Fig. 1a). Although only 5% of scientists reported that they worked 42 h or less before the pandemic, this share increased nearly sixfold to 30% during the pandemic. However, the pandemic appears to have affected scientists in different ways. Although 55% reported a decline in total work hours, 27% reported no change, and 18% reported an increase in time devoted to work.

Scientists perform many different types of work: research (for example, planning experiments, collecting or analyzing data, writing), fundraising (for example, writing grant proposals) and teaching, as well as other tasks (for example, administrative, editorial or clinical duties). Among these different types of work, time devoted to research has changed the most during the pandemic. Whereas total working hours decreased by 11% on average, time devoted to research declined by 24%. In terms of the share of time allocated across the tasks (Fig. 1c–f), research is the only category that saw an overall decline. However, not all researchers reduced the time they devoted to research during the pandemic: 21% reported spending more time on research and 9% reported no change.

Different fields are affected differently

The pandemic appears to have affected scientists working in different disciplines unevenly (Fig. 2a). Scientists working in fields that tend to rely on physical laboratories and time-sensitive experiments—bench sciences such as biochemistry, biological sciences, chemistry and chemical engineering—reported the largest declines in research time, in the range of 30–40% below pre-pandemic levels. Conversely, fields that are less equipment-intensive—such as mathematics, statistics, computer science and economics—reported the lowest declines in research time. The difference between fields can be as large as fourfold.

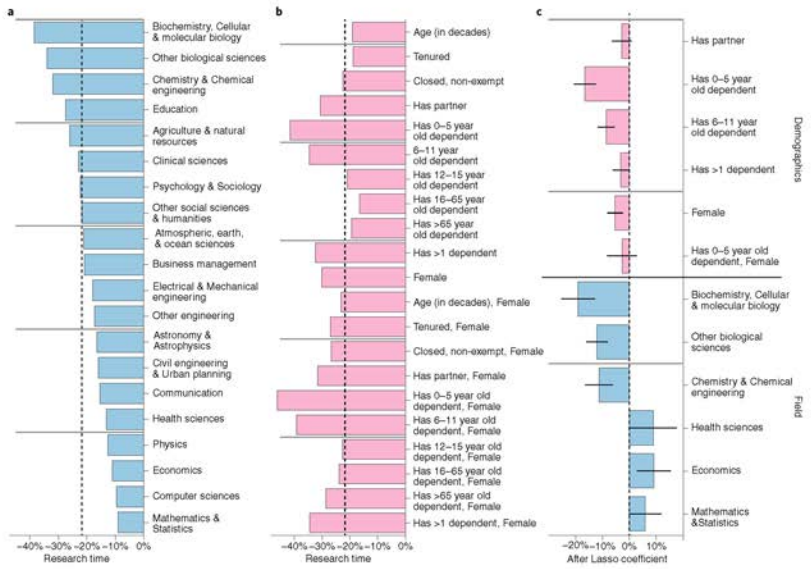

Fig. 2 | Field and group-level changes in research time. a, Field-level average changes in research time. **b**, Group-level average changes in research time. **c**, Changes in research time associated with important features of scientists or their fields, after controlling for other factors. To untangle different factors, here we use a Lasso regression approach to select features that are most predictive of declines in research time (see Supplementary Methods 4 for more). Variable names with 'Female' suffix indicate that the variable is interacted with a female indicator; otherwise the variable describes the average change for all scientists. Error bars indicate 95% confidence intervals.

Female scientists and those with young dependents are disproportionately affected

There is a well-documented, persistent gender gap in science[5,6]. We find that there are indeed substantial differences between our male and female respondents in how the pandemic has affected their work. Female scientists and scientists with young dependents reported that their ability to devote time to their research has been substantially affected, and these effects appear additive: the impact is most pronounced for female scientists with young dependents.

Digging deeper

These field- and individual-level differences may be due to the nature of work common to a field, or they may be due to circumstances unique to individuals (for example, changes in home life due to school closings, social pressures unique to genders, etc.).

In further analyses (Supplementary Methods 4), we find that, except for the case of the bench sciences, it is the individual circumstances of researchers that can best explain changes in the time devoted to research during the pandemic (Fig. 2). Specifically, although career stage and facility closures seem to play virtually no role in changes to time allocated to research when everything else is held constant, gender and young dependents play a major role. All else being equal, female scientists reported a 5% larger decline in research time. But the most important variable of all appears to be having a young dependent: scientists with at least one child 5 years old or younger experienced a 17% larger decline in research time, all else being equal. Having multiple dependents is associated with a further 3% reduction in time spent on research, and scientists with children aged 6–11 years were also affected, but to a lesser extent than those with very young children. Our survey results overall indicate that at least some of the gender discrepancy can be attributed to female scientists being more likely to have young children as dependents.

Taking action

Our survey was limited in scale and scope and cannot be used to draw general conclusions. Only 1.6% of the scientists we contacted responded to our survey. Our sample was self-selected and it is likely that scientists who felt strongly about sharing their situation, whether they experienced large positive or negative changes, chose to respond. Our sample mainly applies to US and Europe-based academic researchers. It is also possible that at least some of the gender

differences we found arose due to differences in reporting, rather than differences in outcomes[7,8]. Nevertheless, comparing our sample with the Survey of Doctoral Recipients[9] suggests that we oversampled on some of the attributes one might hypothesize to be more relevant to disruptions—namely, female gender and the presence of child dependents (Supplementary Methods 3).

Anecdotal accounts of the impact of the pandemic on scientists have been discussed extensively over the past few months on social media and the popular press. Our survey provides quantitative evidence that highlights disparities in how the pandemic has affected the scientific workforce.

The findings regarding the impact of childcare reveal a specific way in which the pandemic is impacting members of the scientific community differently. Indeed, 'shelter at home' is not the same as 'work from home' when dependents are also at home and need care. Because childcare is often difficult to observe and rarely considered in institutional research policies (aside from parental leave related to birth or adoption), addressing this issue may be an uncharted—but important—new territory for institutional leaders. Furthermore, it suggests that unless adequate childcare services are available, researchers with young children may continue to be affected regardless of the reopening plans of institutions. And since the need to care for dependents is not unique to the scientific workforce, these results may also be relevant for other labour categories.

Our female respondents reported larger declines in the time they could devote to research than their male colleagues. And scientists with young children appear to have been particularly hard-hit, especially women, who remain primarily responsible for childcare. Understanding the degree to which these changes in time allocations may translate into changes in their scientific output (i.e., funding, publications) will be extremely important to track, especially given that gender is a variable relatively accessible in data-driven studies[10]. The pandemic will likely have longer-term impacts that are essential to monitor and address disparities, and further efforts to track the effects of the pandemic on the scientific workforce should clearly take into account household circumstances.

A number of institutions have announced policy responses such as tenure clock extensions for junior faculty. Of 34 US university policies we identified, 30 appeared to guarantee the extension for all faculty (see Supplementary Results 1 for more details). Institutions may favour such uniform policies for several reasons, such as avoiding legal challenges. But given the heterogeneous effects of COVID-19, these uniform policies that do not consider individual circumstances, while welcoming, may have unintended consequences and could exacerbate pre-existing inequalities[11].

While this survey provides a snapshot of the immediate impacts of the pandemic at a single time-point, circumstances will continue to evolve, and there will likely be other notable impacts to science. The disparities we observe may even be exacerbated. For example, as institutions begin the process of reopening, there may be different priorities for bench sciences versus work that involves human subjects or that requires field-work travel, which could lead to new disparities across scientists. The possibility of a resurgence of infections[12] may lead to institutions anticipating a reinstatement of preventative measures and directing their focus toward research projects that can be more easily stopped and restarted. Funders seeking to support high-impact programs may adopt a similar approach, favouring proposals that appear more resilient to uncertain future scenarios. Scientists with potential vulnerabilities to COVID-19 may prolong their social distancing beyond official guidelines. In particular, senior researchers may have incentives to continue avoiding in-person interactions[13], which historically facilitate mentoring and hands-on training of junior researchers. The impact of such changes on individual scientists and groups of scientists could be substantial, in both the short- and long-term, exacerbating negative impacts among those at a disadvantage. It is therefore important that institutions and funding bodies take into consideration the consequences of policies adopted to respond to the pandemic, as they may disproportionately disadvantage specific groups of scientists and worsen existing disparities.

Lastly, although our respondents were all based either in the US or in Europe, the pandemic is having a substantial impact on research worldwide, which we do not capture. In the coming years, researchers may be less willing or able to pursue positions outside of their home nation, which may deepen or alter global differences in scientific capacity. Future work expanding our understanding of how the pandemic is affecting researchers across different countries, at different institutions, in different points of their lives and careers, and belonging to different demographic groups will be needed to effectively protect and nurture the scientific enterprise. The disparities we observe and the likely surfacing of new impacts in the coming months and years argue for targeted and nuanced approaches as the world-wide research enterprise rebuilds.

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

Because of the sensitive nature of some of the variables collected, the institutional review board (IRB)-approved protocol does not permit individual-level data to be made unrestricted and publicly available. Researchers interested in obtaining restricted, anonymized versions of this individual-level data should contact the authors to inquire about obtaining an IRB-approved institutional data sharing agreement.

Code availability

Code necessary to reproduce all plots and statistical analyses is freely available at https://kellogg-cssi.github.io/covid_survey/.

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References

1. Council on Government Relations. Institutional and agency responses to COVID-19 and additional resources. *COGR.edu* https://www.cogr.edu/institutional-and-agency-responses-covid-19-and-additional-resources (2020).
2. Stephan, P. E. *J. Econ. Lit.* **34**, 1199–1235 (1996).
3. Fox, M. F. *Soc. Stud. Sci.* **35**, 131–150 (2005).
4. Hunter, L. A. & Leahey, E. *Soc. Stud. Sci.* **40**, 433–451 (2010).
5. Blickenstaff, J. C. *Gend. Educ.* **17**, 369–386 (2005).

6. Huang, J., Gates, A. J., Sinatra, R. & Barabási, A.-L. *Proc. Natl Acad. Sci. USA* **117**, 4609–4616 (2020).
7. Lundeberg, M. A., Fox, P. W. & Punccohař, J. *J. Educ. Psychol.* **86**, 114–121 (1994).
8. Lerchenmueller, M. J., Sorenson, O. & Jena, A. B. *Br. Med. J.* **367**, l6573 (2019).
9. National Center for Science and Engineering Statistics. *Survey of Doctorate Recipients*. http://ncsesdata.nsf.gov/doctoratework/2017/ (National Science Foundation, 2017).
10. Fortunato, S. et al. *Science* **359**, eaao0185 (2018).
11. Antecol, H., Bedard, K. & Stearns, J. *Am. Econ. Rev.* **108**, 2420–2441 (2018).
12. Kiesler, S. M., Tedjianto, C., Goldstein, E., Grad, Y. H. & Lipsitch, M. *Science* **368**, 860–868 (2020).
13. Zhou, F. et al. *Lancet* **395**, 1054–1062 (2020).

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Competing interests

The authors declare no competing interests.

Additional information

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nature research

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Behavioural & social sciences study design

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Study description	A study to quantify the impact of COVID-19 pandemics on scientists.
Research sample	We identified scientists in US and Europe with at least two scientific papers during the past decade. Further details available in Supplementary Information S1.
Sampling strategy	We collected a list of author email addresses from Web of Science. We then randomly shuffled and sampled roughly 280,000 email addresses from U.S.-based authors and 200,000 from Europe-based authors. Further details are available in Supplementary Information S1 and S3.
Data collection	We sent out email invitations with a link to an online survey form. The survey is hosted and collected through the Qualtrics platform.
Timing	The survey was performed in April 2020.
Data exclusions	For our analyses, we focus entirely on responses from the sample of faculty/Principal Investigators, excluding responses from individuals who report to work for a "For-profit firm". We restrict the sample to respondents whose IP address originated from the United States or Europe (dropping 1,049 responses from elsewhere) and drop observations that have missing data for any of the variables used in our analyses. Further details available in Supplementary Information S3.
Non-participation	We estimate a response rate of approximately 1.6%. Further details available in Supplementary Information S3.
Randomization	No randomization.

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Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Human research participants

Policy information about studies involving human research participants

Population characteristics	See above.
Recruitment	We recruit individuals online. Further details on representativeness of our sample available in Supplementary Information S3.
Ethics oversight	The study protocol is approved by IRBs from Harvard and Northwestern.

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The research ecosystem has undergone a complex transformation, necessitating a multifaceted response (opinion)

During the pandemic, the research ecosystem has undergone a complex transformation, which will necessitate a multifaceted response, write Peter Schiffer and Jay Walsh.

Peter Schiffer and Jay Walsh
August 5, 2020

In late March of this year, almost every functional aspect of university research changed dramatically across the nation. Conferences were canceled, travel was postponed and most universities were driven into a new mode of remote instruction. Typically, the only personnel on campuses were those with essential duties and those responding directly to the pandemic. Research was shifted [1] to new modes of operation on a time scale that contrasted sharply with the usual glacial pace of academic change.

Researchers are now cautiously returning to their campuses to re-engage with resources and facilities unavailable in their homes. This restoration of research is a forerunner to the greater reopening in the coming months involving residential instruction at many colleges and universities. In that context, however, all stakeholders must recognize both how broadly and how unevenly the landscape for research has changed.

University researchers are known for their high levels of creativity and resourcefulness, and these strengths have led to a resilient response. Scholars have adapted their work habits toward finishing old manuscripts and proposing new projects. They have made flexible use of resources at hand. Many of them have also directly addressed the crisis itself through development of therapeutics, engineering of PPE and other materials, or research into many facets of the pandemic. And, most importantly, they have paid special attention to the teaching and mentoring needs of students and other trainees.

At the present moment, however, roughly four months from when campuses were largely emptied across the United States, university scholars have vastly different experiences both behind them and ahead of them.

A computational scientist might have been able to continue work from home almost uninterrupted, while a bench scientist might have had lab research totally stopped. The latter now may need to restart experiments from where they were cut off or possibly repeat weeks or even months of preparation.

A scholar who studies live theater or a performing musician who requires an ensemble may still be many months away from continuing their work. By contrast, a researcher who needs library

access to examine manuscripts directly may already have that access restored -- as long as the manuscripts are available in local collections. If the manuscripts happen to be in an undigitized collection on the other side of the globe, separation from that critical resource could stretch much longer. Similarly, the archaeologist, the glaciologist and the ethnographer all may face long disruptions of access to their work and concomitant sidetracking of research plans.

Even researchers in the health sciences, who have been appropriately celebrated for their rapid and often heroic efforts to alleviate the pandemic, will see different vistas depending on whether their specialty is connected to work on COVID-19 or focuses on unrelated topics. Research involving human subjects has been especially impacted, but those researchers also have experienced disparate impacts. While many studies that can be conducted remotely have restarted, or perhaps were never stopped, studies requiring close human contact largely could not proceed as planned and may be postponed indefinitely for subjects who are particularly vulnerable or in an environment that is not amenable to social distancing. Furthermore, some research may be irretrievably damaged. For example, longitudinal behavioral studies may have significant gaps, or perhaps the pandemic has affected subjects in ways that render initial assumptions invalid. In contrast, some researchers have found new directions emerging from the pandemic, encouraged by the opportunity for impact and the newly available grant funding targeted toward shortening and alleviating the virus's damage.

Separate from their research specialties, individual researchers have had widely differentiated experiences over the past four months.

Those who have children at home may have confronted larger barriers [2] to their productivity than those without them. That impact has been reported to fall disproportionately on women [3], and it may well continue until schools and daycare centers return to regular operation. Researchers with particular susceptibilities to COVID-19, those with anxiety about health risks and those sharing living spaces with similarly vulnerable people will all face a much more challenging landscape for advancing their work in the coming months -- as will collaborators and trainees who depend on the people who are directly impacted.

Sadly, younger scholars and those who are socioeconomically disadvantaged may be especially harmed by the pandemic in that they may have more limited resources to allow them to work effectively away from their campuses. Coupled with a bleak academic job market, such factors could impede long-term efforts to diversify the academy.

A Shifting Landscape

Aside from individual impacts on researchers and their programs and projects, the broader research landscape has also shifted considerably in the past four months.

International collaboration is now hindered by multiple travel restrictions applied unevenly to citizens of different nations, and to new impediments to obtaining visas [4]. Simultaneously, federal agencies are increasingly acting on heightened concerns regarding the threat of foreign interference in research [5]. University researchers have been indicted [6], agencies have tightened safeguards [7] and Congress is proposing new regulations [8]. If adopted, new rules

could significantly redraw assumptions about international cooperation and the open nature of fundamental scientific research.

