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on
"The Industries of the Future"

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Introduction

Chairman Wicker, Ranking Member Cantwell, and Members of the Committee, it is a privilege to be before you today to discuss the Industries of the Future and how basic research supported by the National Science Foundation (NSF) has not only fostered their development but will ensure American leadership into the future.

Established by the National Science Foundation Act of 1950 (P.L. 81-507), NSF is an independent Federal agency whose mission is "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF is unique in carrying out its mission by supporting fundamental research across all fields of science, technology, engineering, and mathematics (STEM), and all levels of STEM education. NSF is also committed to the development of a future-focused science and engineering workforce that draws on the talents of all Americans. NSF accounts for approximately 25 percent of the total Federal budget for basic research conducted at U.S. colleges and universities and has been vital to many discoveries that impact our daily lives and drive the economy.

A vibrant scientific workforce and breakthrough discoveries enabled by NSF investments sustain, accelerate, and transform America's globally preeminent innovation ecosystem. A long-term vision, belief in the promise of fundamental research, and commitment to pursuing risky, yet potentially extraordinary discoveries are the hallmarks of NSF. NSF's investments empower discoverers to ask the questions and develop the technologies that lead to the next big breakthroughs. Since its creation in 1950, NSF has supported 242 Nobel Laureates at some point in their careers.

This year, NSF celebrates its 70th Anniversary. In doing so, we will also celebrate the wisdom and foresight of Vannevar Bush and his colleagues, and all those in Congress and the Executive Branch who made the creation of NSF a national priority and a reality. Over the past 70 years, NSF has allowed the Nation to harness ingenuity, foster innovation, and reap the benefits of the economic growth and progress that come with doing so. In fact, many of today's industries are rooted in basic research, with companies such as Google and Qualcomm having received start-up funding from NSF. Every day, the American people benefit directly from NSF-funded advances, from the technology that powers our smartphones and the capabilities that connect them, to improved weather forecasts, to medical devices for diagnosis and rehabilitation.

Fundamental research supported by NSF and other federal agencies builds the foundation for progress. Often, this occurs over decades, where the achievements of a generation are built upon by the next. Occasionally, breakthroughs allow it to happen more rapidly. Ultimately, progress is driven by curious minds pushing the boundaries of knowledge and stretching the canvas of discovery. The United States' leadership in scientific research and development is built upon a uniquely American system where sustained investment in fundamental research is paired with a strong partnership among government, academia, and industry. This public-private partnership has allowed the United States to be the world leader in discovery and innovation for decades and will propel American leadership into the future. Fields such as artificial intelligence (AI) and quantum information science (QIS) hold the promise of unparalleled job growth, continued prosperity, and strengthened homeland and national security. A strong and sustained commitment to this American system of innovation through basic research will be crucial as we compete for preeminence in these and other fields.

NSF and the Industries of the Future

Since its creation, NSF has been the foundation for tomorrow's industries of the future. NSF's mission is to stay at the forefront of science – to fund the high-risk, high-reward research that has the potential to bring the world new discoveries. NSF funds thousands of researchers each year to build the base of human knowledge and in doing so, their work results in innovations in all aspects of our daily lives. They have revolutionized our wireless networks, developed life-saving medical diagnostics, ushered in the age of autonomous vehicles and 3D printing, and brought digital agriculture to our farmers. To catalyze research around some of the most challenging and promising areas of scientific research, NSF has established a set of Big Ideas that range from predicting how an organism will develop observable characteristics to understanding the origins of the universe. The Big Ideas will play significant roles in not only advancing AI, QIS, and other potential industries of the future, but in identifying the yet unknown transformative technologies that will emanate from today's investments in basic research.

The Administration's emphasis on AI, QIS, advanced manufacturing, advanced wireless, and biotechnology as today's Industries of the Future is not only critical to ensuing American scientific leadership in the decades to come, it is also central to our long-term economic success and national security. NSF and our fellow agencies, including the National Institute of Standards and Technology (NIST), the Defense Advanced Research Projects Agency (DARPA), and the Department of Energy have been working closely with the Office of Science and Technology Policy (OSTP) in the White House to coordinate our efforts and collaborate extensively in each of these areas of research and development.

