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Introduction

Chairwoman Johnson, Ranking Member Lucas, and members of the Committee, I am Vice President for Research at Washington State University (WSU). I also currently serve as Chair of the Association of Public and Land-Grant Universities (APLU) Council on Research (COR). Thank you for the opportunity to testify before the Committee today regarding our nation's efforts to build back the U.S. research enterprise from the impacts of the COVID-19 pandemic.

WSU is Washington state's land-grant university and a public research university committed to its mission and tradition of service to society. With six campuses[1] across the state of Washington and a presence in every county through its Extension system, WSU has an enrollment of 31,159 students statewide. More than 9,000 students are first generation. Additionally, WSU employs more than 6,250 faculty and staff. In FY2019, WSU's total operational budget was approximately $1.2 billion dollars, including research and development expenditures totaling $345 million.

As I indicated, I also serve as the Chair of the APLU COR. The APLU COR consists of the chief research officers at member campuses and systems with responsibility for policy and administration associated with research, scholarship, and creative activity. Along with other APLU units, COR looks at strategic issues impacting the public and land-grant university research enterprise and monitors compliance and regulatory issues affecting research. APLU's 199 U.S. member campuses enroll 4.2 million undergraduates and 1.2 million graduate students, award 1.2 million degrees, employ 1.1 million faculty and staff, and conduct $46.8 billion in university-based research. The latter figure represents approximately 60% of the nation's university-based research and development. My position as APLU COR Chair has given me the opportunity to discuss the impacts of the COVID-19 pandemic across a wide segment of U.S. institutions.

WSU has been a leader in The Science Coalition working with other Coalition members to highlight the benefit of the federal investment in research provided by Congress. I want to thank you, Madam Chairwoman and Ranking Member Lucas, for your support of science funding that is so critical to discovery, innovation, and improving the lives of our people through advancing research, scholarship and creative activity.

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[1] WSU campuses are located in eastern Washington (the main campus in Pullman, and the WSU Health Sciences campus in Spokane), south central Washington (WSU Tri-Cities in Richland), and western Washington (WSU Vancouver and WSU Everett). WSU also has a large and active online Global Campus.

Overview

In my testimony, I will focus on three points:

1) The nation's public and land-grant universities have "risen to the challenge" and played critical roles in supporting their communities, states, and the nation in the campaign against SARS-CoV-2. This includes conducting research directly applicable to mitigation of COVID-19. It also includes testing, support of campus and community vaccination efforts, epidemiological studies, and other activities needed to support resumption of university programs in a safe manner while simultaneously working to ensure the health of surrounding communities. Universities have partnered effectively with local, state, and national public health officials and other organizations in this effort. These successes underline the importance of fundamental science in responding to the pandemic, and would not have been possible without the long term investments in educational and research programs made by state and federal governments. In short, the pandemic has highlighted the importance and public impact of the nation's research universities.[2]

2) While the nation's public and land-grant universities have risen to the challenge of COVID-19, the pandemic has had numerous and severe impacts – both short and long term. These include impacts to undergraduate, graduate, and postdoctoral education; partial or complete loss of some research; amplification of gender, racial, and other previously existing inequities; disruption of the flow of talent required to support the nation's "innovation pipeline;" infrastructure impacts; and other factors. The overall impact on innovation is particularly concerning as it is estimated to provide 50% of annual U.S. GDP growth.

3) APLU, its member institutions, and the nation's academic community are grateful for the support Congress has provided via the CARES Act and other means. Looking ahead, continued Congressional support for federal research agencies will be essential for national recovery from the pandemic and transitioning the nation's research enterprise to the "new normal," which assuredly will not look like the situation pre-pandemic.

APLU Universities Have "Risen to the Challenge" of Combating the Pandemic

This past year has been the most challenging in memory. It has been no different for the public university community. The pandemic has upended every facet of public research universities' mission – from education to research and community and industry engagement.

Overall response and university research output

The responses of the nation's public and land-grant research universities to the pandemic share many similarities.[3] As part of the initial set of nationwide restrictions and lockdowns in the March 2020

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[2] See https://www.aplu.org/projects-and-initiatives/research-science-and-technology/public-impact-research.html/ for further information on the public impact of research universities generally.

[3] Additional detail and examples regarding the March 2020 ramp-down and subsequent ramp-up of university research activity, as well as examples of coronavirus-related university research, are available in the testimony of the September 9, 2020 hearing of the Subcommittee on Research and Technology of the House Committee on Science, Space, and Technology.

timeframe, universities across the country took steps to limit on-campus research activities based on public health considerations and stay at home orders. Most research was transitioned to telework, with on-campus activities generally limited to essential work such as maintenance of critical infrastructure required to ramp up research once adequate personnel protection and safety measures were in place.

As state and local directives allowed activities to gradually resume in the May-June timeframe, universities began to ramp up on-campus research activities. University research could not be promptly brought back to the pre-pandemic level, however. Laboratory research has not returned to a normal pace due to reduced personnel density to accommodate pandemic-related personnel spacing guidelines, personnel and budget constraints, and other reasons. Research involving human subjects[4] was particularly impacted. At WSU, for example, human subject research was reduced to approximately 10% of the pre-pandemic level. It has resumed only to the 15% level due to public health considerations, with individual projects approved on a case-by-case, exception basis. Global health research, including U.S. government funded programs, focused on early detection and response to emerging infectious diseases—similar to and including COVID-19—has been severely constrained by the pandemic impact in the U.S. and internationally, and the subsequent inaccessibility and/or prohibition of international travel. As an example, a NIH Fogarty International program to train an integrated cohort of physicians and veterinarians to detect, diagnose, and respond to human infections emerging from animals has been delayed a full 12 months due to the pandemic.