At the same time, university support has been included in federal relief packages to partially address the financial toll of the pandemic, and more relief specifically for research [9] is possible. Further, a bipartisan group in Congress has proposed a vast expansion of the mission of the National Science Foundation [10], with a large multiplier of its budget. All this support is accompanied by a broad recognition of the crucial role that universities have played in pandemic responses and will play in addressing future challenges that the nation will face.

Each of these global shifts by themselves would be considered transformational to university research in a normal time. That they are happening during a global reckoning with the realities of racism, and along with the social upheaval of the pandemic, makes them all the more profound.

As we move into the next phase of the COVID-19 pandemic, we should appreciate the breadth of change across the university research landscape that has happened in such a short time. Rather than a broad and uniform shift, it is a highly heterogeneous shuffling of circumstances that will take months and perhaps years to settle into a new normal. And it will only be made more complex by a possible resurgence of infections or geopolitical changes that are easy to imagine in our near future.

The accompanying challenges to so many university researchers will require action, but the wide variation and the global shifts preclude a one-size-fits-all response. Indeed, a decentralized and nonuniform approach, guided by principles, may be best suited to avoid exacerbating the externally driven heterogeneities. Researchers, along with university leaders, research sponsors and government regulators, must consider the complexity of recent change as they continue to develop the spectacular graduates and produce the transformational discoveries that have made America's universities a model of higher education for the world.

Peter Schiffer is the Frederick W. Beinecke Professor of Applied Physics at Yale University and is serving as a senior fellow at the Association of American Universities. Jay Walsh is the interim vice president for economic development and innovation for the University of Illinois system and is serving as a senior fellow at the Association of American Universities.

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Jay Walsh

Interim Vice President for Economic Development and Innovation
University of Illinois System

Jay Walsh became the University of Illinois' Vice President for Economic Development and Innovation on May 16, 2020, after more than 30 years as a faculty member and administrator at Northwestern University. Most recently, he was Northwestern's Senior Advisor to the President for Research and Science. Dr. Walsh was Northwestern University's Vice President for Research from 2007 until 2019. During his tenure, the University's external sponsored awards grew 91% from $417M in 2007 to $798M in 2019. As the VP for Research, Dr. Walsh oversaw an infrastructure and annual budget that supported research across not only the STEM fields but also the social sciences, arts, and humanities. Northwestern saw a 134% increase in industry funding for research during Dr. Walsh's time as the University's VP for Research. Under his leadership, the Office for Research made significant contributions to the development and support of Northwestern's core research facilities and the number of institutes and centers grew from less than 20 to more than 50 – each with significant external funding. Additionally, he championed global impact programs, such as the Mandela Washington Fellowship-Young African Leadership Initiative and the program on Equality Development and Global Studies, as well as local programs that impact K-12 students in Evanston and Chicago, for example, at Lakeview and Mather High Schools in Chicago and through Science Club at the Girls and Boys Clubs of Chicago.

Dr. Walsh currently serves on the Board of Directors at MxD, the Board of Governors at Argonne National Laboratory, the Board of Directors for Current, the MIT Corporation Visiting Committee for Sponsored Research, the Board of Visitors for Vanderbilt's Engineering School, and the Board of Directors for the University Industry Demonstration Partnership (UIDP). He currently chairs the Board of the Chicago Council on Science and Technology, a Chicago-based science communications group driven by participation from major academic, hospital, museum, and industrial organizations in Chicago. Previously, Dr. Walsh served on the Board of Directors at Fermi National Laboratory, the Illinois Governor's Innovation Council, the Naval Research Advisory Committee, and the U.S. Secretary of Navy Advisory Panel.

Dr. Walsh earned his Bachelor's and Master's degrees in Electrical Engineering from the Massachusetts Institute of Technology (MIT), and his Ph.D. degree in Medical Engineering from a joint Harvard Medical School – MIT program. Dr. Walsh's research on laser-tissue interactions framed the understanding of laser ablation of biological tissue which help to lay the scientific foundation for many of today's standard laser-based procedures in medicine and surgery. More recently, his research focused on the diagnostic and therapeutic applications of light. In 1997, at Northwestern, he was recognized as the Engineering School's Teacher of the Year, and in 2005, he was selected as the Advisor of the Year.

Chairwoman STEVENS. And next up is Dr. David Stone.

TESTIMONY OF DR. DAVID STONE, VICE PRESIDENT FOR RESEARCH, OAKLAND UNIVERSITY

Dr. STONE. Good afternoon, Chairwoman Stevens, Ranking Member Baird, and Members of the Subcommittee. Thank you for allowing me to address you today. Oakland University sits proudly in Chair Stevens's district, and provides undergraduate, graduate, professional, and medical education to about 19,000 students, who come largely from the surrounding counties in Southeast Michigan. Oakland is classified as a Research II University, and does provide doctoral training in physical sciences and engineering that is supported by Federal research funding. But for the purposes of my comments today, Oakland is representing, and speaking to the challenges of, the nearly 400 public universities around the Nation that are neither State flagship nor land grant institutions. These regional universities, which include many historically Black and Hispanic-serving institutions, are the backbone of U.S. science, engineering, and technologies workforce pipeline. We accomplish this by providing meaningful research experiences to our undergraduate students that engage them directly with faculty in solving real problems and committing—contributing to the scientific record by publishing their results. As such, we serve as the launching pad for the majority of STEM students, including the underrepresented minority students and first-generation college students who bring a diversity of experiences, perspectives, and goals to our science and engineering workforce.

In general, the effects of COVID—of the COVID–19 pandemic on Oakland University, and other regional universities, mirrors what you've already heard in terms of disruptions, delays, and added costs of agency-funded research. At this point only a third of Oakland University's funded researchers and students are back in the labs. To give an example, we have a 30-year NIH (National Institutes of Health) funded study of DNA damage, which is important to long term space flight. When these highly productive faculty restarted preparations for their next experiment at the National Supercomputing—sorry, National Superconducting Cyclotron at Michigan State, they quickly realized that the only person on their team who knew how to fabricate their nanoparticle samples, one Mr. Alex Stark, was an undergraduate, who was not allowed back in the lab. The principal investigator petitioned me to make an exception, but I could not contravene the Governor's executive order. In the end, this high-powered team had to wait six more very unproductive weeks to get their expert undergraduate back in the lab.

The pandemic has imposed a different set of challenges on Oakland University and other regional universities than just traditional research grant funding. Support for the high impact practice of undergraduate research, which we know contributes to retention and graduation in STEM, and to sustaining the science and engineering workforce pipeline, comes largely from the university's general fund, which is derived primarily from two sources, tuition and State funding. The pandemic has put both in peril. OU already has incurred more than $25 million in direct losses to the costs of the pandemic. The State also just imposed an 11 percent reduction on

our State funding for this year, and prospects look grim for the next two. Here's an example of what's at stake. Oakland University's world-renowned Eye Research Institute runs a summer research program that is funded through our State appropriation. Our super program has trained 100 undergraduates over the last 20 years. In the early 2000's an undergraduate named Cristina Kapustij conducted vision research in the Eye Research Institute and co-authored a scientific paper. She went on to attend law school at Georgetown, serve as a congressional Health Fellow for Representative John Dingell, and is currently chief of policy and program analysis at the National Human Genome Research Institute. Such is the impact of high-quality State supported undergraduate research programs.

This combination of operational losses and State budget cuts in Michigan and around the country will cripple our ability to provide undergraduate research opportunities, and do immediate and long-lasting damage to the science and engineering workforce pipeline. Oakland University fully supports the *RISE Act* so that agencies have the funds to help our investigators complete their research. We also support H.R. 8044 to help our early career investigators keep their research careers on track. But it is imperative that research funding be distributed more widely. We all know that life circumstances distribute talent such that great ideas often come from unexpected places. This lesson should show us the value of distributing resources across the spectrum of institutions so that we imbue our science and engineering workforce pipeline with the full diversity of experiences, perspectives, talents, and goals.

America must maintain a robust research enterprise and a healthy workforce pipeline. It is therefore imperative that you also complete a fourth stimulus that includes direct university funding, funding for the research agencies, and relief for State governments. Failure to do so will have a huge negative impact on our economy, on the workforce pipeline, and on the students across our country who have committed their lives and livelihoods to science. In that spirit, I ask each of you to support these proposals.

[The prepared statement of Dr. Stone follows:]

Testimony Before the House Research and Technology Subcommittee
(Chair Rep. Haley Stevens)

Introduction

Good morning Chairwoman Stevens, Ranking Member Baird and members of the subcommittee, and thank you for allowing me to address you today. My name is David Stone, I am the vice president for research at Oakland University. I also hold full professorships in public health and philosophy.

Oakland University sits proudly in Chair Stevens' district and provides undergraduate, graduate, professional, and medical education to about 19,000 students, who come largely from the surrounding counties in Southeast Michigan. Oakland is classified as a Research 2 university and does provide doctoral training in the physical and mathematical sciences and engineering that is supported by federal funding. But for the purposes of my comments today, Oakland is representing, and speaking to the challenges of, the nearly 400 regional public universities around the nation that are neither State flagship or Land Grant institutions.

Individually, regional universities do not have the same size research footprint as our states' flagship and land grant institutions, but collectively, we educate and train a larger share of the nation's scientists and engineers, and the scientific achievements of our faculty are not to be gainsaid. Regional universities, which include our historically black colleges and universities, and many of our Hispanic and minority serving institutions, are the backbone of the US science, engineering, and technology workforce pipeline. We accomplish this, in large part, by focusing effort and resources specifically on providing meaningful research experiences for our undergraduate students that engage them directly with faculty, solving real problems, and contributing to the scientific record by publishing their results. Through this effort, we also serve as the launching pad for the vast majority of the underrepresented minority students and first generation college students who bring a diversity of experiences, perspectives, and goals to our science and engineering workforce.

In my testimony today, I want to briefly provide you with a sense of the initial negative impacts of the pandemic shutdown in the spring, the ongoing challenges to research and training, and the likely future harm of the pandemic on research and the STEM pipeline. I will then discuss the importance of addressing these consequences and what may happen if we fail to act to address these impacts. Finally, I will discuss some of the steps we might take and comment on pending legislation to overcome these challenges and ensure that the US maintains a robust research enterprise and an unbroken pipeline of students into careers in science and engineering.

Initial Impact

In Michigan, the initial Impact of the COVID-19 Pandemic arrived on March 13 with Governor Whitmer's emergency stay at home order. From that moment, with the exception of essential activities and research on COVID-19 itself, all laboratory-based research, all field research, and all face-to-face human subjects research at Oakland and on campuses across Michigan stopped. Faculty, research staff, and students were all forced to put down their pipettes, shut down their fMRIs, turn off their computers, say goodbye to their subjects and colleagues, and walk away from their unanswered hypotheses.

The shutdown lasted 2 and a half months. At that point, on June 5, laboratory research was permitted to restart under strict public health guidelines to protect the health and safety of faculty, research staff, and students. These guidelines included specific limitations on the density of personnel in labs, the use of personal protective equipment, the times individuals could remain in shared indoor space, and specific requirements for cleaning and disinfecting surfaces. As seems to have been true for most universities across the country, initial reopening guidelines prohibited undergraduates from returning to labs. While this posed less of a challenge to larger research universities, which tend to rely more heavily on graduate students and post-doctoral researchers, it posed a significant challenge to regional institutions, which tend to rely heavily on undergraduates to assist faculty with their research.

During this period, we estimate that more than 90% of lab, field, and human subjects research were forced to shut down. As was the practice at other universities, Oakland University investigators continued to expend federal grant funds to pay their students and their staff to conduct whatever other project-related work they could during the shut-down, but in most cases, direct progress toward project goals ceased entirely.

Identifiable losses from this period include the loss of specimens and reagents, the canceling of industry contracts (which entailed the loss of funding to support students working on those projects), and the loss of the planting and growing season for our organic garden. Also lost are a whole category of social and behavioral studies looking at factors such as nutrition, weight gain, sleep patterns, education, child development, and exercise. These studies are lost not simply because pandemic protections inhibit methodologies for data collection, but because the normal conditions against which interventions were to be tested are no longer in place, and without those normal baselines, social circumstances, and behavior patterns, results of these studies cannot be compared to prior (or future) studies in the literature. The loss of such studies affects not only the results of these efforts, but they delay, and in some cases derail long-standing research trajectories and plans for, and the timing of, future, larger-scale studies.

While we are still working through the COGR Research Impact Metric model to determine the full financial costs of our immediate losses, it is clear that delays and barriers to full productivity will add significantly to those losses as we move forward.

Examples of pandemic effects on research:

Our chemistry department has a very successful and productive NIH-funded study that has been continuously funded for 33 years. The study looks at DNA damage in cells produced by gamma rays, which is important during long-duration space flights. When faculty for this project were allowed back into their labs in June, they began to prepare for their next use of the National Superconducting Cyclotron at Michigan State University. They quickly realized, however, that the only person on their team who knew how to fabricate their nanoparticle samples, one Mr. Alex Stark, was an undergraduate who was not allowed back in the lab. The Principal Investigator petitioned me to make an exception, but alas, I could not contravene the Governor's executive order. In the end, this high-powered team had to wait six more very unproductive weeks to get their expert undergraduate back in the lab.

A second example tells a very different kind of story. In many states, regional universities train the bulk of the local nursing workforce. When the pandemic came to Michigan, nursing research at Oakland ceased immediately; not because we closed the labs, but because every nurse grabbed a mask and a gown and ran to the hospital. Our medical students and faculty did the same, and we couldn't be prouder. However, while these students and faculty stepped up to care for the community, the work they had been doing to further research and complete the students' education came to a halt.

Current Impacts

As we invite students back to campus for the fall semester, most of our science and engineering labs should have been able to reopen. However, the ongoing constraints imposed by pandemic precautions, including limitations on density and proximity, are limiting productivity and, in some cases, prohibiting certain kinds of experiments and training opportunities.

Currently, three months after the Governor permitted reopening, only 53% of all of our research labs have filed plans with the Research Office and resumed work in their labs. Forty-seven percent of our labs have not even filed plans at this point. In terms of our funded research, only about 35% of our funded research personnel are back at work. These figures no doubt reflect challenges posed by social distancing requirements, personnel density limitations, and supply shortages. However, they also reflect our inability, as yet, to be able to restart projects that require face-to-face data collection, research that requires travel, research that involves collaborators from other institutions, including international colleagues, and engagement with specialized facilities (off campus labs, zoos, nature conservancies).

These trends, coupled with the frank losses of specimens, cell lines, reagents, seasons, and in some cases, normalcy, indicate that the level of need among our faculty for agencies to provide so-called for-cost extensions is going to be much greater than was predicted by the length of the shutdown. For many, if not most labs, the return to full productivity in the near term may be impossible.

And perhaps more importantly, for institutions like Oakland, the immediate effects of these limitations on the research effort will be the costs to undergraduate students looking for the research experiences that they need to compete for medical school or graduate school admissions, to connect with a mentor to help them navigate the undergraduate experience, or to demonstrate to an employer that they have the latest skills or the ability to see a complex set of activities through to completion. We, like many other regional institutions, have large numbers of undergraduate Honors College students who rely on lab and research placements to complete capstones and honors theses that are required for graduation. Already, just a week into the semester, I am hearing from faculty that their inboxes and voice mails are filling up with frantic student requests for placement in a lab or involvement on a project. One faculty member told me she has already agreed to take five honors students into her research program on disabilities. In a "normal" year, this faculty might take one honors student at most.

I would be remiss if I did not also point out that the impacts on the university extend well beyond the laboratory. OU has incurred more than $25 Million in financial losses connected to the pandemic, and those costs are growing as we work to operate in a hybrid educational model for our undergraduates. These losses have been significant, and while we appreciated the CARES act funding of universities, those funds made up for less than half of the costs we have already incurred.

Future/ongoing impacts of pandemic

These challenges, which so far are only consequences of the shutdown during the onset of the pandemic and the protective requirements of pandemic response, will soon be greatly exacerbated by impending State revenue losses (for FY20 *and* FY21); and that assumes we do not see a legitimate second wave of the virus or combinations of COVID-19 and influenza that push us back into full or partial shutdowns.

At regional universities, while some undergraduate research takes place through federally funded research, for example on NIH R15 grants or NSF Research for Undergraduate Experience programs, the majority is funded internally and at the margins. At Oakland University, which strives to keep tuition as affordable as possible, State appropriations provide only about $3,000 per student. Per capita funding levels like these at regional institutions allow for very little support for undergraduate research. Significant cuts in State higher education funding will dramatically limit our ability to provide those opportunities, which in turn, will cause significant damage to the science and engineering workforce pipelines. And if these cuts become the basis for future State appropriations, it will take years for current funding levels to be restored, further exacerbating the damage.