Artificial Intelligence

Artificial intelligence is advancing rapidly and holds the potential to vastly transform our lives. NSF invests nearly $500 million annually in AI research – the largest non-defense federal investment – supporting exploration in machine learning, natural language processing, knowledge representation and reasoning, and computer vision, along with the safety, security, robustness, and explainability of AI systems. In addition to foundational research in these areas, a key to harnessing the promise of AI is translational research that links AI and economic sectors such as agriculture, manufacturing, transportation, and personalized medicine. Equally important is the investment in education and learning, including growing the human capital and institutional capacity needed to nurture the next generation of AI researchers and practitioners.

NSF has a long and rich history of supporting transformative research in AI and machine learning, along with the closely related areas of robotics and data science. Through collaboration and coordination with OSTP, NSF leadership is helping to drive and coordinate AI research and development efforts across the federal government. As NSF Director, I co-chair the National Science and Technology Council's (NSTC) Select Committee on AI, which advises the White House on interagency AI research and development priorities and establishes structures to improve government planning and coordination.

NSF's ability to bring together numerous fields of scientific inquiry —from computer information science to engineering and economics — uniquely positions the agency to lead the nation in expanding the frontiers of AI. That is why NSF has embarked upon an effort to establish National Artificial Intelligence Research Institutes. With NSTC coordination, NSF is partnering with four other federal agencies representing key sectors at the intersection of AI and our nation's economy. The U.S. Department of Agriculture's National Institute of Food and Agriculture, the U.S. Department of Homeland Security's Science & Technology Directorate, the U.S. Department of Transportation's Federal Highway Administration, and the U.S. Department of Veterans Affairs have all joined NSF in this important initiative. NSF anticipates an investment of approximately $200 million over the next six years in these AI Institutes. We are launching this effort this fiscal year and plan to support up to six multidisciplinary, multi-institutional research institutes that will serve as national hubs for universities, federal agencies, industry, and nonprofits to advance AI research and workforce development in key areas while addressing grand challenges. While this year's effort is a collaboration among federal agencies, NSF anticipates engaging other stakeholders in the future, including via private-public partnerships and expanding the topic areas supported.

AI technologies also pose potential challenges, such as the possibility of jobs lost to automation, new security threats, and the potential for algorithmic biases. NSF's Big Idea on The Future of Work at the Human-Technology Frontier (FW-HTF) is one mechanism by which NSF is responding to these challenges while enhancing opportunities for the future of jobs and work. Specifically, the FW-HTF Big Idea will advance our understanding of how technology and people interact, distribute tasks, cooperate, and complement each other in different specific work contexts. We have also developed initiatives with industry to address potential biases in AI systems with the goal of contributing to trustworthy AI systems that are readily accepted and deployed to tackle grand challenges facing society.

The possibilities for implementing AI and improving lives are boundless. For example, NSF-funded researchers at Mississippi State University and Indiana University are working with patients and clinicians in the design of a socially assistive robot to aid in the treatment of depression. NSF-funded researchers at the University of Colorado are examining how augmented reality and AI can enable more efficient, safe, and high-quality construction, which accounts for a significant portion of the U.S. economy. Finally, a large, multi-institutional team of researchers funded by NSF and led by Cornell University is using AI algorithms to devise sustainable solutions to environmental, societal, and economic challenges, from creating new materials for solar panels and fuel cells to designing farm irrigation strategies that simultaneously increase yields, reduce water use, and benefit migrating waterfowl.

Quantum Information Science

Research in QIS examines uniquely quantum phenomena that can be harnessed to advance information processing, transmission, measurement, and fundamental understanding in ways that classical approaches can only do much less efficiently, or not at all. NSF-supported quantum projects are opening new opportunities in the QIS arena, such as new materials, circuits, and algorithms that enable powerful computers, incredibly precise sensors and detectors, and secure digital communications.

