Written Testimony of Dr. Sudip Parikh
American Association for the Advancement of Science
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Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, thank you very much for the opportunity to testify today. I am Sudip Parikh, chief executive officer of the American Association for the Advancement of Science. AAAS is the world's largest multidisciplinary scientific society and the publisher of the *Science* family of journals. Our mission is to advance science, engineering, and innovation throughout the world for the benefit of all people or – put more simply – to advance science and serve society.

Scientific discoveries are the result not of a single eureka moment but years of patient, dedicated, and funded work. Though this hearing is focused on impacts of the pandemic, it is important to consider why our government made the wise decision decades ago to invest in research and development.

Federally funded research has been a critical driver of world-changing discoveries for much of the past century and enhances the everyday lives of Americans in both large and small ways. These discoveries shape how we connect with each other, how we navigate through the world, and how we understand and make choices about our own health and the health of our loved ones.

The smartphones that sit in most of our pockets, for example, are an amalgamation of federally supported discoveries. The liquid crystal display, multi-touch screen zoom, and lithium battery all stem from research supported by the National Science Foundation (NSF). The Department of Defense (DoD) led the effort to establish the Global Positioning System, better known as GPS. Thanks to those efforts, freely available location data – accurate to less than a foot – is only an app away.[1] And speaking of apps, the internet itself, perhaps the most life-altering advancement in communication in our lifetimes, received crucial development support from NSF and the Defense Advanced Research Projects Agency (DARPA).[2] Federal investments in the National Aeronautics and Space Administration (NASA) have led to the invention and ubiquitous use of common household products, including scratch-resistant lenses, memory foam, and ear thermometers. Exhilarating achievements like the rover Perseverance's recent landing on Mars continue to inspire new generations of scientists and engineers to keep expanding the limits of our human reach.[3]

The topic of today's hearing – Building Back the U.S. Research Enterprise: COVID Impacts and Recovery – is incredibly timely for the following reasons:

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[1] https://spectrum.ieee.org/tech-talk/semiconductors/design/superaccurate-gps-chips-coming-to-smartphones-in-2018;
https://www.nasa.gov/directorates/heo/scan/communications/policy/GPS_History.html

[2] https://www.nap.edu/read/6323/chapter/9;
https://www.nsf.gov/news/special_reports/btyb/innovation.jsp

[3] https://www.jpl.nasa.gov/infographics/20-inventions-we-wouldnt-have-without-space-travel

First, over the past year the world has witnessed the critical role that U.S. science and engineering serves in developing diagnostics, therapeutics, and vaccines for the SARS-CoV-2 virus, giving us light at the end of the tunnel despite the relatively poor federal and state response to the COVID-19 pandemic.

Second, science and engineering research have an essential role to play in addressing a host of ongoing challenges that we face, including economic competitiveness, agriculture productivity, food and water security, energy security, and climate change. Unfortunately, our nation's universities and laboratories – the very foundation of our innovation ecosystem – have faced an eroding capacity to nurture ideas, discoveries, and a highly skilled diverse pool of STEM talent as a result of the pandemic.

The time is now to invest in R&D and seize the opportunities to restore and expand the STEM workforce pipeline to include majority and marginalized Americans, strengthen the U.S. innovation ecosystem, protect our economic competitiveness, and increase the safety and well-being of all Americans.

Science Rises to the Global Challenge

Starting in January 2020 and every day since, colleagues at *Science* and I have witnessed breathtaking scientific advancements in our understanding of the SARS-CoV-2 virus and rapid development of therapies and vaccines.

We published the research paper that revealed the structure of the spike protein that enables the virus to attach to a human host and replicate to cause the disease that we know as COVID-19. This rapid discovery and the subsequent advancements were made possible in large part by past federal investments in cutting-edge research. Researchers at the University of Texas at Austin and the National Institutes of Health (NIH) mapped the spike protein's structure within weeks of the release of the viral genetic sequence on January 10, 2020; their quick work relied on knowledge accumulated through years of basic research and led to record-breaking vaccine development for COVID-19. The journal *Science* highlighted this achievement as part of its Breakthrough of the Year, and AAAS and our partners recognized these scientists with the 2020 Golden Goose Award, which celebrates unexpected but world-changing discoveries.[4] This is just one of many striking examples of researchers across the globe working to combat the pandemic.