Let me give one example of the kind of undergraduate research program that Oakland University supports from its State appropriation that reveals the importance of such programs and the angst we feel at the prospect of losing them. The Summer Undergraduate Program in

Eye Research (SUPER program) has been in place at Oakland University's world renowned Eye Research Institute (ERI) for the past 20 years. Over that time, the program has trained approximately 100 exceptional undergrads in research techniques. The students work one-on-one with ERI faculty for 12 weeks during the summer and receive a stipend of $4,000. In the early 2000s, an undergraduate named Cristina Kapustij conducted vision research in the ERI and co-authored a scientific paper with an ERI faculty member and a faculty member in the Department of Physics. She presented results of her work at an undergraduate research conference at the University of Michigan at Dearborn. She later went on to attend Law School at Georgetown, serve as a Congressional Health Fellow in the office of Representative John Dingell, and be a policy analyst at Duke University's Center for Genome Ethics, Law and Policy. She is currently Chief of Policy and Program Analysis at the National Human Genome Research Institute in Bethesda, MD. Others have gone on to scientific careers at places like Pfizer or in academe, and many used their experience to attend medical school and are now practicing ophthalmologists with a bent toward research. This is the kind of highly successful program we fear will be lost if our State funding is diminished.

Undergraduate research is a high impact practice that has been shown to support retention and completion among all students, and can be critical for students from underrepresented minority populations and first generation students. As we think about the significant contributions that regional institutions make to the science and engineering workforce pipelines, it is important to remember that even with the current levels of support for undergraduate research, only 40% of all students who pursue a STEM degree actually graduate in STEM, and that figure is only 20% for students from underrepresented minorities (Altman, et al.). It has also been shown that students who get exposure to STEM disciplines through undergraduate research projects are "more likely to remain in college and persist in STEM majors" (Ibid.). Without additional support to both universities and to State budgets, the combined effects of pandemic precautions and reductions in funding at the State and Federal levels will significantly damage the science and engineering workforce pipelines, especially for women, minorities, and first generation students.

What do we need?

We need a national plan to address the pandemic – we cannot move forward until the pandemic is handled. We a need a coordinated federal and state response that includes: increased rapid testing capability that is less expensive and tied to aggressive and effective contact tracing; clear and consistent messaging on mask-wearing, social distancing, density restrictions, and the risks posed by aerosols; transparency with regard to vaccine development, testing, selection, and deployment; and policies that support people who choose to self-isolate and quarantine out of concern they may be spreading the virus.

Oakland University fully supports passage of the Research Investment to Spark the Economy (RISE) Act to cover the costs of the pandemic directly on research, including funding for the research agencies. It becomes clearer by the month that the limitations imposed by pandemic

precautions are significantly limiting research productivity. At Oakland, where most of our research facilities were constructed in the 1960s, a high proportion of our labs can now accommodate only two people, which in many cases is too few to accomplish essential tasks. It has also rendered impossible most of the hands-on training elements so critical to graduate student apprenticeship. Workarounds for all of these barriers will be more time-consuming than old methods and will require additional resources.

Beyond the resources provided to our funded investigators through the Rise Act, a deal is needed on the fourth stimulus bill – the university funding in both the House and Senate proposals is vital to shoring up the financial condition of universities across the nation. This is funding necessary to keep many institutions viable.

In addition, it is essential that the stimulus bill include funding relief for State governments. State funding of public universities is a critical element to the financial health of these institutions. Michigan just announced in August that they will reallocate resources and tap rainy day funds to shrink a $3B funding gap down to $1 Billion for the next fiscal year. That figure is just shy of 10% of the state's discretionary budget. It is a budget shortfall that has already resulted in an 11% cut to public universities, which we felt just last month when the cut was imposed on our state payment. Importantly, the cuts get worse in the next two fiscal years – as current expectations are that the state is facing an approximately $2 – 3 Billion cut for the next fiscal year and some estimate another $2B for the year after that. These cuts will have to be passed onto the universities and we will be put in the untenable position of raising tuition during a serious financial crisis – preventing access, and losing students – or absorbing the cuts, which will require massive cuts to programs and people. Every state is facing this same dilemma.

Thus, the stimulus funding MUST include support for State budgets, or our ability to provide the research opportunities for undergraduates will be severely limited. Let me say that again, if the federal government does not provide substantial relief to both universities and the States in the next stimulus, the budget cuts facing regional public universities around the nation will effectively eliminate our capacity to provide research opportunities for undergraduate students, negatively impacting the workforce pipeline in critical areas, and diminishing their capacity to contribute to new knowledge for years to come.

For those already in the pipeline, we also need to ensure that there are opportunities for them to go on to graduate programs. To that end, Oakland University endorses the Supporting Early Career Researchers Act (H.R.8044). This innovative bill would establish a pilot program to award grants to qualifying early investigators to conduct independent research for 2 years. While this bill limits its support to investigators whose work can be supported by the National Science Foundation, it is an important proposal because, as identified above, these new investigators are currently experiencing great difficulty in advancing their research.

In fact, all research agencies need to place greater emphasis on early investigator grants. There is a tendency during a crisis to rally funding for large facilities, initiatives, and institutions. And

while this is understandable, keeping the *entire* research enterprise healthy is critical to both the national economy and health of our people. It is imperative that research funding be distributed more widely. We all know that life circumstances distribute talent such that great ideas often come from unexpected places. This lesson should show us the value of distributing resources across the spectrum of institutions so that we imbue our science and engineering workforce pipeline with the full diversity of experiences, perspectives, talents, and goals.

Finally, we must resist the temptation to concentrate all research funding increases on bio-medical responses to the COVID-19 virus itself. Yes, we need significant investments in NIH, CDC and FDA. However, we cannot forget the other areas and agencies that are playing critical roles in addressing the pandemic, particularly computational/modeling research, human behavior research, and improved testing/detection and tracing activities.

In conclusion, I am here asking for your help. America must maintain a robust research enterprise and a healthy workforce pipeline for science, engineering, and technology. It is therefore imperative that you act now to pass these two bills and complete a fourth stimulus that includes direct university funding, funding for the research agencies, AND the relief for state governments. Failure to do so will have huge negative impacts on our economy and on the students across our country who have committed their lives and livelihoods to science, and who are working hard right now to serve our nation and the world through their talents, their energy, and their ideas.

In that spirit, I ask each of you to support these proposals.

Thank you.

References:

CUR Whitepaper #1: *Undergraduate Research: A Road Map for Meeting Future National Needs and Competing in a World of Change*, Joanne D. Altman, Tsu-Ming Chiang, Christian S. Hamann, Huda Makhluf, Virginia Peterson, and Sara E. Orel, 2019.

David A. Stone, Ph.D. is Vice President for Research, Professor of Public Health and Professor of Philosophy at Oakland University.

Dr. Stone holds two interdisciplinary degrees (a combined BA/MA degree and PhD) from the University Professors Program at Boston University. The former explored the intersection of law and psychiatry. The latter combined the philosophy of science, the philosophy of technology, economics, sociology of work, organizational behavior, cognitive science, and expert systems to examine the nature, meaning, and limits of knowledge-intensive technology.

Over the past 25 years, he has taught and conducted research at Harvard's Schools of Medicine and Public Health, Tufts University School of Medicine, Sheffield University (UK) and NIU. He served as founding director of the South East European Research Center (Greece) where he developed and directed a multidisciplinary PhD program focused on addressing the needs of the Balkan nations following cessation of the Balkan Wars. Prior to that, he served as co-founder of the Pediatric and Adolescent Research Center at Tufts University, as director of Harvard's Boston Violence Prevention Project, where he founded BostonCares for Injured Youth and as a faculty member for the medical School's clinical fellows program where he founded the Boston Colloquium for Qualitative Research in Health. As an interdisciplinary researcher, he has secured over $10 million in research funding and another $30 million in funds to support institutional initiatives. He has published in seven disciplines, and taught in five. His recent scholarship examines the nature of interdisciplinarity and takes a transdisciplinary approach to public health, education, and research development.

Dr Stone's various other administrative roles include, Associate Vice President for Strategic Innovation and Planning, Associate Vice President for Research, and Director of Sponsored Projects at Northern Illinois University.

Dr. Stone has served as an American Council on Education Fellow, as President of the National Organization of Research Development Professionals (NORDP), and is a member of the Charter Class of NORDP Fellows.

Chairwoman STEVENS. Great. Thank you so much. And now we'll hear from Dr. Mayer.

TESTIMONY OF DR. THERESA MAYER, EXECUTIVE VICE PRESIDENT FOR RESEARCH AND PARTNERSHIPS, PURDUE UNIVERSITY

Dr. MAYER. Chairwoman Johnson, Ranking Member Lucas, Subcommittee Chairwoman Stevens, Ranking Member Baird, and Members of the Subcommittee, 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. We also greatly appreciate the flexibilities that Federal agencies have offered researchers during this national and global emergency. Our 70-year partnership with the Federal Government has brought our national unparalleled success in basic research at the frontiers of science and transformative innovation in technology and medicine. Most importantly, it has built human capital. The—this academic talent, research, and tech transfer will be key in the emerging industries of the future, such as artificial intelligence (AI), quantum information science, 5G, advanced manufacturing, biotechnology, and others. Today I'm pleased to share the perspective I gained leading the COVID–19 research response at Purdue, and through my collaboration with colleagues in the Big Ten academic alliance and beyond. For context, Purdue is the State of Indiana's comprehensive public land grant university, with over 2,200 faculty, 500 post-docs, and 45,000 students. More than 2/3 of the students graduate in STEM fields. Purdue is committed to affordability and accessibility, and has frozen tuition and fees for the last 8 years. We rank as the 6th most innovative university in the U.S., and are in the top 25 in research expenditures among publics.

In early March the Nation watched as universities flipped from residential to remote instruction in a matter of weeks. The impact on research has garnered less attention by the media. At Purdue the ramp down of on campus research to remote research whenever possible occurred over 3 weeks, and involved over 1,200 principal investigators, with 4,500 funded programs in 100 campus buildings, ag centers, and sites in all 92 counties of Indiana. Travel restrictions severely limited field work and halted in person collaborations across the country and the world. Faculty shared comments such as, "Fortunately, we were able to shift non-experimental work with the data we had in place." With a major shift to remote research, on campus critical research continued. For example, three of our faculty have been working together for years to develop therapeutics to fight coronaviruses. NIH is now funding pre-clinical trials to test their potential drug molecules on the SARS-COVID virus.

In May Purdue implemented a return to operations plan. By the end of June, nearly all of our 1,200 campus research spaces and core labs were back online under modified operation. This translated to access for 7,000 researchers, including 370 post-docs, more than 3,000 graduate students, and 400 undergrads. This number does not include researchers who continue to work entirely remotely. During this time Purdue also collaborated with Microsoft

to create an online tool to quantify the impact on COVID on sponsor programs. Investigators responsible for the 137 million in expenditures reported effort and financial loss. The aggregate for Purdue's entire portfolio is 11 percent, or a $15 million loss on total expenditures. Notably, 50 percent of the researchers who focus on computation, data science, and related activities reported little or no impact over this period. Of those impacted, 70 percent stated restriction access to facilities as the primary reason for the loss.

The no cost time extensions afforded by the Federal agencies have been critical. One researcher shared, "Federal sponsors have been very open to shifting deliverables and scope because they understand our situation." Other institutional losses for research included lost revenue for core labs, facility retrofits, enhanced PPE, testing and contract tracing, and others, are large, and measured in the tens of millions for Purdue alone. In addition to the short-term impact and losses, we expect that researchers will experience ongoing decreased productivity to reduce capacity and modified operations of labs, ongoing travel restrictions, absences due to illness, quarantine, gaps in childcare and school, and many other factors, what we call our new pandemic normal. There is also growing evidence that women and other underrepresented groups in STEM have been disproportionately impacted. The proposed bipartisan *RISE Act*, together with the *Support for Early Career Research Act*, would provide critical supplemental support needed to complete work that was directed—disrupted, and to extend education and training opportunities for early career researchers to mitigate the potential loss of our best and brightest STEM talent at this very critical time for the Nation. Thank you, and I look forward to the Q and A.

[The prepared statement of Dr. Mayer follows:]

Testimony of

Theresa S. Mayer
Executive Vice President for Research and Partnerships
Professor of Electrical and Computer Engineering
Purdue University
West Lafayette, IN

Before the
Committee on Science, Space, and Technology
Subcommittee on Research and Technology
of the U.S. House of Representatives

On
The Impact of the COVID-19 Crisis on University Research
September 9, 2020

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.

Chairwoman STEVENS. Thank you, Dr. Mayer. And now, Mr. Muzzio.

TESTIMONY OF MR. RYAN MUZZIO, PHYSICS PH.D. STUDENT, CARNEGIE MELLON UNIVERSITY

Mr. MUZZIO. Thank you, Chairwoman Stevens, Ranking Member Dr. Baird, Congresswoman Johnson, Ranking Member Lucas, and the entire Subcommittee on Research and Technology, for giving me the opportunity to testify today. I'm an experimental physicist and a graduate student at Carnegie Mellon University. For the past 2 years my work was funded by the Department of Energy, and is currently funded by the National Science Foundation. I thank you all for supporting the mission of the Federal funding—research funding agencies. My doctoral research is aimed at designing materials as thin as a single layer of atoms, such as grafting, and studying and exploiting their properties for real world applications. This research involves in person operation of instrumentation in enclosed spaces with my collaborators at Carnegie Mellon, or the Lawrence Berkeley National Labs in Berkeley, California. My collaborators and I use the same tools, and at times need to be overlapping in space, using the same gloves and viewports on instrumentation. Today none of this work can take place without extreme caution to prevent the spread of COVID–19.

Just last year I was at Berkeley National Labs learning how to operate a tool for my collaborators, who had made the trip to Denmark. This training is integral to my research and career development. Every year I prepare samples to learn and perform measurements there. However, due to the lab shutting down in March of this year, I have not been able to attend in person measurement sessions. My ultimate goal is to work at a national lab for an extended period of time, and missing these sessions impacts my chances of attending—or obtaining such a position. I've also missed opportunities to work and network with researchers at conferences.

The pandemic has also drastically slowed my ability to perform research and make meaningful progress toward my Ph.D., and between March and May my work was constrained to performing only data analysis, and the process was very slow. Now, when I enter the lab, I must follow tedious, but essential, safety protocols, including donning PPE, minimizing the number of people in labs, and wiping down all of the surfaces that we touch. Social distancing has been difficult because we are building a new research instrument, which requires multiple people to work on it in close proximity. In person training is minimized too, slowing everybody's learning process.

But what I bring to you today are my experiences of just one graduate student. There are—they are hardly representative of all of us, and many of us are living in multiple different realities with this virus. To adapt to operating remote instruction, we have had to take time away from our research. Students have been unable to run experiments, brainstorm, and collaborate due to the lack of in-person activities. Delays in graduation, hiring freezes that disrupt job searches, internships, and collaborations are lost. All of these stories are far too common. Disruptions in the academic job market have also come at a high cost for us, making it impossible

for many of us to proceed to do—to proceed with research careers. And we're more than just researchers. We're a linchpin in the entire university system. We come from all over the world to conduct groundbreaking research, teach classes, mentor undergraduates, and without the support—without support, the United States loses—or risks losing a generation of talent forever, impeding the pace of innovation in the country, and in particular in our universities.

That said, academic issues are not all that we are facing in this pandemic, as I have laid out in my written testimony. For instance, at Carnegie Mellon, students are using the food pantry at astonishing rates. Student parents have experienced the most challenging disruption, and have been forced to juggle their research and teaching responsibilities while parenting full time. International students are in particular in a difficult situation due to travel restrictions. One student lost both their father and grandmother during the pandemic, but could not travel home. Beyond this isolation, students have lived in uncertainty caused by sudden policy shifts, like the July 6 directive from ICE (Immigration and Customs Enforcement), requiring them to either attend in person class or leave the country. Two-thirds of the students at Carnegie Mellon are international, and many of them are the most talented individuals I work with.

Ph.D. students report symptoms of—consistent with major depressive order—disorder at higher rates than ever before. Personally, my mental health has taken an impact from this pandemic because of the—because thoughts are constantly clouding my mind about whether my family, friends, or myself are going to—furthermore, being a Black man, I have been deeply affected by the ongoing national conversation about structural racism, and the calls for change through Black Lives Matter movement. All of this has taken significant troll—toll on me. We are not in a bubble.

In closing, graduate school is something we do because we want to be here, to learn and to work with like-minded individuals, and to further our collective knowledge of the world. In the best of times it is intense, and we are not in the best of times. We need support now more than ever. I look forward to answering your questions, and hope you continue to hear directly from graduate students on the front lines of our Nation's research environment. Thank you, Madam Chairwoman.