As with AI, NSF has a long history of investment in QIS research, with NSF-funded researchers paving the way for modern-day technologies and positioning the country for major breakthroughs. This was most recently highlighted in October 2019, when Google announced that a quantum computer had accomplished a task not yet possible on a classical device. When verified, this may prove to be a milestone moment, one that builds on more than three decades of continuous NSF investment in the fundamental physics, computer science, materials science, and engineering that underlies many of today's quantum computing developments – and NSF has supported the researchers behind them, including five of the co-authors who helped create Google's system.

NSF’s Quantum Leap (QL) Big Idea builds upon and extends our existing knowledge of the quantum world to observe, manipulate, and control the behavior of particles at atomic and subatomic scales. The Quantum Leap will enable discoveries in both naturally-occurring and engineered quantum systems and will develop next-generation quantum technologies and devices for sensing, information processing, communications, and computing. NSF’s investment in the QL Big Idea is strongly aligned with Administration priorities and the National Quantum Initiative Act and will consolidate and expand the United States’ world-leading position in fundamental quantum research while delivering proof-of-concept devices, applications, tools, and systems with a demonstrable advantage over their classical counterparts.

Under the umbrella of the QL Big Idea, NSF has several programs focused on harnessing the intellectual power of the United States to unleash the potential of the nation’s quantum-based scientific enterprise and to enhance the Nation’s well-being, economy, and security. For example, The Quantum Idea Incubator for Transformational Advances in Quantum Systems (QII-TAQS) program supports interdisciplinary teams exploring innovative, original ideas in quantum science and engineering. These projects cover a broad spectrum of scientific and engineering approaches and have the potential to deliver new concepts, new platforms, and/or new approaches that will accelerate the development and application of quantum technologies. In FY 2019, NSF made nineteen QII-TAQS awards. These pioneering projects focus on quantum functionality and aim to make transformative advances towards quantum systems through experimental demonstrations and proof-of-concept validations. For example, a transdisciplinary team of researchers from the University of Massachusetts are designing and fabricating new quantum systems where the quantum states are resilient to changes in the local environments, advancing us closer to the reality of a quantum computer. As with this award, our Quantum Idea Incubator program aims to facilitate the process of translating such ideas into reality, fostering breakthroughs in quantum sensing, quantum communications, quantum simulations, and quantum computing systems.

NSF is also embarking on center-scale research in QIS. In 2019, NSF awarded the first grants towards establishing Quantum Leap Challenge Institutes (QLCI). The first phase was a call for proposals to support the formation of broadly convergent research teams with each developing a compelling and comprehensive vision for a Challenge Institute. A total of 18 such awards were made. The second phase of this process, the submission of full Institute proposals, is ongoing, with the first anticipated awards in FY 2020. These Institutes will be large-scale interdisciplinary research projects that aim to advance the frontiers of quantum information science and engineering. Research at these Institutes will span the focus areas of quantum computation, quantum communication, quantum simulation and/or quantum sensing. The Institutes are expected to foster multidisciplinary approaches to specific scientific, technological, and educational workforce development goals in these fields.

Advanced Wireless

Working with other federal partners, including the Federal Communications Commission and NIST, and in collaboration with industry partners, NSF supports fundamental research on advanced wireless technology and is engaged in the overall 5G effort led by Director Larry Kudlow of the National Economic Council. NSF has a proven track record of investment in fundamental research on wireless technologies. For example, today's fifth-generation ("5G") wireless networks have been enabled by NSF's seminal investments in ground-breaking millimeter-wave research dating back to 2004. Looking forward, NSF-supported research will innovate in areas critical to future generations of wireless networks, such as wireless devices, circuits, protocols, and systems; mobile edge computing; distributed machine learning and inference on mobile devices; and dynamic spectrum allocation and sharing. This work will offer new insights capable of making wireless communication faster, smarter, more responsive, and more robust – with profound implications for science and society. NSF's leadership in wireless research has three intertwined components:

- Supporting fundamental research enabling advanced wireless technologies;
- Establishing advanced wireless research testing platforms, in collaboration with industry, to experiment with new approaches at scale; and
- Catalyzing academic, industry, and community leaders to work together to prototype innovative wireless approaches to address societal challenges.