Detailed estimates[5] of the impact of this novel coronavirus suggest an overall loss of research output nationwide, from March 2020 through March 2021, of approximately 20%-40%. This is consistent with our experience at WSU. We estimate our research enterprise was operating at approximately 60% of the pre-pandemic level following our June 2020 limited ramp up of on-campus research. We now estimate output of the WSU research enterprise is approximately 70% of the pre-pandemic level. Note that individual research projects span the entire spectrum of productivity (0-100%); research projects fully dependent on face-to-face interactions or those requiring individuals to be in extended close contact have not been able to collect new data, whereas research that could pivot remotely is fully operational.

Ramp-up of the research enterprise, including testing and vaccination

The bulk of APLU universities implemented some form of coronavirus testing in the spring/summer 2020 timeframe. This testing was strongly motivated by understanding the nature of disease spread within the campus and local community for both public health purposes and to support university decision making regarding the resumption of on-campus instruction, research, and other

[4] Human Subjects Research, according to HHS and FDA regulatory definitions, involves human participants or their identifiable information or specimens, and can be broadly described in two categories: 1) Biomedical Research, including interventions to test drug efficacy, device or therapeutic treatment method (e.g. clinical trials), studies on the human genome, or studies of physical, mental, psychological or physiological conditions (e.g. cognitive disorders, pregnancy). and 2) social, behavioral and educational research, including sociological research (e.g., criminal justice, social justice, race, social movements, mass media, gender and sexuality), behavioral research (e.g., autism, adolescent behavior, emotional analysis, sensory science, eating behaviors, and consumer behaviors), and educational research (e.g., classroom learning, pedagogy, technology use, standardized testing, and instructor education and training)

[5] See the August 2020 Council on Government Relations "Research Impact Under COVID-19" report (https://www.cogr.edu/sites/default/files/Research_COVID_August2020_COGR_FINAL.pdf) and its January 2021 update (https://www.cogr.edu/sites/default/files/Research_Impact_COVID_Jan_2021_COGR.pdf).

activities. Much of this testing activity was done in close collaboration with local, state, and national public health officials. In many cases, including at WSU, Oklahoma State University, Purdue University, and elsewhere, on-campus testing capabilities relied on existing infrastructure, often within schools of veterinary medicine. Within the APLU community, Oklahoma State University launched an early and intensive effort to develop testing capability for both their campus and their state. This provided valuable insight and experience for other APLU members to model.

At WSU, the Washington Animal Disease Diagnostic Laboratory (WADDL), a Level 1 laboratory in the USDA National Animal Health Laboratory Network on the Pullman campus, has been used to conduct limited testing of both human and animal samples for the SARS-CoV-2 virus, the causative agent for COVID-19 in humans. WADDL developed and validated specific laboratory tests at the request of federal, state, and county animal and public health agencies to assist in the response to the COVID-19 pandemic as required under the Clinical Laboratory Improvement Amendments of 1988 (**CLIA**). WADDL supports WSU testing of its faculty, staff, and students, and processes samples for organizations testing residents throughout eastern Washington. The results of human testing are reported to public health agencies and contribute to a state and international database sharing effort for all scientists and healthcare providers to better understand the SARS-CoV-2 virus and combat the spread of COVID-19. Voluntary asymptomatic COVID-19 testing is available for faculty and staff working in Whitman County, location of our Pullman campus. Testing is available at no cost only to individuals not currently experiencing COVID-19 symptoms. Symptomatic faculty, students, and staff are referred to their health-care providers.

Since the initial investment in and implementation of SARS-CoV-2 viral infection testing in spring and summer 2020, university testing activities have matured and are now essential tools in fighting the pandemic and guiding the resumption of normal university activities. Since its summer 2020 launch as a testing facility, WADDL has processed more than 25,500 samples from WSU faculty, staff, and students. In total, WADDL has processed over 67,000 samples from eastern Washington. Notably, WSU testing of asymptomatic faculty, staff, and students at other public (Eastern Washington University and University of Washington) and private (Gonzaga University and Whitworth University) universities in the Spokane area has supported execution of their educational programs.

This semester at WSU, 66 classes (approximately 5% of the total) with experiential learning currently have an in-person component on our Pullman campus compared to 35 classes in fall 2020, with approximately 1,300 students living on campus. As students returned to our Pullman and Spokane campuses for spring semester, WSU requested every arriving student undergo arrival testing to mitigate the spread of COVID-19. WSU completed more than 8,000 COVID-19 tests for students in January 2021. The arrival testing program has been successful in stopping the spread of the virus both on campus and throughout the Pullman community. As of February 10, the WSU Pullman campus has reported only 11 active cases (and Spokane only five active cases) of COVID-19 in both students and employees currently in their 10-day isolation period. In fact, there has been no known transmission of the virus in a research space such as a laboratory.

WSU staff also assist Washington State Department of Health (DOH) in contact tracing efforts of individuals testing positive, including providing quarantine and isolation hotel rooms. Ongoing diagnostic and screening testing remain available on the Pullman campus. WSU's epidemiological modeling, coupled with testing and other data, has been essential in determining ongoing screening testing requirements and has also provided insight to eastern Washington healthcare providers in terms of required hospital beds and other needs.

More recently, WSU partnered with local and state health authorities and the private sector, including Schweitzer Engineering Labs in Pullman, Incyte Diagnostics, and Providence health system in Spokane, to support Washington state's vaccination efforts. WSU provides vaccine cold storage capability for eastern Washington, as are other land-grant universities who serve rural parts of the country. As of February 15, the university has partnered in the delivery of over 12,400 vaccine doses to residents of eastern Washington, and those that work within this region from neighboring states.

Overall, the combination of testing, vaccination, careful design and implementation of COVID-19 personnel safety practices, epidemiological modeling, and close partnership both within universities and externally with public health and other partners has allowed university activities, including research, to steadily increase since the initial ramp-up of on-campus activities in spring 2020. This included a large uptick in research related to COVID-19 but also research in other areas, including social science research that will help us navigate the societal inequalities exacerbated by the pandemic.