[The prepared statement of Mr. Muzzio follows:]

Testimony before
The Subcommittee on Research and Technology
Committee on Science, Space, and Technology
United States House of Representatives

Hearing Titled: The Impact Of The Covid-19 Crisis On University Research

Ryan Muzzio
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Department of Physics
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September 9th, 2020

I would like to thank Chairwoman Stevens, Ranking Member Dr. Baird and the entire Subcommittee on Research and Technology for giving me the opportunity to testify today and for allowing the space to exist for discussion on the impact of the COVID-19 pandemic on University Research. I am both honored and humbled to be able to offer my viewpoint as a graduate student. I hope that this testimony provides stories and voices of graduate students so that you can gain insight into how our lives have rigidly shifted in these challenging times.

After completing my undergraduate degree at Kenyon College in Ohio, I joined Carnegie Mellon University as a Ph.D. student in the Department of Physics two years ago. My work lies in the understanding of novel materials and the fundamental principles that govern their properties in order to introduce them into functioning electronic devices for memory storage, quantum computing, and biomedical applications. I am an experimentalist, meaning my research relies on my ability to operate complex instrumentation in person within multiple labs, cleanrooms, machine shops, at Carnegie Mellon as well as the Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California. For the past two years, my work was funded by the Department of Energy (DoE), and is currently funded by the National Science Foundation (NSF). I would also like to thank the full committee for supporting the mission of both the DoE and the NSF and hope that even more students in the future will be funded by these incredible agencies.

My doctoral research is aimed at designing materials as thin as a single layer of atoms, such as graphene, and studying and exploiting their properties for real world appliances. The working area of my devices is typically half of the thickness of a human hair. This line of research has the potential to revolutionize how we live our lives. It has already made significant advances in quantum computing and biomedical applications. In order to further my research, I must use state of the art technology that allows me to synthesize and measure such materials and devices. I can only create these samples and perform measurements at nanofabrication facilities, machine shops and facilities such as LBNL in person. I firmly believe that not only will my work serve the lives of people in the world for every day work but it will progress science and lay the foundation for future scientists.

In May 2019, I was at LBNL for the first time working at the MAESTRO beamline at the Advanced Light Source Synchrotron (ALS), a DoE facility within LBNL. I was learning how to operate a complicated tool from the scientists who built it—a rare opportunity. My collaborators from Aarhus University in Denmark had made the trip to train me such that we could work together to further our knowledge of graphene. It is almost impossible to conduct such training in a virtual setting. LBNL was the best place for me to not only learn but also network and see the cutting edge research being done there. Since then, my day-to-day research operations included collaborating with many undergraduate and graduate students like myself, professors, and technical staff where I needed to be physically near people in my laboratory and machine shops to perform the necessary job. All of my research facilities require multiple people to be in an enclosed environment for long periods of time. We all use the same tools and, at times, need to be overlapping in space by using the same gloves and viewports on instruments. Today, none of this work can take place without extreme caution to prevent the spread of COVID-19.

For the school year leading up to March 2020, I was preparing material samples for measurements at LBNL to use the angle resolved photoemission spectrometer with nanometer x-ray spotsize (nano-ARPES) endstation at the MAESTRO beamline. This style of instrument can only be found at a handful of facilities world wide. It is understood that nano-ARPES is the state of the art, and cannot be replaced by any other at present. In order to operate it one needs to learn from the staff scientists at LBNL by attending multiple measurement runs. The work I do year-round is in preparation for in-person operation of this instrument but the experience and usefulness of traveling to LBNL does not end at measurement—LBNL is also a gathering place for the best scientists in the world, just as any other national lab. Hundreds of scientists apply to get time on the MAESTRO beamline, and only a selected few get to do so. The researchers who travel to or are permanently located at this facility are amongst the very best in their fields. Learning from them is integral to my research and career advancement. It is a crucial learning experience of my Ph.D. and helps expand the horizons of my knowledge of Physics. It is also an opportunity to get to know these scientists and grow my professional network progressing my understanding of and network in Physics. My ultimate goal is to work in a facility such as

LBNL for an extended period of time, either as a graduate student or postdoctoral researcher. Without attending in-person measurement sessions, my chances of attaining such a position are low.

However, this wasn't the only opportunity lost to the pandemic. In March, I was also ready to present my research to the scientific community for the first time at the American Physical Society (APS) March meeting—the world's biggest conference for condensed matter Physics, that hosts over ten thousand researchers each year. Upon arriving in the host city, Denver, to attend the conference, I found out that the meeting was canceled. Soon after that, all in-person activities at Carnegie Mellon University were canceled and all non-essential travel was suspended indefinitely. Both my presentation and pre-LBNL preparations were canceled resulting in a great loss in scientific opportunity and personal development. Even today, I am unsure whether I will be able to return to LBNL, let alone measure the samples I want to measure.

Work in my field requires an in-person collaborative environment, and is also heavily reliant on training. In my lab, I train new undergraduate students every semester who eventually become fluent in the field and gain research experience by collaborating with me on various projects. These are students who wish to pursue a doctoral degree themselves and this exposure to research helps them gain a better understanding of where their interests lie. Ever since our lab shut down in March, I have not been able to work with them. Not only have they lost the opportunity to learn, explore, and refine their skills, my research productivity has been severely impacted as well.

From the day we had to shut down our lab, my advisor and I anticipated that I would not be able to make much progress on my research until we regain access to on-campus facilities. Between March and May, my research work was constrained to only performing data analysis. While every experimental physicist must analyse data, hardly ever is it the only research work you're engaged in. For those two months, I barely accomplished what I would normally do in a week.

So when CMU invited proposals for phased reopening of research labs in May, our lab soon began the application process to bring ourselves back to campus during CMU's *return to research test phase*. Apart from devising a plan to maximize safety of my labmates and myself, I began buying PPE equipment, including face shields, face masks, two sets of gloves, lab coats, pants, and hand sanitizer. We were chosen to be one of the first labs back on campus in June. For a period of almost 3 months, I could not perform any experiments, slowing progress on my research project. However, reopening by itself was not sufficient for most of my friends whose labs also reopened. Prior to the pandemic, most students used public transit to commute to and from campus, but a reduction in frequency of the Port Authority buses made it difficult for those students to commute. While I was fortunate to own a car, the majority of my fellow graduate students did not. Since our lab reopened in a limited capacity, my daily routine has changed significantly. When I arrive on campus, I have to change into lab-only clothing (including lab coat and pants) that stays on campus. I then don gloves and wipe down every surface I touch throughout the day. To leave the lab and go anywhere but my office, I need to change back into the clothes I wore to campus and, upon returning to my office and lab, I must change back into lab clothing and follow sanitization protocol to re-enter.

For two months since June, I was the only student working in my lab where, in the past, there were three graduate students and four regular undergraduate students. My newly added responsibilities were beyond the scope of my research because I was maintaining instrumentation that I had never used and wasn't even relevant to my ongoing project. My labmates had to move from being research assistants to being teaching assistants to preserve their stipend and tuition support (as research related to their projects could not be conducted remotely), while I was able to stay on as a research assistant by performing data analysis during this period. Without my fellow labmates, I had to learn to establish the pandemic routines of working in a lab. I was the sole person in my lab allowed into the cleanroom for nano fabrication instruments that is used on nearly every project in our lab. This meant that I was in charge of operating these instruments for multiple projects. On top of the unexpected loss of productivity, I had to absorb other work as well.

As people have started to return to the lab, maintaining a six-feet social distance has been difficult because we are in the midst of building a new state of the art instrument in-house to advance the lab's research capabilities as a whole, and that requires multiple people to hoist, turn knobs, and screw in different components. Every part of our lab is a common space that is used by multiple people every day. Gradually, we have been able to get all graduate students and a postdoctoral researcher back to the lab. All of the undergraduate students trained in the past two years are still not able to come. Furthermore, the ongoing training is now nearly back to square one, where we have to now explain procedures remotely or from a distance.

When I come into the lab, I am excited to be productive and work hard, but by the middle of the day I become exhausted from dodging all of the potential COVID-19 contact areas. I work in a state of fear as I constantly wash my hands, apply hand sanitizer, and clean surfaces that I have touched. I trust my labmates to make the right decisions about social distancing, but I worry about my trips outside of the lab to go home or get coffee. I now go to my lab, bring lunch, make coffee in my office and minimize going outside of those two spaces. Every person I meet in the cleanroom and surface that I touch, a small thought arises in my head: *Is this the space where I contract COVID-19 and bring it home to my housemates?*

Now that we have had time to adjust to research, it feels that many months have passed but with only a few weeks of work to show. We have spent many days creating remote access for our instrumentation but not every process can be done remotely, no matter how hard we try. I currently have no plans for returning to LBNL. The facility has reopened for remote non-ideal measurements and I am forced to adapt, else I will be without the data I need to further my research. Even with the measurements I can do, the remote experience does not provide the same exposure to me as an early career researcher as in-person measurements do. I believe that we, as a scientific community, adapted the best we could, but all our efforts towards boosting efficiency in the long-run of COVID-19 could have been spent on the actual research itself.

That said, I am not alone in my hardships. I have heard and witnessed many fellow graduate students go through similar experiences and more. A fellow graduate student put it well, "*Graduate school is harder than most imagine. It is hard during the best of times and we are far from the best of times.*" As another Ph.D. student put it, "*under pandemic research conditions, all parts of grad school that make it bearable are removed and we're left with the parts that are frustrating and emotionally draining.*" all while being home to isolation. The mental toll we are taking is multivariable and takes form in many aspects of our lives. Graduate students are more than just researchers—we are a linchpin in the entire higher education system, we conduct groundbreaking research, drive day to day operations of our labs, and teach and mentor undergraduate students. When it comes to early career researchers like myself and other graduate students, we need a large scale boost in funding, the stakes are nothing less than the U.S. risking losing a generation of talent.

During this time, my mental health has been significantly impacted as I live in malaise. The COVID-19 pandemic is constantly on my mind, my thoughts are often clouded by concern for the lives of my family, friends, and myself. Furthermore, being a Black man, I have been heavily affected by the Black Lives Matter (BLM) movement that dominates my news feed, interactions with family and friends as well as within academia. I do not know how to process such events as the videos revolving online and the protests when I am alone in my house. The continuous stream of information about BLM, COVID-19, widespread job loss and economic drops has demolished my productivity.

My experiences are hardly representative of graduate students across Carnegie Mellon let alone across the country, the graduate student community consists of people in a wide range of life stages and backgrounds. How the pandemic influences graduate students is a dynamic problem with the variables being both time and the student. I believe the most immediate group of graduate students who need help are those who are graduating soon, with uncertainty looming around their future in research. These students are especially hurting because they are looking to finish up projects that, for some, cannot be performed remotely. A graduate student at CMU's

School of Computer Science expressed concern that their graduation date may be pushed back which would result in them needing potentially unavailable funding. Another student in the College of Engineering has already had their graduation date pushed back from the end of the summer to the end of the fall semester so they can keep searching for jobs and have some financial security through their Ph.D. stipend until they can find an employer. The job market for students has dried up quickly over the last few months. One graduate student at CMU was in the middle of job interviews when they were all cancelled and they had to begin their job search again. Many students have voiced concerns about not being able to find a job for post-graduation because they have lost summer jobs and internships, many of them only hearing from their future employers in April, only one month before their date of employment.

Many students who have already graduated are continuing their studies as postdocs in the lab they graduated from. This, in principle, allows one to refine their understanding of their work but in reality it only narrows their chances of evolving their careers. The reason one would take a postdoc is to broaden their understanding of their field and set them apart from their advisor. Ultimately, to get a job in academia or a research lab, one must establish that they are the leading expert in a unique and interesting area of research, not just a replica of their advisor. However, the disruptions in the academic job market has made that almost impossible for many, and has the potential to reduce the number of people who continue in science, ultimately leading to the loss of valuable talent.

These more experienced students are in need of funding which can be accomplished by supporting the *Support Early-Career Researchers Act* which will greatly assist these students by allowing them to be funded and bring their talents to other research groups and eventually take on research roles, whether in academia, in the private sector, or in national labs like LBNL. We have heard from one student who in particular has decided that, due to COVID, he will not be pursuing an academic job. He, like many other students, is worried about the stagnating job market for tenure track professorships. With universities and various industries announcing hiring freezes, there are significantly more eligible job applicants than the jobs available, often

pushing graduating students outside of STEM research.

Similarly, for early stage graduate students COVID-19 is already negatively affecting their research and collaboration prospects. It is only early in one's Ph.D. that they explore different research problems and settle on what they would pursue for the rest of their time as a doctoral student. The pandemic and resulting restrictions have hindered their ability to do so. For people who work in my lab and many other labs at Carnegie Mellon, this is extremely clear: they have yet to be trained, are unable to make connections to labmates and professors, and have limited or no access to facilities. Currently at CMU, the nanofabrication laboratory, which holds the majority of the essential tools that experimentalists like me need to do their work, is limiting their number of people allowed in their facilities. Furthermore, trainings that I would normally conduct myself in successive sessions, are now restricted to only being conducted by cleanroom staff who have very tight schedules and are only allowed to work for four days a week.

In speaking with a first year graduate student, he voiced concerns about his experience so far while recognizing the inherent limitations of what the university can do about them. He is allowed on campus for his single in-person class and has special permission to work in my lab while the rest of his cohort can only attend in-person classes. Students who are in the early years of their Ph.D. have had difficulty finding time to do research. A second year Ph.D. student was taking classes, teaching a course, and trying to find time for research had her summer dreams erased by COVID-19. "*I was really looking forward to the summer; it was the first time [in my graduate career] that I could focus on research and really dive into it but it never happened*," she said. Instead of learning the vital fundamentals of her research, she returned to the lab to find that the instrument that she was in the middle of training on had broken during the duration of the quarantine. Now that she is taking courses again, she is trying to learn how to fix the instrument remotely.

Apart from the first year and mid-career graduate students, I have heard many stories of students who are unsure if their knowledge will be passed down to future generations. A student has

already had to push his graduation date back by six months but is struggling to finish their sample making, data collection, and thesis writing. They said, "*[I am] trying to cram nine months of in person hands on training into three months of remote training in the lab while trying to write [my] thesis, find a job, and finish sample preparation and measurement.*" Knowledge is easily lost in this circumstance. It can take a graduate student years to find the issue that could be mitigated by a quick conversation with a senior graduate student.

Outside of the lab, the COVID-19 pandemic has brought an additional burden to graduate students that we could not have anticipated—each of us is uniquely weighed down by personal relationships to the pandemic. Many students are funded by their department by being a teaching assistant which takes vital time away from your research in normal circumstances, let alone a pandemic where students teaching courses were forced to transition to remote-teaching in the middle of Spring semester. Among the students that I know at CMU, everyone is struggling to teach remotely as effectively as they taught in-person, extending the time away from research. One student in particular has had to do what she approximates is one and a half times the amount of teaching to ensure the students are learning properly. This, in turn, was a great loss of productivity for graduate students in teaching roles. In response to a survey conducted by the CMU Graduate Student Assembly (CMU GSA) in June to understand immediate impacts of COVID-19 and future needs, a student wrote, "*I split my time between teaching at a small New York State school and pursuing my dissertation at CMU. COVID-19 has thrown many aspects of my job into question and made it much harder for me to find the time and energy to continue with my research. My advisors have been very understanding but I worry about my ability to complete my dissertation in a timely manner while being so mentally exhausted.*" Stories like these are very common.