An example of this convergent approach to advanced wireless research is NSF's Platforms for Advanced Wireless Research (PAWR) program, a $100 million public-private partnership comprising $50 million of NSF investment paired with $50 million in cash and in-kind contributions from a wireless consortium of more than 30 companies and associations. PAWR platforms in Salt Lake City, New York City, and North Carolina's Research Triangle are helping to build core wireless capabilities through creative university partnerships, attracting government and corporate research funding as well as local wireless jobs, and utilizing advanced wireless capabilities to enhance city services and economic development. For example, in North Carolina, the NSF-funded PAWR platform will enable research on how to accelerate the integration of unmanned aircraft systems into the national air-space, as well as how to enable new advanced wireless features such as flying base stations for hot spot wireless connectivity.

NSF also recognizes that access to spectrum is crucial to the continued development of wireless systems that can meet the requirements of future technologies and applications in a secure manner. In October, NSF launched a new program on Machine Learning for Wireless Networking Systems (MLWiNS) in partnership with Intel Corporation to accelerate fundamental, broad-based research on wireless-specific machine learning techniques. This program will support new wireless system and architecture designs that can dynamically access shared spectrum, efficiently operate with limited radio and network resources, and scale to address the diverse and stringent quality-of-service requirements of future wireless applications. For example, MLWiNS projects may pursue novel methods to support coexistence between commercial (e.g., cellular, Wi-Fi), federal (e.g., U.S. Navy radar), and astronomical (e.g., passive radio astronomy observations) users of spectrum. In addition, earlier this month, NSF released a new solicitation for Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT). The SWIFT program focuses on effective spectrum utilization and coexistence technologies, which will become more critical as the demands of advanced wireless techniques on a finite spectrum continue to increase.

Just as today’s wireless systems have made significant advances possible, research in advanced wireless promises to do the same. For the sciences, advanced wireless can improve the flow and latency of data and create new possibilities for conducting research. Advanced wireless also holds the promise of continuing the economic growth we have seen in the mobile, e-commerce, digital agriculture, and other sectors of the economy. The ability to communicate is central to human society, and NSF-supported researchers are at the forefront of bringing even greater advances to the American people.

Biotechnology

Over billions of years, life has evolved a vast diversity of innovations - solutions to overcome environmental challenges. Until recently, our ability to understand and exploit these innovations has been limited. But new capabilities to read and edit genomes, new means of sensing biological processes at multiple scales, and new computational and AI approaches in bioinformatics and modeling have vastly improved our ability to understand life’s deepest mysteries. NSF investments in genomics, cellular, organismal, and developmental biology, and in bioinformatics spur advances in synthetic biology and enhance biotechnology beyond the current state-of-the-art. The accelerating power of this biotechnology promises to sustain U.S. economic growth and innovation across multiple sectors that together constitute the bioeconomy.

Biotechnology and synthetic biology are producing extremely fast economic growth and hold immense potential for transformative change across many commercial sectors. Advances in these fields are leading to novel bio-materials; transforming the food, agriculture, and pharmaceutical industries; enabling new capabilities for information storage and renewable energy; and creating new kinds of targeted medical therapies. These bio-industries are driven by fundamental science in biology, which aims to understand and predict the function of living systems, design complex biological systems for useful function, and achieve convergence of insight from engineering, biology, chemistry, physics, and ethics.

To sustain and expand the bioeconomy, we must invest in fundamental research to reveal the underlying basis for the diversity of life's innovations. For example, while we have the capability to sequence the genome of any organism, we do not understand the function of 80% of that sequence for even the best studied species. Advancing our understanding of this unknown code is likely key to predicting genome regulation, which is necessary if we are to open up new opportunities in bio-manufacturing, medicine and agriculture. Further, we have explored the genomic basis for key innovations in only a tiny fraction of species. There is an incredible wealth of biological innovation yet to be discovered and tapped for applications. Finally, a key to rapid discovery is facilitating open and efficient access to bio-data and the bioinformatic tools and cyberinfrastructure necessary to retrieve and analyze big data sets.