At WSU, nearly 150 scientists pivoted their work from existing projects to research contributing to our understanding of COVID-19 and its impact on society. For example, WSU researchers are working closely with CDC-Kenya to expand the existing infectious disease surveillance platforms in Kenya to investigate the transmission patterns, disease severity, clinical presentation, and risk factors for infection of COVID-19 in the country. Another WSU research study is investigating the unintended consequences of COVID-19-related public health measures of deferred cancer treatments.

WSU researchers were also part of a multi-institutional research team led by the University of Idaho that included the University of Rochester School of Medicine and Dentistry and Medical Center, Brigham and Women's Hospital, and Harvard Medical School to study whether breastfeeding women who have COVID-19 transfer milk-borne antibodies to their babies without passing along the SARS-CoV-2 virus. Researchers analyzed 37 milk samples submitted by 18 women diagnosed with COVID-19. None of the milk samples were found to contain the virus, but nearly two-thirds of the samples did contain two antibodies specific to the virus. This research is now informing national and global guidance related to COVID-19 and breastfeeding.

At the University of Iowa, genetics expert Val Sheffield has converted part of his lab to help fight the coronavirus pandemic by creating a simple specimen-collection method that skips the swab and removes the need for medical personnel. All people must do is spit in a cup. Allowing people to collect their own saliva at home helps them avoid potentially risky contact with people at testing sites, supports keeping health care workers healthy, and preserves personal protective equipment (PPE).

In September, North Carolina State University's Nonwovens Institute (NWI) announced a new partnership with Blue Cross and Blue Shield of North Carolina, Freudenberg Performance Materials, UNC Health, the NC Healthcare Association, and NC Medical Society to manufacture N95 masks to equip frontline workers across North Carolina with safe and cost-effective protection from the virus. Two mask-making machines are housed at Durham-based Freudenberg Performance Materials, which provides the manufacturing expertise and workforce needed to install, operate, and maintain the new production lines using novel materials provided by NC State's NWI. As masks become available, the NC Healthcare Association and NC Medical Society will conduct outreach to providers who may lack staffing capacity and contacts to place accelerated orders. UNC Health will provide infection prevention experts who will perform rigorous testing to ensure the respirators offer the highest levels of protection and meet industry health and safety standards.

The U.S. Office of Management and Budget (OMB) provided flexibility on federal sponsored project execution that has been essential to mitigate the effects of the pandemic and ramp-up research activities such as those described above. APLU and its member institutions are very grateful for this support. In particular, in response to the pandemic, OMB issued three memoranda in spring 2020 directing federal agencies to marshal all legally available resources to combat the crisis. The three memoranda relaxed short-term administrative, financial and audit requirements and allowed federal agencies to grant related flexibilities to their recipients, including the extension of single audit submissions and salary payments through September 30, 2020. The most useful flexibilities contained in these memoranda were the ability to charge salaries to grants for people unable to work or worked at reduced productivity, the ability to donate equipment and resources, such as PPE and labor, paid for with grant funds to COVID-19 clinical response, the extension of reporting deadlines, and no-cost extensions. The three memoranda provided universities with the ability to preserve and maintain the underlying research infrastructure during the height of the crisis. Without the ability to maintain the research workforce by paying salaries of those who could not come on campuses, institutions would have been forced to furlough or lay off researchers and scientific staff. Similarly, the flexibilities permitted research infrastructure, such as cell cultures and animal colonies, to be maintained throughout the period when on-campus lab activities could not be performed, as well as through the current ramp-up period of on-campus activities. These provisions all expired on September 30, 2020.

Individual federal agencies such as National Science Foundation (NSF) and National Institutes of Health (NIH) also provided important relief and support to the research community to support its fight against COVID-19. As an example, NSF announced in April 2020 the availability of its RAPID (Rapid Research Response) funding mechanism for COVID-19 related research. Numerous universities, including WSU, have received such “rapid response” grants- and they have been timely. In fact, the work discussed above involving transfer of antibodies specific to the virus to breast-fed babies was partially funded by an NSF RAPID grant.

Land-grant institutions supporting local communities: WSU examples

The pandemic has emphasized the critical importance public and land-grant universities play in serving their local, state, and national communities. Extension programs within these universities typically play a critical role in such service. Examples of WSU Extension contributions are discussed below. Additional examples are available from APLU.

WSU’s Extension programs in partnership with the Washington State Broadband office have provided WSU students and employees, and community members, with free Wi-Fi hotspots. In Washington state, nearly one in 10 rural residents lack access to high-speed broadband. Nationally, 15 percent of rural Americans are offline. For students, limited access hinders their ability to contact advisors or access academic resources. WSU launched the Drive-In Wi-Fi partnership in late April 2020 that began to place broadband access points at WSU’s county and tribal Extension centers, as well as schools, libraries, and community centers across the state. Members of the public can also access the Internet using drive-in hotspots, through a separate public portal. The program quickly drew support from the Washington State Broadband Office, Microsoft Corporation, Avista, Washington State Library, a division of the Secretary of State, and other partners. WSU’s initiative to set up Wi-Fi hotspots is emblematic of what other land-grant universities have done.

WSU's Food Systems program is addressing several issues to assess and improve food access and food security challenges related to the COVID pandemic. This includes active collaboration with the Washington Department of Agriculture to assess impacts on food processing and distribution, and to develop response mechanisms. One highlight of this effort is the creation of a mobile meat processing lab that can be used to address the shortage of meat animal processing capacity/opportunity – especially for small producers.

WSU Extension also piloted and evaluated in Washington (October through December) a "Remote Worker" training program currently offered by Utah State University (USU). Extension will be fielding that training in a co-branded collaboration with USU and the Association of Washington Businesses. The program provides training on the basic "soft" and technical skill sets necessary to be a successful remote worker and issues a certificate which is a meaningful qualification for un/under-employed job seekers. Two of the participants in the pilot cohorts have already found good remote work employment.

