HOUSE COMMITTEE ON THE BUDGET
Chairman John Yarmuth

August 31, 2020

Federal Research and Development Fuels Our Economic Growth, National Capabilities, and Societal Progress

In July 2020, the House Budget Committee held a hearing on "Fueling American Innovation and Recovery: The Federal Role in Research and Development." The committee heard testimony from expert witnesses on the long-term trends in federal research and development (R&D) funding; the challenges and opportunities for advancing technological progress in a competitive world; and the importance of government investments in R&D to our economic growth and productivity, our health and quality of life, and our ability to solve pressing problems.

The hearing clearly showed why science matters (especially now, as our nation remains gripped by the COVID-19 pandemic), why the federal commitment to R&D is critical, and how increased federal investments could enhance and expedite our recovery efforts. "Reinvigorating our science and engineering capabilities," Chairman John Yarmuth said, "could help our nation address the crises we face today while better preparing our nation for the future."

"Science and engineering are more important now than ever in our national preparation and response to current crises, including COVID 19 but also ongoing challenges such as climate change and economic competitiveness." — Dr. Sudip Parikh, CEO of the American Association for the Advancement of Science, and other witnesses discussed the lessons we could learn from this time of crisis. Decades of investments in the life sciences and biomedical research, such as the Human Genome Project, have built immense genomics and biotechnology capabilities. As a result, in six months, scientists have gone from the first isolation of the coronavirus to its complete molecular characterization and the start of initial vaccine trials. However, the U.S. response to COVID-19 has demonstrated the dangers of underinvestment in public health and a dismissive attitude toward scientific evidence. The Trump Administration failed to get the response right, squandering the lead that our scientific and technological knowledge and capabilities could have provided us. The foundational technology underlying coronavirus testing was developed in U.S. universities, yet the Administration continuously fails to implement a testing strategy. Furthermore, the coronavirus has exposed weaknesses in our technology manufacturing capabilities and our reliance on other parts of the world for personal protective equipment (PPE), medical devices, and generic pharmaceuticals. Dr. Willy Shih, Professor of Management Practice at the Harvard Business School, said, "With this has come the realization we have let our capabilities diffuse away in a wide range of sectors, like semiconductors, electronics, machine tools, and countless others."

"To make progress, we have to base our decisions on the facts." — Dr. Paul Romer, Professor at NYU and 2018 Nobel Laureate in economics, alluded to the greatest failure during the COVID-19 pandemic: The Trump Administration's unwillingness to use scientific evidence, data, and research to keep Americans safe. This Administration has systematically undermined scientific integrity by suppressing, distorting, and preventing research that could have been applied to save lives. Dr. Parikh called out the Administration for politicizing and canceling research funding on the origins of the coronavirus, expressing his worry about the threats to scientific integrity. Agencies such as the CDC and FDA that are responsible for critical real-time decisions have been vulnerable to brazen political interference that has distorted their scientific expertise and objectivity. "In the wake of the pandemic," Dr. Romer testified, "we need to revisit the conversation about the failure of our national innovation system to apply scientific insights and capture the practical benefits we desire." Ultimately, the federal government has a vital leadership and coordination role in preparing for and responding to crises that can be the difference between success and failure. We have an opportunity now to reset and reinvigorate U.S. science and technology as part of an aggressive, responsible, and strategic plan to recover from both COVID-19 and its economic fallout.

"Regaining American leadership and driving innovation will require substantial investments of public resources." — Despite its immense importance, federal R&D funding as a share of the economy has fallen from a peak of 1.9 percent in the mid-1960s to less than 0.7 percent in 2018. Most federal R&D funding comes from discretionary spending, and it currently totals more than $150 billion.[1] Since the early 1980s, federal R&D funding has remained between approximately 11 and 13 percent of discretionary spending, but as discretionary spending has declined as a share of GDP, so has federal R&D investment. Deborah Wince-Smith, President and CEO of the Council on Competitiveness, noted that federally funded research and technology development centers, such as the national labs, house unique scientific instrumentation and facilities that are at risk due to chronic underfunding and a deficient and degrading infrastructure. In 1960, the United States drove worldwide developments in science and technology by virtue of the size of its investment, leading the world with 69 percent of global public and private R&D funding. But other countries increased their investments, and by 2018, the U.S. share of global R&D expenditures had fallen to just 28 percent. Moreover, preliminary 2019 data indicate that China may have now overtaken the United States in total R&D spending for the first time – emerging as an increasingly strong competitor with a long-term strategic plan for increasing their R&D funding, intellectual property acquisition, and high-tech manufacturing. "Meanwhile," Chairman Yarmuth warned, "other nations are working to solve both the global health and economic crises by ramping up investments in R&D – spurring their recovery while planning for future advancements that will help them maintain their competitive edge in the global market." To restore our status as a global innovator and successfully compete with other nations, Dr. Parikh proposed that the United States develop a