However, academic issues are not all that students face during this pandemic. Students are using the Carnegie Mellon food pantry at close to twice the rate of utilization pre-pandemic. A study done by the University of Pittsburgh in 2018 found that 29% of all college students in South

Western Pennsylvania were facing moderate to severe food insecurity.[1] The pandemic has made that worse. Moreover, we do not know the scope of this at the national level. At the time, this study was the second largest study ever done on collegiate food insecurity. The full scope of all these issues at Carnegie Mellon was brought to light by the survey conducted by CMU GSA to which close to 400 students responded sharing their personal stories.[2]

Student parents, on average, experienced some of the most challenging disruptions. It is difficult to be an attentive parent and enroll in coursework, let alone conduct doctoral research at the same time—even with support. The pandemic took all support away in a very short time for many. One student has two children who are less than five years old, another is the father of three. The former is only able to work in the early hours of the morning, making sacrifices of his research for the better of his family. The latter has to balance time between taking care of his children, teaching undergraduate students, and doing research—forcing them to stay up until 3 AM to make any progress on their degree, often relying only on 4 hours of sleep every day. Another student who is a mother of a twenty three month old told GSA, "*In late March, everything changed. Daycares closed, leaving me to choose between trying to figure out how to juggle a full course load while parenting a toddler at least half-time, or find an extra $10 per hour to pay for a babysitter/nanny. I am an exceptional student. I took additional credits every term until COVID hit and maintained a GPA above 4.0. That semester I dropped down to four courses and found myself part-time childcare (20 hours per week), so that I could try to keep up. In April, my husband was informed that the project he was working on had been postponed until further notice. I was able to finish out the semester strong, but the costs to our family, both financially and psychologically were steep. These difficulties are ongoing. Our daycare plan costs $400 per month more than it did in our pre-pandemic plan, and I do not know when my husband's income will return. Furthermore, with rising food prices, our grocery bills have*

[1] Cross, A. B. (January, 2018). *Needs Assessment of Collegiate Food Insecurity in SW Pennsylvania: The Campus Cupboard Study.* University of Pittsburgh.
https://www.pasfaa.org/wp-content/uploads/2019/06/CSF2018_CampusCupboardStudy.pdf
[2] Carnegie Mellon University Graduate Student Assembly. (2020). *Graduate Student Experience at Carnegie Mellon University During The COVID-19 Pandemic: Findings from the GSA COVID-19 experience survey*
https://www.cmu.edu/stugov/gsa/External-Advocacy/graduate-student-covid-experience-at-cmu.pdf

significantly increased. I have looked for cheaper housing options and other alternatives, but the cost of moving alone wipes out any potential savings for several years. I still plan to graduate in May, but I lament the courses I might have taken and the financial stability I had planned/hoped to graduate into. It seems like everything we scrimped and saved for over the last 10 years has been wiped away in a matter of months, and I am afraid to start over with nothing and a young child depending on me." Having to teach, do research, and take care of the children all day is an extreme amount of work few can do. The need for support is not a novel issue but the ways we need support has changed drastically. We have built communities to tackle such issues in the past, but as we have been forced to go nearly completely remote, those communities do not exist anymore and students are unsure where to go for help.

Students who could not return from Spring break but were otherwise utilizing the university counseling services during their studies were left without access to therapy as many university counselors are licensed in Pennsylvania only. A student from the College of Engineering, for instance, had to replace their counselor with a phone-based mood tracker application. In responses to the GSA's survey, hundreds of students highlighted their mental health struggles. In fact this is not unique to Carnegie Mellon. In a survey of roughly 4000 U.S.-based STEM Ph.D. students conducted from May to July of this year, 40% reported symptoms consistent with generalized anxiety disorder and 37% with major depressive disorder—jumps of 13 and 19 percentage points, respectively, compared with 2019.[3] Another survey conducted in June and July showed similar results: roughly one-third of more than 3000 U.S. graduate students reported suffering moderate to severe depression or anxiety. It's unconscionable. But this crisis was already in the making, and as a matter of fact, in 2019, the editorial board of the journal *Nature* called for urgent attention to the mental health of Ph.D. researchers after having labeled it a mental health crisis a year ago.[4]

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[3] Chirikov, I., Soria, K. M, Horgos, B., & Jones-White, D. (2020). *Undergraduate and Graduate Students' Mental Health During the COVID-19 Pandemic.* UC Berkeley: Center for Studies in Higher Education. https://escholarship.org/uc/item/80k5d5hw

[4] Editorial. (2019). *The mental health of PhD researchers demands urgent attention.* Nature. https://www.nature.com/articles/d41586-019-03489-1

International students were in an even worse position which was further exacerbated by the July 6th directive issued by the Department of Homeland Security and ICE requiring them to attend classes in-person or leave the country. The sudden shift in policy worsened an already uncertain environment for thousands of Carnegie Mellon students who come from all over the world. While the government rescinded the directive on July 14th, it already had a long lasting impact not just on international students—many of whom were already worried about their families in COVID-19 hotspots—but also domestic students like myself, as was reflected in an Amicus Brief filed by CMU GSA and 15 other graduate student governments with the District Court of Massachusetts.[5] Already in the middle of minimizing disruptions to research due to the pandemic, students and universities were forced to dedicate their time towards fighting this arbitrary and capricious directive.

Many students struggled with financial issues as well. Monetary struggles are common in graduate school because stipends only allow for a comfortable living situation if you live in the right city. One student from the Mellon College of Science had both of their parents laid off work due to the pandemic. The student is now the sole source of income for their family of six. They are very appreciative of the work that CMU has done to keep the stipend secure and stable but are constantly worried about what lies ahead. To alleviate some issues that can be supported financially, at Carnegie Mellon, the Graduate Student Assembly redirected funds that were initially meant for supporting graduate students to attend conferences and other student activities, into an emergency fund. So far, they have dispersed over $60,000 to the fund, through which students who are facing financial insecurities during a time when uncertainty looms over their funded research are able to secure emergency grants. Alumni, the Undergraduate Senate and the university administration and staff donated to the fund as well.

Another student has a tragic story that I cannot fully comprehend the effect on a human being. They are from a foreign country where they have not been back to since 2016. Their father and grandmother passed away during the pandemic and the travel restrictions meant they could not

[5] https://www.cmu.edu/stugov/gsa/External-Advocacy/gov.uscourts.mad.223165.78.1.pdf

even attend their funerals. I'm not sure if anyone can comprehend the devastation this student feels. Their life is forever changed and will take a long time to heal. You can tell that issues faced by graduate students are dynamic, covering many aspects of our lives. Things were not the best before this pandemic, they're even worse now. Hence, any plan for addressing the impact of COVID-19 on scientific research could not possibly be complete without actions on these areas by the federal government. This would also empower the universities to better serve their students.

In closing, graduate school is something we do because we want to be here, to learn, work with like minded individuals, and to further our knowledge of the world. In the best of times, the graduate student experience is intense, and we are not currently in the best of times. Students are understandably distressed by changing circumstances and concerns around social isolation, visa statuses, food and housing security, and faculty expectations for research output, along with plenty of general uncertainty about the future. In times like these, we need support more than ever. I hope you continue to hear directly from student researchers on these issues going forward.

Thank you, Ms. Chairwoman.

Ryan Muzzio

Address: [redacted]
Email: [redacted] | Telephone: [redacted]

EDUCATION

BA: Physics	**Ph.D. Physics (pursuing)**
Kenyon College | Gambier, Ohio	**Carnegie Mellon University | Pittsburgh PA**
08/2014 – 05/2018	**09/2018-Present**

RESEARCH INTEREST

I seek to investigate the electronic properties of novel materials and devices in the 2D regime by utilizing nano-scaled angle resolved photoemission spectroscopy (nanoARPES) and mesoscopic device fabrication. This union will give immediate insight on how electric properties change as the device is in operation, thus birthing *in-operando ARPES.*

RESEARCH EXPERIENCE

Graduate Research

Advisor: Dr. Jyoti Katoch

Probing electronic structure of 2D materials-based devices using nano-scaled ARPES

- Fabrication and measurement of graphene-based field-effect transistors to electronically tune the many body effects which are monitored through nanoARPES. NanoARPES was preformed at the 7.0.2 beamline within the Advanced Light Source, Lawrence Berkeley National Labs.
- Incorporation of CVD grown 2D materials for device application such as twisted bilayer graphene, twisted transition metal dichalcogenides. Resulted in measurement of spatially-resolved electronic structure of gate- and current- controlled twisted bilayer graphene. NanoARPES measurements were performed at the I05 beamline at the DIAMOND light source at the Harwell Science and Innovation Campus in Oxfordshire.
- Fabrication of twisted bilayer graphene devices with target angles through semi-encapsulation and heterostructure flipping.

Magneto transport of WTe_2 based devices

- Fabrication of WTe_2 based devices in a glovebox environment.
- Measurement of Fe_3GeTe_2 magnetization switching via spin-orbit torque imposed by spin currents in WTe_2 flakes in the 2D regime.

Construction of the lab at Carnegie Mellon University

- Building and maintenance of two custom 2D material heterostructure transfer tools.
- Design and maintenance of transfer tool inside the glovebox.
- Construction of custom-built molecular beam epitaxy system.

Undergraduate Research

Advisor: Dr. Frank Peiris

Probing the zero-momentum electronic properties of double perovskite Sr_2CrReO_6

- Temperature dependent ellipsometry of wave numbers between 250 and 50,000 to understand the optical properties of materials. Other materials properties were probed via X-ray diffraction and reflectivity, absorption spectroscopy, AFM, and Raman Spectroscopy of materials

Advisor: Dr. Lisa Prato

Inspecting the properties of young stars in binary systems

- Data collection by operating the Discovery Channel Telescope using a near-infrared spectrometer
- Data reduction and analysis to extract parameters of hundreds of stars such as temperature, velocities, pair separation, surface gravity, and circumstellar disk properties.

PUBLICATIONS

Published

[3] Alfred J. H. Jones*, **Ryan Muzzio***, Paulina Majchrzak*, Sahar Pakdel, Davide Curcio, Klara Volckaert, Deepnarayan Biswas, Jacob Gobbo, Simranjeet Singh, Jeremy T. Robinson, Kenji Watanabe, Takashi Taniguchi, Timur K. Kim, Cephise Cacho, Nicola Lanata, Jill A. Miwa, Philip Hofmann, Jyoti Katoch, Søren Ulstrup, "Observation of Electrically Tunable van Hove Singularities in Twisted Bilayer Graphene from nanoARPES" Accepted for publication in *Advanced Materials* (2020); ArXiv:2006.00791. * represents equal authorship.

[2] **Ryan Muzzio***, Alfred J. H. Jones*, Davide Curcio, Deepnarayan Biswas, Jill A. Miwa, Philip Hofmann, Kenji Watanabe, Takashi Taniguchi, Simranjeet Singh, Chris Jozwiak, Eli Rotenberg, Aaron Bostwick, Roland J. Koch, Søren Ulstrup, Jyoti Katoch, "Momentum-resolved view of highly tunable many-body effects in a graphene/hBN field-effect device" *Physical Review B,* 101, 201409(R) (2020*)*. * represents equal authorship.

[1] T. S. Allen, L. Prato, N. Wright-Garba, G. Schaefer, L. I. Biddle, B. Skiff, I. Avilez, **R. Muzzio**, and M. Simon "Properties of the Closest Young Binaries. I. DF Tau's Unequal Circumstellar Disk Evolution" *The Astrophysical Journal*, 845:161 (16pp), (2017).

Under Review

Davide Curcio, Alfred J. H. Jones, **Ryan Muzzio**, Klara Volckaert, Deepnarayan Biswas, Charlotte E. Sanders, Pavel Dudin, Cephise Cacho, Simranjeet Singh, Kenji Watanabe, Takashi Taniguchi, Jill A. Miwa, Jyoti Katoch, Søren Ulstrup, Philip Hofmann, "Accessing the spectral function in a current-carrying device", arXiv:2001.09891.

TRAINING AND SKILLS

Material Growth

- Mechanical exfoliation of 2D materials, and Van der Waals heterostructure fabrication.

Nanoscale Device Fabrication

- Electron beam lithography, plasma etcher, electron-beam deposition, X-ray diffraction and reflectivity, Raman spectroscopy, Ellipsometry, and wire bonder.

Material/Device Characterization

- Angle-resolved photoemission spectroscopy, x-ray photoemission spectroscopy, Scanning electron microscopy, semi-contact atomic force microscopy, and magneto transport.

Coding Languages

- C, Mathematica, Origin, and Igor Pro

Teaching

- Lead teaching assistant for three years during my undergraduate career. Teaching assistant for introduction to astronomy (Fall 2018) and Experimental physics (Spring 2019). I was responsible for in-class work as well as grading.

Management and Administration

- Co-founder of Kenyon College Radio and Optical Astronomy Research. Co-founder of Kenyon College's SACNAS chapter. Responsible for training in-coming graduate and undergraduate students who enter our lab and work with chemicals and 2D device fabrication.

PRESENTATIONS

- Pittsburgh Quantum Institute, 2020: *Momentum-Resolved View of Highly Tunable Many-Body Effects in a Graphene/hBN Field-Effect Device.*
- Pittsburgh Quantum Institute, 2019: *Towards in-operando nanoARPES of Quantum Devices.*
- Alleghaney Obserevatory, 2019: *Young Stellar Objects: The opening chapter in the life of a Star.*
- Kenyon College 2017: *Investigating the Optical Properties of a Particular Double Perovskite Thin Film.*
- American Astronomical Society, 2017: *Effective Temperatures for Young Stars in Binaries.*
- American Astronomical Society, 2016: *Component Properties of T Tauri Star Binaries.*

AWARDS

- Spring 2020: Pittsburgh Quantum Institute poster presentation award.
- Spring 2019: Pittsburgh Quantum Institute poster presentation award.

COMMUNITY SERVICE

- Carnegie Mellon Summer 2020: I am one of two student volunteers who are on the *Equity, Diversity, and Inclusion Committee*. We meet to discuss and put in action plans for increasing the department's equity diversity and inclusion.
- Carnegie Mellon Spring 2020: I assisted in hosting the Conference for Undergraduate Women in Physics by giving tours of my lab and serving on a panel about the inclusivity of minorities in physics.
- Young Scholars of Western PA summer 2020: Remotely held a question and answer session for middle schoolers during the historic Space-X launch.
- Carnegie Mellon Fall 2018: I ran a day-long scientific workshop for four groups of 20 middle schoolers, in partnership with *Breakthrough Pittsburgh*. Our goal was to inspire the newest generation of scientists.
- Kenyon College Fall 2017: I ran a public program for the Kenyon college community for Vera Rubin Day. This day is dedicated to scientists who did not receive credit for what they contributed to science.
- Kenyon College, 2015-2017: With *Head Start*, I raised money for, set up, and participated in a holiday party for underprivileged children of Knock County, Ohio.

Chairwoman STEVENS. Well, thank you so much. Thank you to all of you, and, Ryan, thank you for that courageous and important testimony. We are now going to begin our first round of questions, and the Chair is going to recognize herself for 5 minutes.

We are here today to talk about the research and innovation directive of this Nation that is people-fueled by the universities and the research centers that exist throughout our country. And certainly today we've had the opportunity to really hone in on the role that innovation and economic development play as a cohesive force in communities and localities across this country. We know that we are at a crux. We know that we need to unlock the human capital, the talent, as well as the innovation dollars, the investment dollars. We've had this conversation before as a Committee in previous hearings, where we have been able to discuss and hone in on the principle of where the Federal Government comes in as a catalytic research partner.

And, Dr. Stone, I really want to commend you for being so student-focused, and obviously it's very important that we had Ryan as one of our witnesses giving the background of the student voice, the student experience. And certainly, in your testimony, hearing about the Eye Research Lab at Oakland University, as well as some of the other recent student experiences that have taken place. And what I'd like to hone in on is something that this Committee focuses on, particularly in our role with the National Science Foundation, which is unlocking the Federal dollars to be of best use for the ultimate success of the research, and the outcomes of that research.

And so, if you look at the grants, or the research awards that you're getting, one, I'm very interested to hear about the timeframe, and adjustments to the timeframe, and the flexibility. Two, the additional support that you might need for safety measures, or protocol, or adjusting to this current environment, and some of the uncertainty with the timeframe on that. And then three, Dr. Stone, if you don't mind, also—you can kind of combine this all into one, but I think what's so special about what's going on at Oakland University is something you touched on, being a smaller university that's not land grant, that's doing a lot with a little, and some of how you're existing today as a university with the measures that you put into place as a university to operate right now, or—with the contact tracing, and some of the testing that you have going on at the university. And you get a whopping 2 minutes to answer, David.

Dr. STONE. Thank you, Chair Stevens, and I might ask you to repeat the first part, since it didn't start as a question, but let me start with the time loss challenge. As I said, we are a research—we do do lots of funded research, NIH, NSF, DOD (Department of Defense), others, and the fact that this far into the pandemic, only about half our labs are back online at all, and only about 35 percent of our faculty and students who are normally paid on funded grants are active in their labs, is saying to us that the challenge here isn't simply replacing the 2–1/2 or 3 months that we were out of our labs, it's that it's very difficult, and you heard this a bit from Ryan, to re-think about how you structure experiments that usually require people to stand right next to each other, or share a

given instrument, to do that when they have to stay 6 feet apart. I mean, we have State rules that govern how we can practice research, and, in doing that, we're seeing that a lot of the research that we're trying to do is simply impossible with the old ways, and we haven't yet found the new ways. We are challenging ourselves every day to think about how can we do that experiment without violating State rules, without putting students and faculty at risk of COVID–19, which nobody wants.

So as we think about the needs for the agencies to give us sort of what's been called, you know, for cost extensions, or full cost extensions, it isn't simply going to be for the time that was physically lost in the lab, it's going to need to also cover the challenges that we have in overcoming how you do research this way, because we can't do it, in many cases, in the old way. This is equally a challenge at OU. The reason I focused on the undergraduate pipeline is that that's critical, and undergraduate research isn't funded usually by grants, but is funded by the States, and that's our bigger challenge.

Chairwoman STEVENS. Well, we—we're right at time, David, so I'm going to stop there, but I will loop back at the end there on that first question. And then, with that, I'm going to pass it over to Dr. Baird, to keep us on time, for 5 minutes of questioning.