Impacts of the Pandemic on the Nation's Public and Land-Grant Universities

While the nation's research universities have risen to the challenge and are responding effectively to the pandemic, there remain significant short- and long-term impacts to the nation's university research enterprise. As discussed above, overall output at research intensive universities is estimated to have declined by approximately 20%-40% from the period of March 2020 through March 2021. COVID-19 has impacted faculty members, postdocs, technicians, and graduate students in numerous ways, including student educational progress, career development of faculty and staff, work-life balance, the development of collaborations and partnerships, and immigration status. COVID-19 has also had the unfortunate effect of exacerbating pre-existing gender, racial, and other inequalities.

Financial, operational, and related impacts to institutions

The nation's public and land-grant universities very much appreciate the support Congress has provided via the CARES Act and other means. Since the start of the pandemic, Congress has provided $37 billion to support students and institutions of higher education across the country. WSU has received $21.76 million and recently received an additional $34.9 million for a total of $56.66 million. WSU has aided almost 11,000 students system-wide and every dollar Congress has provided to students has been allocated to support their needs during the pandemic.

While Congressional support has been very helpful, the pandemic has nonetheless impacted university finances, infrastructure, and the ability of our public and land-grant universities to pursue their missions generally. Over the last several years, U.S. colleges and universities have become increasingly dependent on tuition and student fees as state appropriations for higher education have significantly declined over time. COVID-19's disruptions to traditional instructional models, to international students, and to the economy are all producing significant financial shortfalls for universities, with smaller universities more heavily reliant on tuition the most affected.[6] At WSU, for example, system-wide additional costs attributed to the pandemic through December 31, 2020, have

[6] APLU estimates of pandemic related costs and revenue loss are available at https://www.aplu.org/members/councils/governmental-affairs/CGA-library/aplu-97b-heerf-request-and-justification/file

totaled nearly $6.1 million. Simultaneously, WSU has lost revenue as a result of the pandemic. In September 2020, WSU forecasted a $105 million drop in revenues from state appropriations, tuition, housing, dining, and other auxiliary units in FY2021. These revenue reductions are partially offset by associated reduced expenses, leading to a projected net revenue loss of $54M.

According to an APLU member survey designed to ascertain the level of institutional expenses and losses due to the pandemic, APLU members saw a total of $20.8 billion in revenue losses and expenses related to safety measures. This included $6.5 billion in revenue loss for spring and summer, $11.2 billion revenue loss for fall, and $3.1 billion in expenses for safety measures. To help fill the funding gaps, Congress provided APLU institutions with $1.7 billion in CARES Act and $4 billion in the Coronavirus Response and Relief Supplemental Appropriations (CRRSA) Act funding for institutional expenses and losses. Even with the $5.7 billion in Congressional support, the 199 public research universities that comprise APLUS's membership collectively face a $15.1 billion funding gap as a result of the pandemic.

Institutions of higher education have also seen increases in costs associated with public health measures such as testing, cleaning procedures, as well as urgent investments to support online instruction. According to an APLU member survey, APLU institutions have spent over $3.1 billion on safety measures including COVID-19 testing and contact tracing, face masks, cleaning, and operating quarantine dorms through the spring and fall 2020 semesters. In response to unavoidable costs, revenue reductions, and forecasts of declining revenues, many universities found themselves having to reduce other expenditures across the board to strengthen their finances. This included hiring freezes, often on an institution-wide basis. Substantial research support services – everything from academic libraries and research cores to laboratory safety and research security compliance – are funded by a combination of grant overheads and general appropriations. In this sense, the fully loaded cost of sponsored, or externally funded, research is not fully covered by grant awards, and this was exacerbated by the pandemic due to the need to purchase personal protection equipment (PPE) and other costs. As a result, universities must cover sponsored research costs from other sources.

The nation relies on its universities to train the next generation of researchers and scholars essential to functioning of the "innovation pipeline" that translates fundamental research advances to achievements that benefit the lives of our people every day. Financial impacts associated with the pandemic have significantly impacted hiring and staffing, with short- and long-term impacts to the innovation pipeline. In particular, more than 300 U.S. universities and colleges announced hiring freezes, in some cases even rescinding offers that had already been made. According to the Science Careers Job Board, faculty openings in the sciences were down approximately 70% in 2020. Many of these individuals have sought employment elsewhere and will be permanently lost from academia.

The ramp-down of laboratories and laboratory-based scientific research activities not only impacted research progress and projects, it also added pressures around internal costs and core facilities. Even if salaries and benefits continued to be paid uninterrupted, as other direct expenses such as travel, equipment, or materials were unspent, universities still had to pay for many of the expenses to support research equipment, personnel, utilities, and other costs that may have been covered by allowable indirect costs charges related to federal grants. But without research activities campuses could not recover these operational costs. These losses contribute to budget shortfalls at many institutions.

The impacts of the pandemic on core university laboratories has been significant. Universities typically support widely used research instrumentation in areas such as genome sequencing, microscopy, and magnetic resonance imaging through a combination of internal funding and use charges. These core laboratories also rely heavily on user fees from faculty, staff, and students directly engaged in research. The reduction in on-campus research has thus directly impacted these core facilities, leading to loss of key support staff and physical infrastructure. At the University of California Los Angeles, the School of Medicine lost $3 million per month supporting their core facilities before they began to slowly ramp-up in the spring. At WSU, the overall core lab business from WSU customers was down by approximately 25% in 2020.

The pandemic also essentially eliminated research-related travel, including the ability to conduct numerous types of agricultural and other field research. Loss of seasonal data and specimens has delayed research by at least a year, and in the case of specimens requiring longer generation times, even more. The situation is particularly concerning for students and early-career researchers. Travel restrictions also directly inhibited some types of collaborative research requiring investigator presence. Scholarship and creativity in the fine arts is also largely on hold due to closure of venues.