Many other examples of research across a multitude of scientific and technological fields continue to produce valuable information to help us respond to this global pandemic. AAAS, along with eight other organizations, founded the Golden Goose Award in 2012 to highlight stories of the world-changing benefits of federally funded, curiosity-driven scientific research. Past awardees include the scientist who discovered the proteins known as cytokines – which we now hear in reference to "cytokine storms" that characterize some severe cases of COVID-19 –

[4] https://science.sciencemag.org/content/367/6483/1260; https://www.goldengooseaward.org/01awardees/spike

and the field biologists whose discoveries led to the PCR technique of amplifying and analyzing DNA, which is used in COVID-19 diagnostic tests.[5]

This brief list of scientific advances, many of which were the result of unanticipated and serendipitous discoveries, offers just a glimpse into the varied ways that federally funded research has the potential to touch every aspect of our lives and underscores the importance of continuing to fund these vital endeavors.

Even now, time and again, researchers have rallied and found creative opportunities to continue their work, despite massive obstacles. Their ingenuity has included shifting and redirecting research to focus on the pandemic, retrofitting laboratories and equipment, and finding new ways to work in this era of social distancing.

For example, we heard from an Iowa researcher who studies virtual reality training for soldiers, first responders, and other populations including factory workers. For safety reasons, the researcher's team had to transition experiments to a home setting, which posed significant challenges: developing new software and data transfer capabilities, working with an Institutional Review Board for approval of the new experiment design, and finding new methods to recruit subjects and interpret their data. Though scientists and engineers are rising to the moment and using their talents to solve problems, these solutions do have costs, as in the case with this researcher: milestones postponed with funding agencies, delayed graduation for students, and the need for bridge funding to help support those who work in the lab after the grants run out.

This raises a troubling question: what groundbreaking science, currently underway, might be lost as a result of funding constraints associated with the pandemic? With this interruption, what life-changing advances might we never get to see?

Success Comes with a Price

This committee held a hearing in September 2020 to address the significant disruptions to research conducted at our nation's universities. As the pandemic emerged, universities were faced with determining what was essential research to continue, in some cases retrofitting labs to focus on COVID-19 research and creating a safe environment for researchers and students. For some scientific disciplines – particularly research that involves field studies, longitudinal studies, and non-COVID-19 research involving animals and humans – significant amounts of research have been lost. We've heard from members who have had to restructure experiments, leave field work unfinished, and face delays in project completion, publications, and the supply chains for needed equipment. To be sure, some important research has continued – for example, *Science* has covered key scientific developments over the past year in areas such as genome editing,

[5] https://www.goldengooseaward.org/01awardees/cytokines; https://www.goldengooseaward.org/01awardees/thermus-aquaticus

neutron stars, climate change and policing.[6] Impacts are affecting some individuals more than others.

There are human and social factors, as growing evidence shows that the pandemic has exacerbated preexisting inequities among women and other underrepresented minorities in the scientific community. As you'll hear from Dr. Levine, early-career researchers – graduate students, postdoctoral researchers, and new faculty – have lost or risk losing research opportunities and job prospects.

Women in STEM, and those with young children, have faced unique challenges. One recent survey of principal investigators found that "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."[7] Multiple analyses have also pointed to a drop in submissions by women on preprint servers, which allow versions of scientific manuscripts to be posted online prior to formal peer review.