Mr. BAIRD. Dr. Mayer, in order not to get into your time, in your testimony you state you're leading the COVID–19 response for the university-wide research enterprise at Purdue University, and I know that President Daniels has called the school back, and the students, they have had quite a challenge, and made a tremendous effort over the summer to bring the students back. So would you briefly discuss some of the key aspects of Purdue's response, and how you're coordinating these all across Purdue's multiple campuses?

Dr. MAYER. Thank you, Ranking Member Baird, for asking about the integrated response. It has—I think I begin by saying that I think for most of us involved in the response we—and, as you probably say, the—a COVID day is equivalent to about a week or normal time, so it has been a very intense and integrated response. The timeline for the research response did move quite differently than the academic response. We ramped down over a course of 3 weeks, as we—as I indicated, shut down or ramped down activities remaining with critical research activities. We were fortunate, in the State of Indiana, that we were able to maintain a fairly large level of activity. We had over 400 labs that were able to continue to work at reduced capacity.

And one thing that I'd really like to emphasize, I think this came up before, is that our entire enterprise, from our faculty to our students, they are flexible and agile, and they've worked incredibly efficiently to make the best of a very bad situation, spending the 3 weeks, as we gave them advance warning about the ramp down, trying to wind down experiments, collect data so that they could continue to work efficiently for what was, at that point, an undefined period of time. But I think that that has really been beneficial in ensuring that there was some degree of continuity. We've pointed out that oftentimes missing critical—a lab member can really disrupt the research, and that has definitely been the case.

Briefly turning our attention to the ramp up, it really was a whole of university approach, including the other campuses, and that we had to, as the research enterprise—it's not simply about the research labs. And one thing that I'd like to point out is that we oftentimes think of research labs as people in white coats next to wet benches, but in a—in our research enterprise, recall that we are really the feeder to all industry sectors. What that means is everything from agriculture, people working in the field, to people conducting biomedical research, all the way to doing engine research, and those labs are all distinct. So through this process we worked with, as Dr. Walsh pointed out, our individual groups in order to customize the safety measures that they needed to put in place so that we could meet the safety criteria so that our faculty and our students could come back and continue the very important work that they're doing.

We focused on continuing to de-densify campus, and so even though we have moved to re-open labs, and I did do a poll of our Big Ten, the range of opening right now is everywhere from 50 percent to providing access to labs, but that does not mean that the labs look the way that they did before. We're operating—many are operating remotely. We are asking our students, whenever possible, to work remotely, and we have to reduce the overall capacity at any given time, so that's really changing the way that we're doing work. We're moving into what we're calling the new pandemic normal, and so the amount of effort—I think this was an earlier question. COBRA did a very interesting study, and projected that the cost of doing research under the new pandemic normal, under these modified operating conditions, will be higher than previously, so we need to take all of these measures into consideration. But it has been a whole of university approach. There's not a single group that we haven't worked with, and I just really want to, once again, recognize all of the tremendous faculty, and students, and post-docs for all of the efforts, and trying to make the best out of a very bad situation. Thank you.

Mr. BAIRD. I appreciate you remind me of the term de-densify. That's what we use in this situation, de-tensify. So I yield back.

Chairwoman STEVENS. Great. And, with that, recognizing Chairwoman Johnson for 5 minutes of questions.

Chairwoman JOHNSON. Thank you very—am I muted? Can you hear me?

Chairwoman STEVENS. Yeah, we can hear you just fine.

Chairwoman JOHNSON. OK. Thank you very much. I guess I would like to point this question to all of our witnesses, but most especially to Mr. Muzzio. I'm very concerned about the potential loss of talent due to the contraction of the academic work market. The unprecedented financial strain on universities has led some institutions to implement hiring freezes, which threatens to derail recent graduates and post-docs at a critical point in their career. This potentially irreversible loss of talent from the research pipeline could have lasting negative consequences for the U.S. innovation and economic competitiveness. Can you talk about what is needed to help the recent Ph.D. recipients weather this crisis? And I know that several Members of the Committee have introduced this bill to establish a new $250 million fellowship program at the National

Science Foundation. Could you also give us some thoughts on this bill and the *Supporting of Early Career Researchers Act*? So let me—I'd like to hear from all of you, but I'd especially like to hear from Mr. Muzzio.

Mr. MUZZIO. Thank you very much for that question. So I will say that I definitely support, and I know that the Carnegie Mellon Graduate Student Assembly, and the MIT (Massachusetts Institute of Technology) Graduate Student Council, both support this bill. And I think that it will certainly allow these fine students, who are, for one, as I said, very good at what they do, as they are the expert in their field, but also they are struggling to graduate. And so—I'll get to that point in a second, but if they are able to take this money with them and be funded through the NSF, and bring themselves to a different lab, this will certainly help them, there's no question about it. And they will be able to—I think that that will open up doors, as I said.

But, to kind of go back to my earlier point about them struggling, one student in particular reached out to me and was telling me that he's trying to graduate. It's already been pushed—his graduation date has already been pushed back by 6 months or so, and—or, sorry, about 4 months, and he's trying to get data by going into the lab about once a week, which usually he's working 6 days a week, and then, on top of that, he's having to train students in an emergency way because during the whole summer he was unable to train his students, who are being introduced into the lab. And so now he's looking at the situation as, one, where will I go after I graduate, with less data than I want to, with less papers than I want to, which is the fundamental going into the next step, but also how will I leave my lab in a good situation?

Chairwoman JOHNSON. Thank you.

Dr. MAYER. If I may?

Chairwoman JOHNSON. Next witness.

Dr. MAYER. Congressman Johnson, this is Theresa Mayer——

Chairwoman JOHNSON. Yes.

Dr. MAYER [continuing]. From Purdue University. I want to add a point that I think is very important to make, and you made earlier, which is, if we look at the downstream opportunities currently for the academic enterprise, polling all of the Big Ten, and this is not uncommon, we are largely under a hiring freeze scenario for new faculty, and so the pipeline, the opportunities, the downstream opportunities, are simply not there. The different industry sectors are being impacted differently, some continuing to hire, while others not in a position to hire, and so the support, particularly of the *Early Career Researchers Act*, is an essential part of the solution to ensure that we maintain continuity and provide opportunities to weather the storm, and allow our enterprises to recover to provide those downstream opportunities for our best and brightest to continue in that pipeline.

Chairwoman JOHNSON. Thank you very much. Any further comments?

Dr. WALSH. I'll keep mine very short. This is a critical time in people's careers, when they're just finishing their Ph.D., and having the support that is in the *Supporting Early Career Researchers Act* is really exciting, and will help an incredible number of stu-

dents who have put an incredible amount of time into their STEM education, and allow them to move forward, and really provide the return on investment that the U.S. Government and the taxpayers have already put into each of these folks.

Chairwoman JOHNSON. Thank you very much. I yield back. Thank you.

Chairwoman STEVENS. Great. Thank you, Chairwoman Johnson. With that, we'll recognize Ranking Member Lucas for 5 minutes of questions.

Mr. LUCAS. Thank you, Chair. Dr. Walsh, in your testimony you emphasized the need for U.S. research relief funding to maintain the continuality of research across disciplines, to maintain the flow of talent from within and to the U.S., and to continue to fuel innovation in vital national prosperity and security. You also mentioned that foreign government investment in research has not halted, but, in fact, has increased in many countries during this time. Could you speak to how China's research enterprise is recovering from the crisis, and, while you're thinking about that, also elaborate on how the pandemic would impact global competitiveness if we see dramatic shifts in research investments around the world.

Dr. WALSH. Representative Lucas, that's—those are great questions. Regarding China, I would note that Xi Jinping gave a talk within the last few weeks, and he said that China must make breakthroughs in core technologies as quickly as possible, and he was making that statement in regard to the changes that occurred in the global landscape, in part due to COVID, and in part due to international relationships. There's a history within China of taking those statements and turning them into action, and I think that none of us would be surprised to see that those actions move forward. Regarding China, I think we will absolutely see activity. I don't, frankly, know what they're doing right now, but it is clear that that messaging—that that was clear messaging that came out of the leadership in China.

I think you're also going to see a time when there are very heterogeneous responses to COVID–19. Certainly one of the things that we have seen in the United States is that different universities have different responses to COVID–19. You've got a couple of them represented here, and, as Dr. Mayer has stated, within the Big Ten, and actually across the major research universities. You know, she and I have done a lot of—had a lot of conversations with folks, and seen many different ways of doing things. Some of these universities are going to pick paths that move them forward quickly. By the same token, I think you're going to see countries that look at the landscape here and decide how much of an opportunity there is to advance their research, which is what the point of this conversation is about, and their economies. So the question is, how much of this is an opportunity to move forward, and how do we move that forward? I must applaud Congress in moving forward with the *RISE Act*, which will allow the research that has already been funded to be completed, and it won't stop the research that has been proposed from moving forward also. I'll yield to others.

Mr. LUCAS. Dr. Mayer and Dr. Walsh both on this question, speaking of the nature of universities, I'm a land grant university graduate, very proud of that, from Oklahoma State University.

Given that both Purdue and the University of Illinois are land grant institutions, can you elaborate on the role they played in supporting their communities as they battle coronavirus, and how your institutions have continued to serve community engagement during these trying months? Because, after all, it's research, it's education extension, the land grant principles. Either one of you.

Dr. MAYER. Thank you, Chairman Lucas. I really appreciate you asking that question. The engagement portion of our mission is an essential—the third leg of the stool, so to speak, for our land grant institutions, and we've continued to support, in multiple ways, including through our agricultural extension, working hand in hand with our communities around the State, continuing to ensure that—understandings from disruptions due to COVID as individual farmers are concerned about supply chain disruption. We also have a manufacturing extension program that is very actively engaged. They worked hand in hand with small manufacturers across the State to basically transition to being able to help to supply critical PPE to the country. We also have a health care advisor team that is working with communities. Particularly, I think, what we're finding is that during the COVID time we are finding increased use of opioids, and they work hand in hand with our public health officials in individual communities to really try to engage in educational opportunities as we think about the interrelation between drug addiction, mental health, and our—the current crisis that we're facing.

Mr. LUCAS. With that, Chair, I see my time's expired. This has been a very worthwhile hearing, and I remind my colleagues the U.S. Congress controls the purse strings. Yield back.

Chairwoman STEVENS. Thank you. And, with that, the Chair is going to recognize Dr. Bill Foster for 5 minutes of questions.

Mr. FOSTER. Well, thank you, Chairwoman Stevens, and Ranking Member Baird, and our witnesses for joining us today. And I'd like to continue Ranking Member Lucas's observations about the importance to note the contributions that university researchers are making to combat COVID–19 in their communities and their States.

Dr. Walsh, the University of Illinois system has developed a comprehensive approach, which is called SHIELD, that includes rapid saliva tests that are developed at Urbana-Champaign, and is being performed on as many as 15,000 students per day. And I was especially at how quickly this has been deployed to other smaller institutions, such as Northern Illinois University, which I believe at least one of our witnesses has some history with. And, you know, although the SHIELD Program itself has been entirely funded by the U of I, and indirectly by the much-maligned State of Illinois, Federal grants helped develop the ecosystem that allowed for this rapid development. Dr. Walsh, can you explain how Federal funding contributed directly and indirectly to this breakthrough, and how the Federal Government can help expand SHIELD and programs like it?

Dr. WALSH. Representative Foster, thank you very much. You're right, we developed very quickly a saliva-based test for COVID–19 that has sensitivity and specificity that's sufficient to help us mitigate the spread of the virus, that has a turnaround time that al-

lows us to isolate and quarantine folks quickly, that we can do in reasonably high frequency, so it's low cost, and it's non-invasive because it's saliva-based. The whole process started in late March, actually. These were federally-funded researchers who were doing work on other viruses, or a variety of different chemical reactions, and they pivoted their work to develop a new way of doing polymerase chain reaction, PCR-based measures of the nucleic acids within the viruses. That work, as I said, pivoted, and within a month or so, using labs that had been federally-funded for a long period of time, came up with a new method of isolating the RNA within those viruses.

Then there was a question of where does the University of Illinois at Urbana-Champaign put a lab that can do human testing? And the answer was, well, we have a veterinary school, we can do it there. So there was a veterinary lab that had been federally-funded for quite some time that was repurposed for human testing, and that's where the tests are being run. Fast forward to now, as you mentioned, we're testing up to 15,000 a day. The average is actually 70,000 a week, and we're catching very early in the process folks who are usually asymptomatic—not usually, almost entirely asymptomatic, but carriers of the virus, and we're isolating them from the rest of the community, contract tracing, and moving their contacts to quarantine. We've spread this across other universities, the publics, the R–2s and R–3s across our State, and we are now talking also with communities across the State of Illinois. So, going back to the land grant mission, we view this very much within our land grant mission to spread the use of this technology quickly across the State so that others could take advantage of the ability to detect COVID–19, too——

Mr. FOSTER. Well, thank you, that's a real success story that we shouldn't be shy about letting the world know about. You know, I am also very worried that we're going to see a so-called K-shaped recovery, where the wealthy institutions with billion-dollar endowments recover relatively quickly, while the smaller, less wealthy universities get left behind. And, you know, Dr. Walsh, you actually published an opinion column that touched on this, about how the pandemic is transforming the entire research ecosystem, and so I was interested in, you know, what are some of the implications of that transformation, and what should we do—in Congress be doing about this?

And, you know, in particular, and this is, I guess, a question for any witness who wants to take it, you know, given the disparate impact of COVID on—in different fields, you know, for example, researchers in computational biology, field biology, or laboratory biology would be impacted very differently by COVID, is it better for Congress and the agencies to distribute relief directly as grants to researchers and students, or to contribute the relief funds to research institutions, and let the institutions allocate that money to their researchers and labs? Or do we do a mixture of both? Does anyone have an opinion on what the best approach is there?

Dr. WALSH. I see the time that we have here, and I'm going to keep this——

Mr. FOSTER. OK.

Dr. WALSH [continuing]. Short. I think you give it to the researchers. I think that, you know, you give it, through the agencies, to the researchers, and, for the most part, that's the best way to move forward on this. But I would love to hear others' opinion.

Mr. FOSTER. OK. Thank you, and anyone who wants to respond for the record, please feel free, because we're faced with that kind of decision all the time in these emergency relief programs. Thank you, yield back.

Chairwoman STEVENS. I swear 5 minutes is not the same 5 minutes over virtual as it is in the hearing room. It's a shorter 5 minutes, so thank you, Bill, that was—those are great, and we do want to keep gnawing on that, so why don't we try and get that for the record? But, with that, we've got a couple other Subcommittee Members in the queue, and we're going to start with Congressman Balderson. 5 minutes of questions.

Mr. BALDERSON. Thank you, Madam Chair Stevens. Good to see you this afternoon, early afternoon. Thank you, panel, for being here. My questions are for the whole panel, and anybody can just take the liberty to jump in, Columbus is home to one of Nation's largest and most vital research institutions, the Ohio State University (OSU). It is essential to my district, and the Nation, that researchers at OSU are able to continue their great work in partnership with the Federal Government and private partners. I'm hoping you all could tell us a bit about how each of your institutions have been navigating this crisis from the beginning. In terms of strategies to overcome the challenges posed by COVID–19, what have you found that has worked, and what has not worked? I believe the collective knowledge of your experiences could ensure the entire research apparatus continues to succeed in these trying times. And any of the panelists may start off.

Mr. MUZZIO. I can give a little bit of background what it was like to be in the lab. So, upon returning from the canceled March meeting, I was working in the lab, trying to do as much as I could, knowing the impending shutdown of the lab, and we eventually had to close all of the labs and go home, and work from home for about two or so months. And during that time, apart from the lack of productivity, we started to write up documents and order PPE equipment just in preparation for all of the things that we were going to have to do in order to be safe.

So we, my lab, were approved to be one of the first labs back onto campus, and that—the way that we did that is by applying, and it went through many sectors of people who are experts in this sort of information, which I can get more information later, but not right now, of who they are. But we went through all of them, and we were finally approved, and so ultimately we are now in the lab, and there's other labs that are back, but we all have our protocols, and we're all, you know, signing into different—or you have to sign in to all the different doors and everything like that to ensure that people are safe, and to minimize this risk. But there's always that impending potential for the lab to shut down again. So that's my experience——

Dr. MAYER. I'll just add a——

Mr. BALDERSON. Thank you.

Dr. MAYER. I'll add a few words. I described our experience at Purdue. During my oral remarks, I underscored the strong collaboration. That was a strong collaboration. Regular bulletin boards, our listservs, were lighting up virtually every minute for periods of time, particularly during the ramp down. That included the Big Ten Academic Alliance, and so in regular contact with my counterpart at Ohio State and other universities. And, in fact, we iterated with one another to inform and learn as different people were in different stages of both the ramp down as well as the recovery.