Impacts on particular types of institutions and communities

Many students at smaller, public institutions are low income, minority, or first generation students. These underserved students have either limited or no opportunity to engage in research. This is discussed in detail in a January 2021 report entitled "Building America's STEM Workforce: Eliminating Barriers and Unlocking Advantages.[7]" The report states: "Historically, the majority of federal research funding has been distributed to a fraction of our country's research universities. In 2018, for example, of the more than 600 colleges and universities that received federal science and engineering funding, approximately 22% received more than 90% of federal science and engineering funding while only serving 43% of all students and 34% of the nation's underrepresented minority (URM) students. This discrepancy results in students at the approximately 500 remaining colleges and universities, including almost two thirds of the nation's URM students and more than two thirds of Pell grants recipients, having either limited or no opportunity to engage in research."

In addition to having very limited research opportunities, these underserved students are also far more susceptible to the negative educational and financial consequences of COVID-19. As these universities are left out of COVID-19 opportunities for vaccines, testing, and grants, it amplifies existing workforce and other inequities.

Faculty, especially assistant professors, at smaller institutions struggle to compete effectively for federal funding against their counterparts at larger institutions with more resources and better infrastructure. COVID-19 exacerbates this issue. Overall, lower university resources at smaller institutions prevented wide-scale COVID-19 testing and vaccination, and thus, inhibited return to research activity. Many professors had additional teaching commitments due to the increased number of classes arising from enhanced student-to-student distancing requirements. Since having smaller research portfolios generally translates to higher teaching loads, these impacts were likely higher at institutions with less research funding. Institutions with smaller research portfolios often do not have resources to invest in rapid response research projects while many larger institutions were able to fund such projects internally. Additionally, NIH adopted a "fund the funded" approach to COVID-19 response,

[7] https://www.aps.org/policy/analysis/upload/Building-America-STEM-workforce.pdf

blocking many smaller programs from new or expanded funding opportunities and continuing the trend of undue concentration of federal funding. Therefore, smaller federal funding portfolios means less likelihood of getting federal dollars for research relief assuming relief is based on current funding levels.

Historically Black Colleges and Universities (HBCU) have proven to be extremely effective in graduating Black students, particularly in STEM areas. HBCUs represent less than 3% of colleges and universities in the U.S., but they confer 40% of all STEM degrees and 60% of all engineering degrees for Black students. Additionally, according to the National Science Foundation, the top ten baccalaureate institutions that produce Black students who go on to earn doctoral degrees in science and engineering were, except for one institution, all HBCUs. One of the deciding factors in acceptance to graduate programs is previous research experience, and STEM students at HBCUs are engaged in research at a higher rate than Black students at predominantly white institutions.

While HBCU's award a high fraction of STEM degrees to Black students, their research and development expenditures are slightly less than 1% of the U.S. Higher Education Research and Development expenditures. This stark difference is a major factor driving the relatively low presence of Black scientists and researchers in STEM fields. The pandemic has only highlighted this and other inequalities. For example, the relatively low fraction of research and development expenditures at HBCUs has undercut their ability to handle additional costs associated with the pandemic.

The pandemic has intensified an already challenged training environment for HBCU STEM students and faculty. HBCUs generally operate with resource limitations, which necessitate having teaching and research personnel with high workloads operating with often outdated infrastructure and technologies. The impact and significance of the STEM graduates produced and overall research competitiveness can only grow and expand exponentially with enhanced capacity building through strategic investments in these institutions. To be impactful in driving qualitative outputs and scholarly productivity in HBCUs, one consideration is to invest in the building and maintenance of state-of-the-art core laboratory infrastructure in the STEM training environments. In addition, support is needed for a series of strategic personnel hires to ensure cultivation of a critical mass of highly qualified faculty – with an eye toward building and retaining interdisciplinary and collaborative research teams to drive research enterprise at small- and medium-sized institutions.

Across the nation, numerous studies have shown that women researchers are most impacted by pandemic. This is because women form the majority of caregivers for children and elders. Additionally, a greater proportion of women scientists than men scientists are in temporary or insecure employment such as adjunct posts in which they may only be paid when teaching courses. As a result, the pandemic has highlighted the vulnerability of women researchers who are trying to manage work-life balance, while shouldering the bulk of the domestic and family responsibilities. A January 2021 National Bureau of Economic Research (NBER) study[8] with over 20,000 Ph.D. respondents indicated that women academic researchers lost roughly double the daily time devoted to research compared to male academics. The trends are accentuated for academics with younger children, especially pre-tenure women with children. This will have long lasting impacts on the career trajectory of women faculty. The burden or homeschooling and lack of childcare is impacting women researchers more than men. Without childcare or school, women researchers are less able to do field work. Additionally, the overall impact on field work has been severe with the reduction in undergraduate assistants. Time-sensitive

[8] As reported by Science magazine- see https://science.sciencemag.org/content/371/6530/660.summary

experiments are not able to be done. Nature (December 2020) reported that publications in all areas have surged, but men have led women in submissions, particularly in the life and health sciences.

Ramp-downs and remote working have affected outputs of laboratory-based researchers, including enhancing existing inequities in allocation of laboratory space to women researchers. Due to personal circumstances, more women researchers than male researchers have had to work remotely for longer. Time spent at the bench impacts the pace at which publishable data are acquired by women compared with men; fewer women in the lab translates to lesser number of publications with women first author contribution; and it leads to a decline of the women academic pipeline, which will have long-term impacts. This disproportion will also impact the career profiles of male and female scientists differently over the years to come. The effect of the pandemic will be found in the future job market gender profile and employability by gender, not because of gender bias per se, but because of greater academic outputs imbalance than was previously observed before the pandemic. This will not be limited to the academic settings.