[1] Includes a small amount of mandatory spending. Does not include related tax expenditures.

visionary, ambitious R&D roadmap and increase federal R&D funding 11 percent annually thorough 2035 to implement it.

"Disruptive technologies are reshaping the economy and society. Continued leadership in these technologies will be essential for the United States to maintain its position as a world economic and military leader." — The greatest global competition, Ms. Wince-Smith said, will be for leadership in the multiple, revolutionary technologies that are converging simultaneously: biotechnology and gene-editing, nanotechnology, artificial intelligence, autonomous systems, and a new phase of the digital revolution linked to big data and widespread deployment of sensors. These general purpose, or "platform," technologies have the potential to transform and disrupt industries, markets, and jobs across sectors; to raise productivity and living standards; and to provide solutions to the challenges we face in health, energy, food production, clean water, and sustainability.

"Applied science programs can have major, immediate, and long-lasting impacts on the day-to-day lives of ordinary Americans." — Dr. Parikh highlighted federal support for applied and mission-oriented research as an important pathway for increasing investments in technologies of practical use. By focusing on underinvested areas and engaging users of the knowledge produced, these programs are integral to solving societal challenges in such areas as health, national security, and environmental stewardship. U.S. Department of Agriculture research, for example, has enhanced agricultural productivity, nutrition, and safety, with very high economic rates of return. The National Oceanic and Atmospheric Administration (NOAA), using U.S. Geological Survey (USGS) streamgage data, developed a new National Water Model that has improved flood forecasting for emergency responders, water infrastructure managers, and local officials. Moreover, "some of the most powerful innovations emerging from federal R&D come not from pure serendipity, but from what has been called 'connected science'," which Dr. Parikh explained is the intentional targeting of potentially revolutionary research to real-world challenges and outcomes. The Defense Advanced Research Projects Agency (DARPA) is the quintessential example of this approach, which has driven world-changing innovations in microelectronics, wireless communications, GPS, synthetic biology, and autonomous vehicles – and achieved both greater scientific discovery *and* more technical patents than traditional approaches. The National Science Foundation's Engineering Research Centers are another example that has yielded hundreds of discoveries and inventions and dozens of spinoff firms.

"It is clear that our framework for scientific investment is ready for a refresh." — In 1945, Dr. Parikh explained, Vannevar Bush wrote *Science: The Endless Frontier*, a framework for federal scientific investment and academic-industrial partnership that has guided our national policy ever since. In this "linear model," the federal government invests in basic research at universities and laboratories, and private industry refines new ideas to provide practical benefit through product development. But all four witnesses agreed that this approach is outdated in the modern world and that we need an expanded framework. The scale, scope, and interconnectedness of the science and engineering enterprise far surpasses what it was 75

years ago. Research fields cross-pollinate and incorporate feedback from industry, leading to many more pathways for discovery and innovation. Indeed, Dr. Romer argued that the "linear model" never fully captured the relationship between basic science and technological progress: the invention of the steam engine, for example, catalyzed the basic science of thermodynamics, not vice-versa.

As the largest single contributor to national R&D, the federal government has a leadership role in coordinating these many pathways to support economic growth, social benefit, and national security. And although private-sector R&D investments have gradually increased over time, the private sector is more risk-averse and has a built-in bias toward incremental advances and familiar markets rather than breakthroughs or new markets, leaving significant gaps. Dr. Parikh and Ms. Wince-Smith argued that a new federal framework should emphasize full spectrum innovation: integrating, coordinating, and optimizing investment in fundamental science, mission-driven technology, and useful knowledge programs that empower all our innovation assets, from universities to entrepreneurs to large companies.