I also want to underscore the importance of the APLU, the American—well, the Association for Public and Land Grant Universities, which is a network of public institutions across the country that includes R–1s and R–2s, and I think, through that network, once again, we were able to share best practices, and so it's been a highly collaborative and engaged process, and continues to be. When I was preparing, I very rapidly reached out to the Big Ten, and had immediate responses in terms of just being able to share where they are in the recovery.

Mr. BALDERSON. Thank you.

Dr. WALSH. I want—just a couple quick things. Actually, virtual meetings are interesting, in the sense that they work, in a lot of ways, really well. You can go and you can listen to a talk that you wouldn't normally be able to go to because it's really easy to get there, OK? There are aspects of it that don't work, because you can't do networking there, but there are aspects that work. Opening up the labs has actually worked really well. The coronavirus is not spreading in the labs. These are folks, you know, we have a grad student here, who know how to put on protective equipment, and know how to use it, and you don't get a lot of spread of the virus. What doesn't work for those students, especially for the new students, is training them. It's hard to stand shoulder to shoulder with a brand-new student and teach them how to turn a knob, how to, you know, how to operate a piece of equipment, and especially how to do that safely.

The other thing that's not working really well is core facilities. I mentioned that earlier. Representative Foster asked where should the money go, researchers or institutions? Core facilities. A nanofabrication lab, you have to have funding for that that goes directly to the institution to fund that sort of thing. All right.

Mr. BALDERSON. Thank you all very much. Thank you, Chairwoman Stevens.

Chairwoman STEVENS. Yeah, great question, great responses. And, with that, we've got Congressman Anthony Gonzalez here for 5 minutes of questions.

Mr. GONZALEZ. Hello. Thank you, Madam Chair, for convening this hearing, and thank you, everybody, for all that you're doing during this pandemic. Certainly a unique time. I wanted to start with Dr. Walsh, if I could, or anybody who has insight on this. It's obviously been a massive disruption, from a research standpoint, but, you know, what are we learning from other countries with respect to how to continue the research enterprise, and are we falling behind? I think it's obvious that, you know, our research enterprise is being damaged by the COVID–19 pandemic in certain ways, but, relative to our competitor nations, how do you feel we're stacking

up, and what can we learn from them, in terms of overcoming these barriers, and getting back on par?

Dr. WALSH. So, you know, there's a couple of answers to that question. One is, frankly, it's early to tell exactly what every country is doing. I'm not sure you were in the room earlier, I mentioned that China is looking to move forward in funding of core technologies, which generally I would take as AI, quantum——

Mr. GONZALEZ. Yeah.

Dr. WALSH [continuing]. Those sorts of technologies. And, you know, I suspect what you will find is that other nations will put substantial resources at this time into technologies that will move their ecosystems, in particular their innovation ecosystems, their economic ecosystems, and their national security, that they will move those forward. That's what I expect.

Mr. GONZALEZ. Thank you. And, you know, I think you highlighted a longstanding issue, which is one that I've been talking about in this Committee for the last year and a half, or almost two years now, which is chronic underfunding, and lack of focus, in my opinion, from the Federal Government with respect to how we fund our research enterprise. I'm somebody who wants to significantly increase the funding that we provide to the basic research space because it's, you know, it's my opinion that that's an investment, that's money incredibly well spent. And, you know, in a world where we're competing on every major technological innovation with the Chinese Communist Party, those are fights that we need to win, frankly, and so I appreciate what you said there.

Also in your testimony you mentioned the need, or not the need, but the necessity to reimagine operating assumptions with respect to our research enterprise as a result of COVID–19. What could you share in that vein that we all should know about, and, you know, what learnings might we be able to pass on to the broader research community as a result of some of these sort of changed operating assumptions, if you will?

Dr. WALSH. Yeah, I don't think any of us would've imagined that we would hold a congressional hearing in the way that we're doing this.

Mr. GONZALEZ. Yeah.

Dr. WALSH. I think there are a lot of things that we just couldn't imagine doing, you know, the better part of a year ago. We would've all just said this is crazy. I mentioned earlier you could do virtual meetings. Dr. Mayer and I are involved with University-Industry Demonstration Program, UIDP. It sprung out of the National Academies a few years ago. They very quickly pivoted to a virtual meeting, in March and it went really well. And what went well about that is that people could attend that meeting who couldn't normally attend because their institution didn't have enough funding for them to attend.

So I think what we're going to see is we're going to see remote meetings, you're going to see remote seminars. You're going to also see some remote experiments that are done in ways that couldn't be done previously. You know, you're going to have a collaborator someplace that you're going to send a sample to, and they're going to set it up, and you're not going to have to travel, and actually things are going to get more efficient because of that. We wouldn't

have necessarily thought of that previously, but I think we're now in a place where we're being forced to think differently, think outside the box, and folks aren't saying, you're crazy to do that. Frankly, we're in a position where we're allowed to do this. So, you know, back to one of the points I've been making, there's real opportunity here, and we have to figure out what those opportunities are.

Mr. GONZALEZ. Great. Thank you for that, and I agree, although I will say in person hearings are significantly more effective, in my opinion. But, that being said, I will yield back. Thank you.

Chairwoman STEVENS. It's because the 5 minutes goes quicker over virtual, so——

Mr. GONZALEZ [continuing]. But you're probably right.

Chairwoman STEVENS. No, great questions by our Subcommittee Members. And, you know, listen, this is a popular topic, and everyone's all excited about this legislation we're doing, and these great topics, and this is why we're on this Committee. And now we've got 5 minutes of questions from Congresswoman Bonamici of Oregon here, so pass it over to her.

Ms. BONAMICI. Thank you so much, Chairwoman Stevens, and thanks to the Ranking Member, but thank you to all the witnesses. I strongly support the bipartisan bills we're talking about today, the *RISE Act*, and the *Supporting Early Career Researchers Act*, and I'll continue to advocate for their passage, hopefully in a coronavirus relief package.

But I wanted to talk—Mr. Muzzio, thank you so much for being here and sharing your perspective. I recall a few years ago talking with a Ph.D. candidate who was working with NSF and NASA (National Aeronautics and Space Administration). Because of the 2013 government shutdown, she missed the window in which to launch her balloon from Antarctica, and her research was set back a year. That shutdown lasted 17 days, so if you multiply that times—so much longer now that we've been dealing with the pandemic—I've been hearing from graduate students, like you, who have been forced to set aside their research because of the pandemic.

And this spring, my alma mater, the University of Oregon, the physical distancing requirements forced graduate students in education to halt observations in classrooms that are used to inform their research. We had archaeology students lose the opportunity to participate in scheduled summer digs. Those students aren't alone. According to the recent estimates from the Council on Government Relations, research universities are seeing somewhere between a 20 to 40 percent research output loss just between March of this year and February of next year. So in your testimony you talked about how these disruptions to the academic experience have the potential to reduce the number of people who continue in science, ultimately leading to the loss of valuable talent. So how can Congress better support graduate students in not only restarting your research, but also restoring confidence in the Federal research enterprise to support the next generation of students?

Mr. MUZZIO. Thank you very much for that question, and thank you for the support on those two bills. And I think that the—currently, the thing that will have the most immediate and long-lasting support for graduate students who need it the most right now will be to support those two bills, the *RISE Act*, as well as the *Sup-*

porting Early Careers Researchers, and—or *Act*. And, you know, to support that yourself, but also to get other people on board with it as well, and—so to have these discussions and, like, hold hearings like this. And I thank you so much, and—for having this, for allowing us to have our voice heard.

Ms. BONAMICI. We appreciate your voice very much. And I saw a lot of heads nodding in the affirmative when my colleague was talking about increasing the funding for Federal research. Absolutely agree with that.

Dr. Walsh, Oregon State University is one of the Nation's leading oceanographic institutions. It operates an oceangoing research vessel program, and prior to the pandemic, OSU scientists were scheduled to sail three international ocean discovery program expeditions this year on an NSF vessel. All expeditions are postponed at least a year. That creates a sort of domino effect for delays and cancellations for in demand research that's already been scheduled. So, in your testimony, you noted that most researchers have had their work temporarily halted, derailed, and some regressed. What are the consequences of disrupting the continuity of research in the short term? How will those disruptions affect our ability to solve the world's most challenging programs—or, excuse me, like the climate crisis, for example, in the long term?

Dr. WALSH. Yeah. So, you know, there's a lot of heterogeneity here, but in oceanography—and just as background, I grew up in Woods Hole, so there's an oceanographic institution there—what ends up happening is they don't go out, and there's almost always a seasonal component to that work, and therefore, just as your example of a student not being able to launch a balloon at a particular time period, you're going to lose either a significant amount of time greater than what you would think, or a whole year for that sort of work. So, in those sorts of cases, the loss is really significant. And this is why the *RISE Act* would be tremendously helpful, and the *Supporting Early Career Researchers Act* would be really helpful, so that you have continuity of these programs.

Ms. BONAMICI. Thank you. And, as the clock ticks down, Dr. Walsh, I want to thank you for your study about the unequal effects of COVID–19 on women, and you note that female scientists with young children experienced a substantial decline in time devoted to research. I've been working on this issue, so I'm glad you acknowledge the importance of addressing the need for affordable child care. It comes up in economic development conversations. We won't restart our economy without access to child care. It's something the House has recognized, we passed the *Childcare Is Essential Act*. And I know that time's about to expire, so if you can't get an answer in, I'm going to ask if you would submit for the record, do you see a role for higher education institutions in helping to fill the need for child care as a way to help close the gender gap in science?

Dr. WALSH. Short answer, yes.

Ms. BONAMICI. Terrific, thank you. Thanks so much, and I yield back. Thank you, Madam Chair.

Chairwoman STEVENS. Great. Great to have you here. And, with that, the Chair's going to pass it over to Congressman Garcia for 5 minutes of questions.

Mr. GARCIA. Thank you, Madam Chair, I appreciate it. Thank you for the panel joining us today, very important discussions. I'm a proud co-sponsor of the *"Early Career Researchers Act"* myself, so this is of critical importance as we navigate this really uncharted waters. I really appreciate you guys taking the time. Most of my questions have actually been addressed already, so I'll just simply ask a question I think that Dr. Mayer was touching on earlier. You were mentioning, Doctor, effectively the second and third order effects as they touch adjacent industries, whether it's the agricultural businesses, the pharmaceuticals.

What I'm wondering, and this is really directed to any of you, have you seen any telltales or indications of impacts to national security as the result of the strains or delays in any of the research that we're seeing at any of these major universities? The reason I bring that up is because that does help us provide more of an impetus beyond some of the research that we've been discussing here, and can help us really translate that to the average American when we start talking about how this affects frankly, our Nation's security. So I'm just wondering if we've seen any telltales of that, or if it's still too early in the development stages of some of the technology you're dealing with.

Dr. MAYER. I will begin. Just as we touched on the other areas of research, the critical work that universities conduct in support of national security has been impacted as well. If you look at—particularly as we look at the areas—the 11 modernization areas for the Department of Defense, I think many of our institutions did have that as part of our critical research——

Mr. GARCIA. Um-hum.

Dr. MAYER [continuing]. Lists, so, during the ramp down, we worked very diligently to try to keep that research moving, at least in a limited capacity, so we didn't lose access to key facilities. We have been conducting work in hypersonics research, for example, and we were able to keep our wind tunnels operating at limited capacity to continue studies. Microelectronics is key to the backbone of our national security, so—as we're looking at all of these areas. But they really suffered the same level of impact, in terms of lab closures, in terms of delays in protocols, so it—we didn't see substantial differences.

Mr. GARCIA. OK, thank you.

Dr. WALSH. So, you know, the one quick thing I would say is that, for national security, and the reason that we've done well in this country, is we have really great people who are involved in that, and we have really great technologies.

Mr. GARCIA. Absolutely, yeah.

Dr. WALSH. And, you know, and so what you're getting at is the key component here, and that is, you know, basic research provides new technologies, and really great people, you know, the soon to be Dr. Muzzio and his colleagues at Carnegie Mellon, and across the country. So the two acts that are moving forward will help mitigate the impact of COVID–19 on potentially national security issue.

Mr. GARCIA. Absolutely. Thank you guys, and thanks again for your hard work through this very difficult time. I'm sure we will do everything we can to support you, and I really appreciate you guys taking the time there. Madam Chair, I yield back.

Chairwoman STEVENS. Thank you, Congressman Garcia. And, with that, we've got at least one more Member with questions, and that's Sean Casten, Congressman Casten from Illinois.

Mr. CASTEN. Thank you, Madam Chair. Thank you all so much. Dr. Walsh, I want to follow up on some of what you talked about with my colleague, Mr. Foster. I think what you guys have done with saliva testing is awesome, but I'm wondering if you could personalize it a little bit for us. Am I correct, are you based at—on the—over on the Champaign campus?

Dr. WALSH. I'm with the system, so I'm on all three campuses.

Mr. CASTEN. OK. Well, for someone who is a part of that campus, I mean, the numbers mean something, but if you're based full time on that campus, whether student or faculty, how often are you tested?

Dr. WALSH. Twice a week.

Mr. CASTEN. And how long does it take for your test results to get back?

Dr. WALSH. So the short answer right now is longer than we want, which is about a day. We're trying to get that down to about 6 hours.

Mr. CASTEN. Wow. And if someone tests positive, what do you do, practically?

Dr. WALSH. So when they test—when the test results come out, the positives are turned over to the Public Health Department—actually, all the data flow to the Public Health Department—and those are the folks who get in contact with the students to tell them, or faculty or staff, if they happen to be positive. Then there's an isolation component that occurs, so if the student is living in a dorm, we have dorms in which we can isolate them. If it's a faculty or staff member, then we ask them to isolate at home. We also contact trace, and that's done in a couple of different ways, but then those who are close contacts are quarantined.

Mr. CASTEN. What I find sort of so cool and so depressing about that is that at the start of this pandemic we had a lot of experts testifying that we should do as a country exactly what you are now doing, you know, rapid testing of everybody, identify, isolate, contact trace. And kudos to you all for doing it, shame on us for not.

You know, I know our office is working with some of you guys about trying to do some of the rollouts. Can you help us understand, what is constraining your ability to massively ramp this up, and what, if anything, could lead you to remove those barriers in Congress?

Dr. WALSH. Yeah. So we've broken up the rollout of SHIELD, which is what Representative Foster indicated is the name of this. So SHIELD is on campus. It's being rolled across the State of Illinois beyond the campuses, and rolled out beyond the State of Illinois so there's three different levels at which we're doing it. The biggest challenges that we have are some supply chain issues, in particular with equipment, and also, frankly, just training of people to stand up this whole operation. It is really not just testing. It is an entire program where you figure out who you want to test, you arrange for them to be tested, which means you have to go collect a specimen from them, and then you have the data—so you have a chain of custody all the way from the beginning, when they walk

in before you, to when you get the results to them, and to the public health officials. So, you know, the testing is just one of the hard parts. There are many other hard parts to this that, very candidly, we're learning every day how difficult this really is, especially when we move from a couple thousand a day to 15,000 a day.

Mr. CASTEN. Full disclosure, when this hearing ends, I am—I'm off to go meet with some of your colleagues to inspect some labs up in Northern Illinois that might be able to provide at least a debottleneck up here for some of the community, so it's—let us know what we can help, and if you have thoughts on those bottlenecks.

The last thing, just with the time we have left, and I don't know if you're—you feel sort of qualified to answer this or not, but, if I'm understanding right, you are doing the first really large scale testing of asymptomatic populations. Is it—maybe it's too soon, but are you learning anything about the virus, and how it spreads, and its dormancy from this population, or, if you aren't, are there things you expect to learn from the fact that you now are testing everybody, not just the people who are symptomatic or were exposed?

Dr. WALSH. Yeah. So there were a few things that we've learned. Yeah, there are events—this isn't a huge surprise—there are events that are sort of super-spreader events, and we've certainly seen those on our campus. I would say there's one other part to this, and that is we stood this up not only at three campuses, but also a small university in Southern Illinois in a relatively sparsely populated county, Bond County, which has about 17,000 people, and at Greenville University, which has about 700 folks, and they came in with the same positivity rate that we've seen at other places, 1 percent, and the short version is they're not spreading within their campus right now. The only new positives they've had are people coming from the outside. So we have learned that if you find the people who are positive, and you remove them from the community, then, big surprise, the virus doesn't spread.

Mr. CASTEN. From your lips to God's ears. Thank you, and I yield back.