Women leave academia earlier than men, leading to a perceived male-dominated output environment, even though the scientific outputs compared to gender and average year are found to be on par with pre-COVID-19 scientific outputs. This is likely to change since a larger proportion of academic female researchers than male researchers have either chosen or had to choose another career outside academia, further shortening the average academic life of women and limiting their contribution to scientific knowledge. Alternatively, those who have chosen or been able to remain in position as laboratory researchers will be more likely to have less scientific outputs and thus, be less competitive on the job market than their male counterparts. Further, the negative impacts to females in academic roles is likely to have long-term negative impacts on the quality and quantity of education and research unless the situation is actively addressed.

Functional networking has also been affected, both internally and externally. In-person networking through conferences, as well as increased visibility at conferences through invited talks, have been challenged. This impact is yet to be investigated. Regardless, it is easier to network in person at a conference than to email a stranger who has given a talk online viewed by many and to whom questions asked were filtered and delivered anonymously. At a conference, question and answer sessions are one of the recognized opportunities for women scientists to make themselves known and engage with experts in the field. The unconscious bias that junior scientific women have against putting themselves out there compared to their male counterparts will be further worsened by the remote-conferences structure. It would be imperative to monitor how remote conferencing has impacted networking from a gender perspective, as it is likely to greatly impact the career progression and job market opportunities of women more than men.

For early-career scientists, the disruptions have made it increasingly challenging for them to complete necessary research and to advance their careers. The slowed research progress also indicates legitimate concerns about career trajectory for early-career scientists, including those with caretaker responsibilities. As a result, many institutions are adapting their tenure and promotion processes to account for some of these impacts. Due to the unprecedented impact of COVID-19, some institutions, including WSU, the University of Washington, Ohio State University, Penn State, and Florida State University, made the decision during the last academic year to pause their tenure and promotion clock for one year. Several early career scientists who have yet to achieve stable external funding were forced to use start-up packages to pay for the costs associated with the pandemic.

Graduate students are facing similar challenges as faculty members during the COVID-19 pandemic but are receiving fewer assurances. In the spring of 2020, countless graduate students watched their education modality change overnight, putting degree timelines in question. Furthermore, these students worry about losing the external and university funding that supports their research. Prospective graduate students are experiencing major disruptions to the entrance exams, application, and admission process. Graduate student cohorts are shrinking in some fields as universities put school-funded Ph.D. programs on pause due to the fiscal constraints for 2021-2022. As of October 8, 2020, more than 108 doctoral programs across the country concentrated in the humanities and social sciences are not admitting new students in the fall of 2021. The reasoning behind these pauses is to ensure that there is enough funding for current school-funded Ph.D. students. Moreover, graduate students are not able to interact and connect with senior scientists at virtual conferences as effectively in a remote environment which will negatively impact their career growth.

Professional students in programs such as medicine, nursing and pharmacy have also been dramatically impacted by the pandemic. Similar to other students, their didactic face-to-face curriculum changed almost overnight. They experienced limited access to campuses for their clinical skills development and intermittent and unpredictable access to the experiential learning clinical settings. Further, they have been impeded by the inability to take board examinations (e.g. boards examination for medical students that are critical for residency placements) or to complete many of the requirements for degree completion. The cumulative impact for our professional students has included financial impacts, slowed progress to degree completion and uncertainties regarding the changes in the professional field of practice. As an additional point, the professional students associated with the WSU Health Sciences program have significantly increased service activities involving patient care, vaccination, and overall volunteerism. This has been inspirational. As an example, pharmacy and nursing students at WSU Spokane are actively engaged in local vaccination efforts.[9] Spokane residents being vaccinated will often find a WSU student "on the other end of the needle."

Additionally, there may be selected financial impacts for STEM graduate students. Some are dependent on teaching assistantships for their stipends, but the availability of teaching assistantships for laboratory courses at many universities dropped in spring 2020 due to the ramp-down. Additionally, doctoral students are facing delays from disruptions to laboratory and field research, which may slow their degree progress. Some may no longer be on track to graduate within the time frame that external or university funding typically covers. These students may need extensions to their degrees, possibly to their grant funding, in order to complete their dissertations.

While all students are facing issues with research due to pandemic-related shutdowns, international graduate students and postdocs are facing a unique set of challenges. The biggest concerns for international students and researchers revolve around the ability for them to join, or rejoin, the U.S. academic research community. The global pandemic's travel disruptions coupled with immigration and visa-related challenges may result in fewer international students and researchers coming to the United States. These are significant concerns as international students make up more than one third of the total U.S. graduate enrollment in science and engineering.

The effects of the pandemic and current visa restrictions on WSU graduate students have been pronounced. WSU's 1,150 international graduate students represent about half of the graduate student population. Due to the pandemic and immigration restrictions, about half of the international student

[9] See https://www.spokesman.com/stories/2021/jan/26/rise-to-the-challenge-wsu-nursing-pharmacy-student/ .

cohort has returned home, in many cases delaying their career progress. Furthermore, approximately one-third of newly admitted graduate students have deferred admission.

WSU international graduate students have also faced numerous funding concerns. Students returning home cannot stay on assistantships even if they stay enrolled- leading some to terminate their studies. Funding for those students remaining in the US has dropped as research grants have paused work, and teaching assistantships have decreased due to lower enrollments and departmental financial constraints. COVID-19's economic impact has also decreased the amount of funding available from international students' home countries. In many ways, there is a "perfect storm" financially for international graduate students. At WSU, regrettably, we have stories of international graduate students struggling to pay even minimal food and utility bills.

The research enterprise is at risk of losing a whole cohort of graduate and post-doctoral students seeking training and education, which includes researchers from underrepresented groups, minorities, women, and junior researchers. This will have profound and long-lasting impacts on both the research workforce and the research portfolio. Understanding this and other associated pandemic impacts is paramount to maintaining America's global competitiveness, technological leadership, and the economy of the United States.