According to a global survey of 20,000 Ph.D. holders referenced in a National Bureau of Economic Research working paper last month, mothers suffered a 33 percent larger drop in research hours than fathers. The survey, conducted from May to July 2020, also found that mothers took on more household and childcare duties than fathers.[8]

A Policy Forum published in our own journal, *Science*, about moving academic research forward during the pandemic, laments that "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."[9]

Underrepresented minorities in STEM have also been disproportionately impacted. The Student Experience in the Research University Consortium conducted a survey last year on the impact of COVID-19 on students at 10 research universities.[10] The survey, which received responses from about 30,000 undergraduate and 15,000 graduate and professional students, consistently found that students of color, as well as low-income and working-class students, were more likely to experience anxiety and depression, food and housing insecurity, and higher rates of financial hardship for both themselves and their families than their white and higher-income counterparts.[11] The American Medical Association provided further examples of how existing

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[6] https://science.sciencemag.org/content/371/6530/696; https://science.sciencemag.org/content/370/6523/1402

[7] https://www.nature.com/articles/s41562-020-0921-y

[8] https://www.nber.org/papers/w28360

[9] https://science.sciencemag.org/content/368/6496/1190.full

[10] https://cshe.berkeley.edu/seru-covid-survey-reports

[11] https://www.insidehighered.com/news/2020/09/16/low-income-and-students-color-greatest-need-pandemic-relief

inequities in our society have been exacerbated by the pandemic, with deleterious effects for racially marginalized groups. To name just a few examples, students of color and from lower-income backgrounds may face reduced access to the technology and bandwidth that makes virtual education possible. And people of color are experiencing the health effects of COVID-19 disproportionately, which means that students of color are likely to be shouldering an increased burden of grief.[12]

The pandemic has also added burdens to researchers with disabilities. Krystal Vasquez, a graduate student in atmospheric chemistry at the California Institute of Technology who has hypermobile Ehlers–Danlos syndrome, a connective tissue disorder, found that unpaid time spent advocating for COVID-related policies that protect disabled and chronically ill students took time away from her work hours. Additionally, though the option to work from home has been helpful to many disabled people, the disability community has voiced concern that when the pandemic ends, research institutions will remove the options that currently increase accessibility.[13]

We must not set in motion a future where fewer women and minorities submit research grant proposals and research publications, where career opportunities for promising scientists are derailed, and where mentors for future scientists are in shorter supply.

That Price Risks our Innovation Future

Our failure to sustain our investment in research and development (R&D) is threatening not only Americans' opportunities, but our innovation leadership. The ability of the United States to compete with other countries, including China, should be thoughtfully considered by this committee and Congress. Make no mistake, we remain in a global race for innovation advantage, and we've been allowing ourselves to slip. Since the mid-1990s, we have fallen to 10th in the world in R&D intensity – R&D as a share of a nation's GDP – and 14th in the world in *public* R&D intensity.[14] China continues to gain on our lead in total R&D expenditures, has risen to second in the world in highly-cited researchers and highly-cited publications, and since 2008 has experienced a 500 percent rise in triadic patents, which are patents for the same invention filed in multiple international patent offices and a good measure of innovative capacity.[15]

It's not just China: other economies like Germany, Korea, and Taiwan also rank ahead of the United States in metrics like R&D intensity and researchers per capita.[16] Some of these same countries are pumping billions into their research and innovation ecosystems to jumpstart a path forward for COVID relief.

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[12] https://www.ama-assn.org/delivering-care/public-health/protecting-underrepresented-students-and-residents-during-covid-19

[13] https://www.chemistryworld.com/careers/underrepresented-scientists-hardest-hit-by-pandemic/4012868.article

[14] https://www.aaas.org/news/snapshot-us-rd-competitiveness-2020-update

[15] https://clarivate.com/blog/highly-cited-researchers-2019-strong-evidence-of-mainland-chinas-rise-to-the-highest-levels-of-research/; https://ncses.nsf.gov/pubs/nsb20206/impact-of-published-research

[16] https://www.aaas.org/news/snapshot-us-rd-competitiveness-2020-update

These are not just statistics. The trends have real and tangible effects at home and in our communities. Failing to take the right steps means not just the loss of innovations or companies but human capital and losing high-skilled jobs and opportunities. An analysis of job boards during the fall application season revealed that STEM postings were down by about 70 percent.[17]

Approximately one in four doctoral students and half of all postdocs – representing the next generation of STEM innovators – rely on federal financial support, and the federal government is the largest source of support for university research, an important foundation of not just discovery but training.[18] Universities are increasingly important influences on the inventive activities of nearby firms and on the creation of new startups.[19] Having a ready workforce of skilled science graduates is also important for firm innovation.[20] Disruptions to this ecosystem can have serious ripple effects on the broader innovation economy.