NSF has current initiatives to address scientific challenges and foster new applications that will accelerate the U.S. bioeconomy. With a new suite of investments within the Understanding the Rules of Life Big Idea, NSF-funded research seeks to develop a predictive understanding of biological systems at all scales. This knowledge is what drives advances in understanding the human body and improving health, and will permit sustainable, efficient food production. Likewise, biological principles and biomaterials can drive next-generation information storage technologies that will be the basis for future devices and systems in AI, QIS, Advanced Manufacturing, and Advanced Wireless. NSF's Semiconductor Synthetic Biology for Information Storage and Retrieval (SemiSynBio) program is supporting work on future bio-based microelectronics. These and other NSF investments will enable us to harness biological systems and construction of synthetic living systems to foster completely new technologies and bio-based manufacturing.

In addition, to accelerate the adoption biotechnology products and ensure their socially responsible use, NSF supports research on ethical questions and impacts arising from innovative new technologies and their integration into society. For example, NSF's Science and Technology Studies program and Ethical and Responsible Research program fund workshops and studies investing in a range of topics, from societal and social justice issues in synthetic biology to ethics and responsible innovation in genome engineering. NSF is also investing in predictive modeling that is critical to measuring environmental risks related to genomic manipulation of organisms and to aspects of biosecurity.

Advanced Manufacturing

NSF has played a leading role in fostering the development of advanced manufacturing and making revolutionary processes like 3D printing a reality. NSF's Advanced Manufacturing program continues to support the fundamental research needed to revitalize American manufacturing to grow the economy and the workforce, and to reshape our strategic industries. NSF research accelerates advances in manufacturing technologies with an emphasis on multidisciplinary research that fundamentally alters and transforms manufacturing capabilities, methods, and practices.

We are currently entering the 4th industrial revolution, where computing and networking are integrated into factory floor operations to improve productivity and quality while reducing cost.

NSF-funded research on model-based smart manufacturing is transforming static manufacturing systems into adaptive, "smart" systems, powered by artificial intelligence, that can sense and adapt to changing environments, and optimize performance. These smart systems can schedule required maintenance of machines in a predictive fashion, reducing downtime due to unexpected failures, and react to changing plans when new products are introduced into the factory.

NSF's investments touch on numerous aspects of advanced manufacturing. Cyber-manufacturing advances will enable small-scale producers to cooperate with large-volume factories, leveraging high-throughput and high-quality production lines. Novel sensing systems such as laser scanners and computer vision can be integrated into factory floors to improve production quality, detecting potential failures in-line and thereby reducing scrap. Advanced semiconductor, quantum, and optical device design, fabrication and processing will be used for applications in biomedical, alternative energy, communications, computing, and sensing systems.

Through our Engineering Research Centers (ERC), NSF supports collaboration among researchers in different scientific disciplines and partnerships between industry and universities. These collaborations produce both technological innovations that strengthen the competitive position of industry and engineering graduates who will be creative innovators in a global economy. For example, the Cell Manufacturing Technologies ERC at the Georgia Institute of Technology (in partnership with the University of Georgia, the University of Wisconsin-Madison, and the University of Puerto Rico) enables robust, scalable, low-cost biomanufacturing of high-quality therapeutic cells to bring affordable, curative therapies for incurable chronic diseases. And the Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies ERC at the University of Texas at Austin (in partnership with the University of New Mexico and the University of California, Berkeley) is exploring manufacturing processes to revolutionize future-generation mobile computing and energy devices.

The Industry-University Cooperative Research Centers (IUCRC) program also enables university researchers to collaborate with industry partners to conduct use-inspired research. For example, the Center for Advanced Design and Manufacturing of Integrated Microfluidics (CADMIM), which is currently composed of sites at the University of California, Irvine and the University of Illinois at Chicago is developing low-power, automated, self-contained, mass-produced microdevices capable of multi-step biochemical assessments. CADMIM's research will support the development of diagnostics critically needed for the environment, food supply, and medical situations enabling these diagnostics to be done inexpensively, quickly, and accurately on the spot.

The US government has also made significant investments in the Manufacturing USA institutes. NSF participates in all these institutes, inviting our researchers to propose projects that could result in industrial implementation. All these institutes also have significant investments in workforce development, which complements NSF's program in Advanced Technological Education (ATE). The ATE Center for Advanced Automotive Technology in Macomb, Michigan, which helps train workers for the auto industry, is a prime example of how coupling industries with local workforce development benefits communities, industry, and the nation.