Looking Ahead – Transition to the "New Normal" and Congressional Support

It is clear that the research enterprise within U.S. colleges and universities has been through a major disruption. But even during the crisis, university researchers have continued to forge ahead and pursue knowledge and discovery. The examples highlighted today showcases the importance of research to both address the current pandemic and other challenges facing society. There will be future pandemics, however, and now is the time learn from our COVID-19 experience and plan accordingly. This will require significantly more investment in research and development as well as our associated research and public health infrastructure. At the same time, the U.S. maintaining its position as a world-leading innovator requires the nation to continue to invest in a broad range of current and emerging fundamental, applied, and developmental research opportunities. As we have seen with COVID-19, this work will be increasingly interdisciplinary, requiring a well-planned portfolio approach to the nation's research investments.

The increasingly interdisciplinary nature of modern research highlights the importance of collaboration, including international participation in the nation's research enterprise. In particular, international scholars and students play a vital role in advancing discovery and innovation at the nation's research universities. Travel and visa policies should be examined and modernized to support collaboration and exchange of ideas. APLU universities are committed to performing these collaborations in a safe and secure manner consist with federal guidance.

As we recover from the pandemic, a new pandemic normal for how research is conducted will emerge. How we conduct research in the new pandemic normal will look different than prior to the pandemic. While this can seem daunting, it also presents us with opportunities to look at new paradigms and models that will better serve the research enterprise throughout the 21st century.

For example, remote work and learning has exposed the need for universities and colleges to rethink how we do research and the role that virtual tools and platforms may play in the search of knowledge. Researchers are making great progress in this area already. The "Robotarium" at Georgia

Tech[10] allows thousands of faculty and students (and non-researchers as well) to remotely test their robotics control programs in a controlled, safe environment. Other possibilities under investigation include fully remote research laboratories (including virtual reality headsets and motion sensing gloves controlling artificial intelligence (AI) lab robots), fully remote meetings with three-dimensional virtual objects manipulatable by attendees, and "classrooms without walls" including, for example, the ability to manipulate complex data sets in three dimensions. Many of these opportunities will be realized thanks to the coming revolution in artificial intelligence.

Indeed, the pandemic has highlighted the rapidly emerging role of AI in conducting research. In March 2020, The Allen Institute for AI (AI2) created a machine-readable COVID-19 dataset incorporating published COVID-19 research results. The AI2 developed an initial capability, known as CORD-19, in ten days. CORD-19 now incorporates over 280,000 scholarly articles. This machine learning capability allows individuals, including researchers, to directly ask questions related to COVID-19 and obtain answers based on the results of these 280,000 articles. This is a fascinating demonstration of the power of AI and machine learning, and a window into the major changes AI will bring to the nation's research enterprise.

I thank Chairwoman Johnson, Ranking Member Lucas, and other members of this committee for sponsoring the Research Investment to Spark the Economy, or RISE, Act, which would provide $25 billion to federal agencies to support independent research institutions, public laboratories and universities throughout the country to continue work on thousands of federally-backed projects impacted by the COVID-19 pandemic. The funding would also be used to support early-career researchers and graduate students, researchers in disciplines not fully recovered (such as human subject research and fieldwork), and vital facilities.

In particular, these funds will help mitigate the increased costs of doing research associated with the pandemic. Research, particularly laboratory and experimental research, costs more to conduct and takes a longer time to complete due to personnel and operational constraints associated with COVID-19. Many of these costs, such as those associated with infrastructure, are expected to persist as we prepare for the next pandemic event. The RISE Act funds will also be used to mitigate many of the inequalities dramatically exposed in the current pandemic. This includes gender and racial inequalities, as well as the weaknesses in research infrastructure present at our research institutions, particularly so at smaller and HBCU institutions. Finally, the RISE Act funding is essential to help address the long-term reduction in support for federally funded fundamental research. This long-term trend, which threatens the U.S. "innovation pipeline," has been discussed frequently within Congress and is very familiar to you.

Additionally, APLU is grateful for your joint leadership in introducing the Supporting Early-Career Researchers Act on January 5, 2021. This legislation would create a new postdoctoral fellowship program at the National Science Foundation to support early-career researchers whose opportunities have been affected by the COVID-19 pandemic. This act should also acknowledge and mitigate the impacts arising from changes in traditional career paths.

Both pieces of legislation are critical to the prevention of loss of research and talent due to any economic disruptions that may have occurred due to the public health emergency. Research universities and colleges across the nation play a critical role in the recovery of the pandemic. That is why investing in our academic research institutions is so vital. The growth of the U.S. economy and our leadership

[10] See http://www.robotics.gatech.edu/robotarium.

around the world depends on our nation's continued ability to lead in scientific discovery and technological innovation.

Without supplemental research funding, the contributions of research universities and hospitals to America's health, economy and national security will be impaired for a long time to come. Relief is needed to allow federal agencies to provide research grant and contract supplements (i.e., cost extensions) for expenses arising from COVID-19-related impacts; emergency relief to sustain research support personnel and some base operating costs for core research facilities and user-funded research services; and support for additional graduate student and postdoc fellowships, traineeships, and research assistantships to allow early-career scientists to complete degrees and enter the workforce rather than leaving science and engineering altogether.

Failure to provide this funding now will force federal research agencies to make difficult decisions between funding the completion of existing research projects or funding new projects. Some federal agencies are already planning for this possibility. Rescuing the nation's scientific research enterprise and supporting new research should not be an "either-or" choice – both are vital to our nation's health, security, and economic competitiveness and recovery.[11]

Conclusion

APLU and its member institutions very much appreciate the strong support provided by Congress during the pandemic. It has allowed the nation's public and land-grant universities to "rise to the challenge" and play critical roles in supporting their communities, states, and the nation in the campaign against the coronavirus. In short, the nation's universities remain more dedicated than ever to their core missions and supporting the people of our nation.