Chairwoman STEVENS. Great. Well, with that, we've reached the conclusions of our questions, but certainly not the conclusion of this topic. And it's fair to say that this hearing's been very, very informative, and so we want to thank our witnesses for leaning in with us. I'd also say, to what Dr. Stone mentioned in his testimony, particularly around the need for COVID funding to support State budgets, that end up impacting university budgets. It's been amazing to see what—the talent coming out of all of these research institutions, and the talent that one of our soon to be Ph.D.'s is bringing to his research enterprise, and in particular the rapid adjustments that our researchers have had to make, and also the impacts that their talents have brought to combatting COVID–19, or addressing COVID–19.

Obviously it's nice to hear your overview, Dr. Walsh, and we've heard from Dr. Foster and, you know, at length about some of the work that you all are doing with the University of Illinois system. I would also say, even as a smaller research institution and university with Oakland University, it—just hats off to all of you. You know, we've seen OU grads form testing companies, and implementing different strategies across the country, as well as what all

of you are doing as a smaller university, and so it's really important, to me, having had the experience now as a Congresswoman, and in this Committee, but also previous to coming into Congress, having worked with all of you, and—not—you personally, but your institutions, and remaining very excited and enthusiastic. And so we, you know, are going to continue to come up with the best and most cohesive strategies, one for human capital and our workforce potential, which is just such a precious asset for us here in the United States, and what we all care so much about. Dr. Baird and I were very pleased to have last year the *Building blocks of STEM Act* signed into law which we worked on together, and it's this joint collaboration, and the dialog that we insist on having in this Committee to lead to great results.

So, with that, our record is going to remain open for 2 weeks, and this is for any additional statements from Members, or questions that they might have of you, and so we'll—we can do some questions for the record. And thank you all so much to your dedication to your professions. This just—is why we're here doing this work, and, of course, we appreciate that it's very Midwestern focused, so it's nice having colleagues from across the country, you know, seeing what we're doing here in the heartland. That was not intentional at all, but it's a—just really a testament to the work that all of you do. And so, with that, thank you all so much, and I'm going to close out this hearing, and the witnesses are excused, and the hearing is now adjourned. Thank you. Thank you all so much.

[Whereupon, at 1:17 p.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

Answers to Post-Hearing Questions

Responses by Dr. David Stone

U.S. HOUSE OF REPRESENTATIVES SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Questions for the Record to: Dr. David Stone Vice President for Research Oakland University Submitted by Chairwoman Haley Stevens

1. I'd like to hone in on how we're really unlocking federal dollars to be of best use for the ultimate success of research and its outcomes. If you look at the grants or research awards that you're getting, can you expand on the timeframe and adjustments and/or flexibility that you've received from National Science Foundation and other agencies that has been helpful? Or that you have needed but haven't received?

As I noted in my testimony, there are two significant challenges going forward for research in a covid-19 environment. The first is that there are laboratories and experiments that cannot operate efficiently or effectively while meeting state rules (or simply sound public health practice) intended to limit the spread of the virus. To address this challenge, Congress and the research agencies need to consider extending funding for ongoing projects funded by NSF and other research agencies beyond the three months of shut down, so that this research can generate the scientific results they were originally funded to produce. The second is that there are instances where the "normal background" against which an intervention is being tested has been undermined by the pandemic. In these cases, Congress, the agencies, and the OMB are going to need to permit classification of research as "stopped due to COVID-19," without penalty for the investigator or any presumption that the PI or institution mismanaged funds.

At this point, we have yet to see clear guidance from NSF, OMB, or other science agencies (let alone a uniform policy that would apply to all agency funding) that address the "for-cost extension" issue. Without additional funds, investigators will be pressed to "complete" experiments and provide (and publish) "results" without the time or capacity for the levels of discourse and deliberation required of solid scholarship. The result across the full spectrum of funded research is likely to be an increase in retractions, findings that the community cannot fully embrace (which could lead to allegations of misconduct), or results that are mistakenly pursued, which will result in further wasted time and resources. What is required here is a standard process whereby investigators are permitted to submit revised budgets and scopes of (remaining) work to ensure completion of the project. This kind of process, in the spirit of investigator-led work, is far preferable to any policy that simple tacks on a pre-set number of months to existing projects.

The second set of cases, those in which the pandemic has so swamped background conditions that the experiment simply cannot be completed, needs a different kind of solution. Consider the case of a nutrition study looking at the factors that relate to the "freshman 15" phenomenon. When state-based lockdowns commenced in the spring, students were sent home, thereby disrupting their standard meal structure. Those students also went home to a world of initially limited food options, to levels of stress and confusion, to worlds where all forms of daily activity and opportunities for exercise changed, where, in short, everything related to their habitual, daily routines were interrupted. There needs to be a cross agency policy (with OMB recognition) that in such cases, where the study could not continue and that it may be impossible to provide meaningful "results," the project is permitted to close without penalty or prejudice. Such situations should be understood as misfortune, rather than mismanagement, and

reviewers in future funding rounds should not hold such cases against the investigators. Similarly, as Congress reviews agency outcomes for 2020-2022, they will need to make analogous accommodations.

2. Is there additional support you need for safety measures or protocols for adjusting to the current environment?

It seems clear at this point, that the need to continue to provide supplemental funding for PPE and other public health measures required to allow research to be undertaken will extend well beyond the expenditure time limit of the CARES Act of December 31, 2020. Even if a vaccine is reasonably effective and widely distributed by late spring or summer, the use of PPE and related measures will likely remain a standard practice (and so an ongoing expense) for the remainder of 2021.

3. How is the university research community doing overall with the measures you've put into place to operate, such as contact tracing and testing?

Oakland University lacks the financial resources and administrative infrastructure necessary to conduct regular on-campus testing or university-specific contact tracing. Instead, we have relied on the State and Oakland County for testing and tracing resources. To date, our university community has done a remarkable job of limiting the spread of the virus on campus. So far, we have seen only a handful of cases. But with our high percentage of commuter students, it is unclear whether we can sustain low levels of campus spread as cases in Oakland and Macomb Counties approach those we saw in April.

One last point I would make is that we need to see the issues raised in this hearing in a larger context. As we think about the effect the COVID-19 pandemic is having on the American research enterprise, we must remain aware that similar effects are being seen across our economy and in our abilities to project both hard and soft power. As we continue to struggle with lockdowns and the limitations imposed by the practices necessary to limit the spread of the virus, other countries have, in a day to day productivity sense, returned to normal operations. I liken this to being in a triathlon. While we are still swimming, slogging slowly through the water, China, Taiwan, and other countries are already on their bicycles, speeding ahead of us.

Responses by Dr. Theresa Mayer

"Dr. Mayer: We know that the COVID pandemic has placed a massive strain on America's research enterprise, especially on the basic research that is conducted by our universities. Can you please elaborate on what the national security implications will be if the we do not take the necessary steps to preserve our scientific infrastructure and protect our innovation pipeline? What steps should Congress take to avoid such a fate? In addition, if you have data that supports your assessment, please share it. "

The long-standing partnership between the federal government and research universities has broad implications for our national security. Together with public and private sector partners, our universities have played a critical role in the discovery and innovation pipeline that has resulted in leap-ahead capabilities that have given the United States a distinct strategic and technological advantage, and the ability to prepare for the next threat. As the COVID-19 pandemic has reinforced, in the future, our national security will depend even more strongly on our ability to lead the world in transformational advances across a growing number of diverse fields, including engineering, cybersecurity, artificial intelligence, quantum science, agriculture, biosciences and many others. Additionally, our universities must continue to expand the pipeline of highly skilled, clearable scientists and engineers to fill critical workforce needs in these advanced technology areas within the national security enterprise.

Transformative advances that drive our innovation economy and national security are built on the foundation of our leading talent and access to state-of-the-art infrastructure. Our universities support a vast array of scientific infrastructure that is geographically distributed across the country – from the most advanced cryo-electron microscopes, used to image the coronavirus and other biological threats, to some of the nation's only Mach 6 and above quiet wind tunnels, used to test aerothermodynamic properties of advanced hypersonic vehicles, to complex cyber and cyberphysical system infrastructure, used to protect our IT and critical infrastructure assets against malicious attach. This sophisticated infrastructure is supported by leading researchers and technical staff who provide the deep and long-lived intellectual capital required to tackle the most pressing scientific and technological challenges of our time. All of these components are essential to enable cutting-edge research and development, and train the next generation of talent that fuels our innovation pipeline. Further, as we saw during the pandemic, almost overnight, our universities were able to redirect critical cyber and experimental capabilities and self-organize into collaborative teams to fight the coronavirus threat. This agility and accessibility contributed to our highly accelerated understanding of and response to the coronavirus, and it underscores the importance of sustained public and private investment in continuing to maintain this world-leading network of scientific infrastructure that supports our national security.

Scientific discovery and innovation require a sustained investment and commitment. Both time and funding are limiting factors on scientific capabilities and progress. We will never recover the time lost in the ramp down and return to operations for the research enterprises at universities across the country, which resulted in delayed findings and deliverables. To directly quantify this impact, At Purdue, we collected quantitative data on the percentage lost, if any, on salary, travel and other allowable costs to quantify this impact. Between March 1, 2020 through June 30, 2020, out of a total $137 million sponsored program expenditure base, there was a 20% loss on total salaries and benefits alone. The losses were distributed almost uniformly across the federal agencies, including those that predominately support national security research and development

such as DARPA, DOD, and DOE. 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. The financial strain to universities due to lost time and revenue from COVID-19 related disruptions as well as increased costs associated with the COVID response has forced sweeping reductions in institutional and state funding to sustain existing infrastructure and invest in new systems. This will have a long-term impact on our nation's ability to retain a global competitive advantage.

America's preeminence in research and scientific discovery can only be maintained by steady development of the next generation of scientists and engineers. The disruptions in the research enterprise along with changes in instructional delivery, financial hardships, and travel restrictions have also impacted this talent pipeline. Many graduate students and post-docs have been forced to delay their graduation by a semester or more. As a whole, the nation is also seeing a reduction in the number of entering undergraduate and graduate students into our universities. Hiring freezes in industry and academia have caused current students and trainees to delay the next phase of their careers or find alternative opportunities outside of their chosen field of work.

Private industry and philanthropic organizations are increasingly investing in the future through science, but these partners will never be able to match or replace the size or scope of the federal partnership in research. The federal government-university research partnership is essential to our nation's health, security, growth, and competitiveness. The proven value of the federal research enterprise is both broad and deep, and now is a critical time to invest to support the people and the infrastructure that enable these transformative advances. Now, as ever, the federal government plays a critical role in providing opportunities and lowering barriers for cultivating America's inquisitive and industrious minds. Scientific observation and analysis will also help us be a safer, more resilient nation when future pandemics and other large disruptions threaten our daily lives.

Appendix II

Additional Material for the Record

LETTER SUBMITTED BY REPRESENTATIVE EDDIE BERNICE JOHNSON

September 24, 2020

Attn: Members of the Subcommittee on Research and Technology of the House Committee on Science, Space, and Technology:

Engine is a non-profit technology policy, research, and advocacy organization that bridges the gap between policymakers and startups. Engine works with government and a community of thousands of high-technology, growth-oriented startups across the nation to support the development of technology entrepreneurship. We welcome the opportunity to provide comments for the record on the impact of COVID-19 on university research. Campuses across the U.S. serve as important hubs of innovation, providing the fuel and hands-on experience that entrepreneurs need to launch their own startups. But the pandemic has hampered this type of activity by limiting access to critical research needs and may slow the growth of new startup formation.

Universities and researchers are struggling to adapt to the 'new normal' imposed by restrictions resulting from the COVID-19 pandemic. As mentioned by the witnesses, researchers have had to work with laboratories operating at slower capacities—delays that are hindering, or even reversing, the progress made in their research prior to the pandemic.[1] Some of this research may form the basis of future startup concepts, with ideas transitioning from university-generated R&D into economically viable small businesses and startups.[2] As capital access remains a core concern amongst startups, it is important for policymakers to be mindful of the ramifications the pandemic will have on job growth if startup funding streams—like those provided through university partnerships with the federal government—are not sustained. As Engine previously commented to the House Small Business Committee on the innovation pipeline, "startups and small businesses represent large drivers of U.S. economic and job growth, federal support for research and development is important to the continued growth of American innovation."[3]

As Dr. Theresa Mayer—the Executive Vice President for Research and Partnerships at Purdue University—stated in her written testimony, "[i]n the past 25 years, our nation's university faculty and

[1] See hearing resources, available at: https://science.house.gov/hearings/the-impact-of-the-covid-19-crisis-on-university-research; and see written testimony of Dr. Joseph Walsh, available at: https://science.house.gov/imo/media/doc/Walsh%20Testimony.pdf
[2] See Engine's Comments to the House Small Business Committee on Feb. 27, 2020, https://static1.squarespace.com/static/571681753c44d835a440c8b5/t/5e582a468fa56521103d6600/1582836294242/House+Small+Business+Committee+Feb+27.pdf
[3] *Id.*

student researchers disclosed nearly 400,000 inventions that led to more than 11,000 startups."[4] This work is crucial, not only because of the important discoveries generated through university research, but also because of the number of jobs that may ultimately be created when university research leads to the development of the next new startup. Without continued support for university research, including through funding to support research grants, many startups may be slower to launch or may simply not have the opportunity to exist.

University of Illinois System Interim Vice President for Economic Development and Innovation Dr. Joseph Walsh noted during the hearing that another important byproduct of university research is the output of talent generated from research programs.[5] This talent—often in the STEM fields—is essential for innovative American businesses to grow and thrive. As Dr. Walsh stated, "[t]hose new graduates go on to produce discoveries or propel companies for a lifetime and thus are an incredible return on the research investment."[6] While the intellectual foundation provided by graduate students is the backbone of scientific research, this next generation of American experts may not be able to break into roles and opportunities that will launch them into their careers.[7] Without congressional support of university research, the pandemic may ultimately dampen the 'university to startups' pipeline.[8] As Dr. Walsh put it, the current pandemic may jeopardize a whole generation of young American scientists' careers.[9] Also concerning is the impact the pandemic has had on international students, many of whom use the education they gain at American institutions to work and innovate in the United States upon graduation. Conflicting policies surrounding online vs. in-person attendance and the ability to remain in-country made the U.S. an even less hospitable place for talented immigrants to grow their skills.[10] As Engine stated in a recent blog post, "[i]mmigrants are vital to the United States, and welcoming immigrants into the country speaks to the ideals on which our nation was founded. High-skilled immigrants play a critical role in developing ideas and founding new ventures that keep the United States at the forefront of innovation."[11] With current restrictions on legal immigration—like those surrounding H-1B visas—already making it more

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[4] See written testimony from Dr. Theresa Mayer, available at:
https://science.house.gov/imo/media/doc/Mayer%20Testimony1.pdf
[5] See written testimony of Dr. Joseph Walsh, available at:
https://science.house.gov/imo/media/doc/Walsh%20Testimony.pdf
[6] *Id.*
[7] See hearing footage, available at:
https://science.house.gov/hearings/the-impact-of-the-covid-19-crisis-on-university-research
[8] *Id*; and see written testimony from Dr. David Stone, available at:
https://science.house.gov/imo/media/doc/Stone%20Testimony.pdf
[9] See written testimony of Dr. Joseph Walsh, available at:
https://science.house.gov/imo/media/doc/Walsh%20Testimony.pdf
[10] See written testimony of Ryan Muzzio, available at:
https://science.house.gov/imo/media/doc/Muzzio%20Testimony.pdf
[11] Jennifer Weinhart, *To Support Tech Companies, U.S. Should Embrace High-Skilled Workers*, Engine (Sept. 18, 2020), https://www.engine.is/news/to-support-tech-companies-us-should-embrace-high-skilled-workers

difficult to attract needed talent to the U.S., policymakers should not enable policies that will further hinder the important economic contributions of these innovative thinkers.

Finally, as Engine has stated in the past, Congress should look to providing other forms of funding in support of university research.[12] For example, incubators and accelerators are often located on or near college campuses. These important organizations can help turn a university-generated idea into a thriving startup. As we recently commented to the House Small Business Committee, incubators and accelerators are often "better support than some federal grant programs for new startups, due to their ability to meet a startup's immediate and short-term needs, while still enabling university-generated innovation to commercially expand."[13] Policymakers should increase support for these important organizations, as they work to enable startups and entrepreneurs to weather the economic impacts of the pandemic.

Engine appreciates the opportunity to provide feedback on the far reaching impacts of the COVID-19 pandemic on university research. This issue is important to the next generation of startup ventures and is critical for long-term economic stability and job creation in the U.S. Engine is happy to be a resource to the subcommittee on issues affecting startups, and we look forward to further engaging with the subcommittee on issues affecting startups in the future.

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[12] See Engine's Comments to the House Small Business Committee on Feb. 27, 2020, https://static1.squarespace.com/static/571681753c44d835a440c8b5/t/5e582a468fa56521103d6600/1582836294242/House+Small+Business+Committee+Feb+27.pdf

[13] *Id.*

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