"Research universities are increasingly expected to be drivers of economic development, serving as local sources of innovation." — Ms. Wince-Smith and other witnesses described the powerful regional impacts of investments in R&D research and capacity. Localized clusters around universities and federally funded research centers increase the inventive activities of nearby firms, accelerate the creation of new startups, attract additional private R&D investment, and advance regional economic opportunities – creating jobs in both the short and long term. Large R&D investments during World War II, for example, led to local innovation clusters associated with increased patenting, high-tech industrial growth, and manufacturing employment over decades. University and national lab technology transfer, commercialization, and industrial engagement programs can help further accelerate that knowledge transfer.

"Because of our investment in the land grant universities, we moved into a position of technological dominance prior to World War II." — Dr. Romer said that land grant universities are a prime example of how to empower local research oriented toward innovative practical knowledge – such as the development of the iron ore palletization process at the University of Minnesota, or the creation of chemical engineering as a discipline critical to the petrochemical industry. Similarly, federal investments in agricultural research significantly increase technological change and agricultural productivity in recipient states. Yet today, U.S. R&D is distributed unevenly across the country, with just ten states accounting for two-thirds of R&D spending. Strengthening support for land grant universities and investing in regional innovation hubs and technology clusters presents an opportunity to expand the rate of U.S. innovation and diversify technology-based economic growth beyond the coastal hubs.

"The capabilities are embodied in people. The people are everything." — Dr. Shih reflected the consensus among all four witnesses that individuals are at the heart of the research, development, and innovation enterprise. The federal government is central to developing this talent pool along three avenues: investing in schools, community colleges, and universities;

reforming immigration policies to attract talented and high-skilled immigrants; and reducing barriers to diversity and inclusion. Dr. Romer said investments in universities and in the education system have been our highest-return investments, and he recommended dramatically increasing the number of portable, merit-based, federal fellowships for science and engineering graduate students. Dr. Parikh noted that "38 percent of the Nobel Prizes awarded to Americans since 2000 have gone to immigrants," and that "the population of post-doctoral [students] in America… is one-third immigrants." A thoughtful and welcoming immigration system would help attract and retain the best and brightest as they contribute deeply to R&D and innovation in the United States.

"We need to…double down on educating and training our own citizens, particularly women, minorities, underrepresented racial groups." —Ms. Wince-Smith testified that we also need to bring a greater cross-section of our own citizens into the innovation system. "We know," Dr. Parikh said, "that our nation's research and education has far to go to reflect a diverse and inclusive system, and to improve exposure to invention and innovation for people of all backgrounds." Currently, children from high-income families are 10 times more likely to become inventors than those from lower-income families. The patenting rate per capita for Black Americans is lower now than it was in 1899. Successfully increasing equity and inclusion in the R&D ecosystem would not only help to move our nation forward and increase equity and fairness, it would also increase GDP per capita by as much as much as three to four percent.

"Science has a substantive role to play in advancing shared opportunity and fair treatment for all Americans." — Beyond diversity and inclusion in the scientific workforce, Dr. Parikh further argued that science – and especially social science – is critical to providing the data and evidence base we need to tackle broader issues of social justice. Science can shed light on data related to incarceration, officer-involved shootings, crime reduction, health disparities, and other topics pertinent to equity and fairness. We must also ensure the benefits of R&D investments, from new medical treatments and therapeutics to emerging digital capabilities, are accessible and equitably shared among all Americans.

Ultimately, federal R&D spending increases aggregate economic output, generating an estimated three to eight times the initial investment and providing a powerful example of the value and impact of the federal budget's discretionary investments. The United States has a strong system of research universities and labs, industry-university collaboration, and entrepreneurship and venture capital. But we must make the choices *now* to invest in the American people, the emerging technologies, and the innovation infrastructure that will enable us to fuel our economic growth, solve societal challenges, and lead the world going forward. The twin coronavirus and economic crises facing our nation today provide a unique opportunity to harness the power of American innovation to not only beat the virus, but also to supercharge our economic recovery and save lives and livelihoods. "Without a renewed commitment to science and innovation," Chairman Yarmuth said, "we risk squandering our recovery and the opportunity to move our nation forward as a global force for good."