Postdocs and early-career researchers will go where the opportunities are. The U.S. has always been that place. But if we do not respond appropriately to this pandemic, we risk losing this talent at great detriment to our nation.

Recommended Steps for Research Relief

We recognize that there are many sectors of the U.S. society and our economy that have been negatively impacted by the COVID-19 pandemic. Unfortunately, our scientific and technology enterprise, which will be integral to helping our nation move forward, is also at risk from the COVID-19 pandemic.

The Council on Governmental Relations (COGR) has calculated the estimated costs of the pandemic on academic research institutions. The January 2021 update laid out three sobering impacts at U.S. research universities: "1) research output losses between 20 and 40 percent, 2) financial disinvestment impact in the *hundreds of millions of dollars* at individual institutions, and 3) potential impact approaching *tens of billions of dollars* across the entire U.S. research enterprise."[21]

Timely funding is needed to address the urgent challenges described above, particularly the most important asset in the scientific enterprise – highly skilled, diverse scientists and engineers. Buildings and experimental tools can be replaced on the legislative schedule, but people cannot wait.

Research relief is necessary to avoid the long-term impacts of the COVID-19 pandemic on the U.S. research and innovation enterprise, and legislation such as the bipartisan, bicameral RISE

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[17] https://www.sciencemag.org/careers/2020/10/amid-pandemic-us-faculty-job-openings-plummet

[18] https://ncsesdata.nsf.gov/gradpostdoc/2018/html/gss18-dt-tab003-1.html; https://ncsesdata.nsf.gov/gradpostdoc/2018/html/gss18-dt-tab003-2.html; https://www.aaas.org/sites/default/files/2018-11/UniSource1.jpg

[19] https://doi.org/10.1068/a3930

[20] https://doi.org/10.1016/j.respol.2014.03.005

[21] https://www.cogr.edu/sites/default/files/Research_Impact_COVID_Jan_2021_COGR.pdf

Act lays out a funding plan supported by the community. As I've outlined in my opening remarks, the success of this enterprise has benefited from federal funding of cutting-edge research across multiple mission agencies. The RISE Act supports that foundational principle.

The $25 billion authorized in the RISE Act is an estimate based on the disruptions in the early months of the pandemic. It authorizes funding to fill urgent gaps across key federal agencies that further research to promote national security, energy security, and food security, as well as public health and environmental protections. The longer we postpone this vital support, the higher the costs will be, and federal agencies will be faced with determining whether to fund cost extensions to existing research disrupted by the pandemic or fund new grants that will allow our innovation enterprise to regain momentum.

Funding is only part of the solution. We encourage federal agencies and research institutions to work in partnership in developing policies that do not reflect a "one-size-fits-all" approach as they consider bridge funding of existing grants and funding new research grants. The higher education community has outlined a number of policy actions that can be implemented to support scientists and students at U.S. universities.[22]

In addition, policies that provide support for early-career scientists, women and underrepresented minorities can help to ensure that we do not lose even the small gains we have made in diversifying our science and technology workforce – for example, Chairwoman Johnson and Ranking Member Lucas's Supporting Early-Career Researchers Act. We encourage Congress to work with the new administration to explore opportunities to expand the number of research fellowship programs and to provide additional flexibilities to assist researchers whose studies have been interrupted and delayed. The creativity and innovation boost that comes from diverse teams is critical in competing with the sheer numbers of scientists and engineers being produced by our global competitors such as China. Our greatest asset is scientific excellence coupled with the diversity of thought derived from the diversity of the experiences on our teams.

Understandably, the government has a keen interest in allowing ongoing research to resume and regain its pace, but we must also invest in new early-career scientists waiting to begin their research and expand our scientific and technological horizons, lest we create a clog in the STEM talent pipeline or altogether lose this talent to other sectors.

I cannot emphasize enough the importance of responding with urgency as soon as possible. Funds received a year from now may provide some eventual relief to institutions, but they will be too late for young scientists and engineers struggling to stay afloat in these turbulent and uncertain times.