The pandemic has unfortunately also highlighted existing gender, racial, infrastructure, and other inequalities and challenges within our university research system. It is also clear that the "new normal" following the pandemic will differ substantively from life in the "before time."

It is imperative that APLU, similar organizations, and university leaders work closely with public and private sector colleagues to address these challenges and develop a robust vision and plan for supporting our nation's public and land-grant research universities following the pandemic. The health of the nation's research ecosystem – and the innovation and enhanced quality of life that arises from it – are at stake.

Finally, we are grateful for the committee's leadership in exploring the impact of the pandemic on our nation's research institutions and for your support of the RISE Act and the Supporting Early-Career Researchers Act. Continued Congressional support for federal research agencies is essential for national recovery from the pandemic and transitioning the nation's research enterprise to the "new normal," which assuredly will not look like the situation pre-pandemic. The nation relies on its

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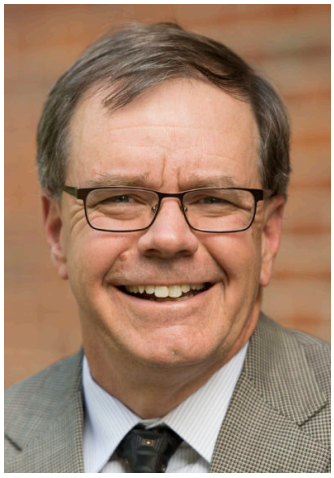
[11] AAU/APLU/AAMC/ACE Association letter to Congressional Leadership 1/26/21 – (https://www.aplu.org/members/councils/governmental-affairs/CGA-library/associations-letter-supporting-26b-research-relief-request/file)

universities to train the next generation of researchers and scholars essential to functioning of the "innovation pipeline" that translates fundamental research advances to achievements that benefit the lives of Americans every day.

I am grateful for this opportunity to offer this testimony today. Thank you.

CHRISTOPHER J. KEANE, Ph.D.



Vice President for Research

Professor of Physics

Christopher Keane is Vice President for Research and Professor of Physics at Washington State University. He received a B.S. degree in Physics and Engineering, Magna Cum Laude, from the University of Rochester in 1980. He received his Ph.D. in Astrophysics from Princeton University in 1986. Dr. Keane then joined the Inertial Confinement Fusion Program at Lawrence Livermore National Laboratory (LLNL), performing computational and experimental research in x-ray lasers, inertial confinement fusion (ICF), and ultra-high intensity laser–matter interactions.

Dr. Keane joined the U.S. Department of Energy in 1996 as the Associate Director of the Office of Inertial Fusion within the Office of Defense Programs in what is now the National Nuclear Security Administration (NNSA). He held several leadership positions at NNSA, ultimately serving from 2004-2007 in the Senior Executive Service as Assistant Deputy Administrator for Inertial Fusion and the National Ignition Facility (NIF) Project. In this latter position, Dr. Keane was responsible for the NNSA ICF Program, including construction of the $3.5 billion NIF laser. He also worked closely with NNSA, Office of Science, and Office of Science and Technology Policy leadership to establish programs aimed at advancing the study of fundamental high energy density science. This includes the NNSA/Office of Science Joint Program in High Energy Density Laboratory Plasmas. This program now supports a large fraction of the U.S. researchers involved in this rapidly evolving and exciting area of science.

Dr. Keane rejoined LLNL in 2007 and went on to serve as director of the NIF User Office from 2009 through June 2014. In this role he worked with LLNL, Department of Energy, and other leaders to launch the NIF user program. This successful program allows academic and other users to conduct astrophysics and other experiments aimed at using the football-stadium sized NIF's unique capability to examine the behavior of matter at extreme pressure. Dr. Keane also served in 2014 as Acting Deputy Principal Associate Director for Science and Technology within the LLNL NIF and Photon Sciences Directorate.

Dr. Keane joined Washington State University in 2014. He has taken significant steps to reshape the University's research enterprise. Dr. Keane spearheaded the 120-day study identifying WSU's areas of research excellence and areas where operational improvements were needed. He led WSU faculty and staff in articulating "grand challenges" – institutional multidisciplinary research areas that focus on urgent regional, national, and global problems. The grand challenges effort resulted in the funding of four focused research initiatives that have yielded an approximate 17x financial return in terms of

awards received. He has also led major operational improvements to the WSU Office of Research. This included enhancing performance and efficiency of offices overseeing animal and human subject experiments, commercialization and industrial engagement, proposal submission and award, and other services essential for supporting faculty and staff engaged in the research enterprise. WSU has recorded record research expenditures in the past several years under Dr. Keane's leadership.

Dr. Keane also has significantly strengthened the partnership between WSU and the Pacific Northwest National Laboratory (PNNL), launching three WSU-PNNL Joint Research Institutes as well as programs supporting Ph.D. research at PNNL for WSU graduate students and joint research appointments for PNNL staff and WSU faculty. He serves on the Board of Directors for the Pacific Northwest National Laboratory.

Dr. Keane is a Fellow of the American Association for the Advancement of Science and a member of the American Physical Society. He is the recipient of the NNSA Silver Medal, the Defense Programs Award of Excellence, and the Fusion Power Associates Special Award. He has also served on several major national and international advisory and review committees, including the DOE Fusion Energy Sciences Advisory Committee, the United Kingdom Fusion Advisory Board, and most recently the Los Alamos National Laboratory Complex Natural and Engineered Systems Review Committee. He has authored more than 100 scientific publications.

In 2018, Dr. Keane was elected to membership in the Washington State Academy of Sciences, an organization that advances science in the state and informs public policy.

Dr. Keane was elected as a member of the Association of Public and Land Grant Universities Council on Research Executive Committee in 2016. He was elected Chair of the APLU COR in summer 2020, with his appointment lasting through mid-November 2021.