Looking beyond the urgent needs of the pandemic, science has always had strong bipartisan support from the U.S. Congress – and the American people have benefited greatly from those past investments. We thank you for your foresight and the funding that has been appropriated over the past years, and we encourage the members of this committee to continue to work in partnership with your colleagues in providing robust and sustainable funding for R&D this year

[22] https://www.aau.edu/sites/default/files/AAU-Files/Key-Issues/Federal-Budget/COVID-Priorities-for-117th-Congress.pdf

to allow our nation to continue to push the envelope of scientific discovery, harness technological advancements, advance economic opportunities, and protect our citizens from the next crisis.

In July 2020, I testified before the House Budget Committee on American innovation. In my remarks I urged policymakers to renew investments in our research enterprise, and in conclusion, I would like to emphasize this point again today. We are living in an era in which science and engineering have delivered extraordinary advances that are improving health, well-being, and economic prosperity for Americans and people around the world – and we are on the cusp of even more life-improving developments and discoveries. But we must not lose sight of the critical role that science serves in identifying new threats and revealing new horizons. Done well and learning from the past, supporting our nation's scientific enterprise will be vital to serving the well-being of all our citizens and bolstering economic security for all. I am confident in the ability of the people in our science and technology enterprise to rise to the challenges of the coming era, but they cannot do it without your leadership and support.

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Sudip Parikh, Ph.D., became the 19th chief executive officer of the American Association for the Advancement of Science (AAAS) and executive publisher of the *Science* family of journals in January 2020. Parikh has spent two decades at the nexus of science, policy, and business.

Immediately prior to joining AAAS, Parikh was senior vice president and managing director at DIA Global, a neutral, multidisciplinary organization bringing together regulators, industry, academia, patients, and other stakeholders interested in healthcare product development. He led strategy in the Americas and oversaw DIA programs that catalyzed progress globally toward novel regulatory frameworks for advanced therapies not amenable to existing regulations.

Prior to DIA, Sudip was general manager of the Health and Consumer Solutions business unit and vice president at Battelle, a multibillion-dollar research and development organization. He led a $150 million business unit with over 500 scientific, technical, and computing experts performing basic and applied research, developing medicines and healthcare devices, and creating advanced analytics and artificial intelligence applications to improve human health. Previously, Parikh led Battelle's global AgriFood business unit. Headquartered in London and Geneva, this unit provided environmental fate research and agriculture product development services from laboratories throughout Europe and the United States.

From 2001 to 2009, Parikh served as science advisor and professional staff to the United States Senate Appropriations Committee, where he was responsible for negotiating budgets for the National Institutes of Health (NIH), Centers for Disease Control and Prevention, Agency for Healthcare Research and Quality, Biomedical Advanced Research and Development Authority, and other scientific and health agencies. A key legislative liaison to the research and development ecosystem, Parikh was on the frontlines of many science policy issues debated during that time, including embryonic stem cell research, cloning, disease surveillance, bioterrorism, cyber security, and doubling the NIH budget.

An active member of the scientific advocacy community, Parikh serves as a board member and officer for several impactful organizations, including Research!America, Friends of Cancer Research, and ACT for NIH. He has received multiple public service awards, including recognition from the American Association of Immunologists, the National AIDS Alliance, the Coalition for Health Services Research, and the Juvenile Diabetes Research Foundation.

Sudip is committed to early STEM education and, as a parent of three energetic young children, he prioritizes volunteering as a mentor for Science Olympiad teams at two elementary schools.

Early in his career, Parikh was a Presidential Management Intern at the NIH. He was awarded a National Science Foundation Graduate Research Fellowship while earning his Ph.D. in macromolecular structure and chemistry from the Scripps Research Institute in La Jolla, Calif. There, he used structural biology and biochemistry techniques to probe the mechanisms of DNA repair enzymes bound to DNA. The son of Indian immigrants who worked in the textile and furniture manufacturing plants of North Carolina, Parikh completed undergraduate studies at the University of North Carolina at Chapel Hill, first as a journalism major before switching into materials science.

January 2020