NSF's investments in advanced manufacturing, including the integration of data science, AI, robotics, and cybersecurity into modern manufacturing systems, will increase the efficiency and sustainability of the production of the next generation of products and services across nearly every sector of the economy. These developments will yield advantages such as reduced time to market, new performance attributes, improved small-batch production, cost savings, energy savings, and reduced environmental impact.

Training the Next Generation Workforce

For the United States to continue global leadership in these and other areas, we must also develop the next generation of the STEM workforce. Our future depends on our investment in inclusion, in diversity, in training of STEM teachers, and in inspiring the next generations through formal and informal learning. Continued global leadership also requires investment in the next generation of scientists trained to pursue questions beyond the traditional scientific disciplines. NSF is investing in education research across all levels of learning – from preK-12 through graduate education and beyond – which then informs education and training programs to better develop skill sets in cutting-edge technologies, promote highly collaborative team science, and foster greater diversity in the workforce. Programs such as Computer Science for All (CSforAll), Discovery Research K-12, and Research Assistantships for High School Students (RAHSS) train the next generation of researchers to be nimble, multifaceted scientists with the ability to harness the tools of innovation across multiple fields.

NSF prepares K-12 students for the industries of the future through its education research and development programs such as Innovative Technology Experiences for Students and Teachers (ITEST). Early, positive engagement in STEM is very important for students to pursue fields such as computer science and ultimately be prepared for technological jobs. Through the ITEST program, researchers at the University of Washington are examining how stereotypes influence 8-12-year-old girls' motivation to study computer science. These researchers are comparing interest stereotypes – stereotypes about whether girls or boys like computer science more – to ability stereotypes – stereotypes about whether girls or boys have higher aptitudes in computer science. The results of their research will lay the groundwork for future interventions that directly target interest stereotypes to boost girls' motivation to pursue computer science education and technological jobs that will be in high demand.

Broadening participation in STEM fields to ensure a diverse pool of future STEM degree holders is a major priority for NSF. The INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science) Big Idea is a comprehensive national initiative designed to catalyze the STEM enterprise to collaboratively work for inclusive change, resulting in a STEM workforce that reflects the population of the Nation. In doing so, we will enhance U.S. leadership in STEM discoveries and innovations by drawing youth from every part of the country into the STEM fields.

Conclusion

The Industries of the Future are cross-cutting, convergent, and interdependent fields of research that collectively offer enormous economic potential and are critical to the Nation's long-term economic and national security. We cannot focus on dominance in only one area, as advances across the spectrum of the science and engineering disciplines are needed to harness the potential of these promising fields. Just as our ability to advance machine learning across sectors of the economy will be improved by advances in quantum computing, the biotechnology economy will be buoyed by breakthroughs in advanced manufacturing. Advanced wireless capabilities hold the potential to improve how we collect, transmit, and analyze data across all fields of science, and how we integrate new technologies and advances across industries and throughout our communities. Finally, we must also ensure that we support the socio-economic research needed to understand how humans interact with and are impacted by these advanced systems.

NSF has also put an emphasis on supporting researchers as entrepreneurs, and to take their ideas to the marketplace. NSF's I-Corps program provides entrepreneurial education that equips scientists with the tools needed to transform research and discoveries into innovative technologies. The Small Business Innovation Research (SBIR) program helps startups develop their ideas and bring them to market. From 2007 to 2016, NSF's SBIR program funded roughly 400 companies each year. Any one of these companies could be the next groundbreaker to usher in a new era of advancement.

Just as the convergence of the NSF-funded page-rank algorithm, wireless devices, touchscreen interfaces, and other innovations catalyzed unanticipated industries and U.S. dominance in mobility and e-commerce, there is similar opportunity for advances at the intersection of Al, QIS, Advanced Wireless, Advanced Manufacturing, and Biotechnologies to lead to revolutionary new industries of the future.

Thank you for the opportunity to testify before you today. With the support of this Committee and the Congress, NSF will continue to invest in the fundamental research and the talented people who improve our daily lives and transform our future.

France A. Córdova
Biography

The Honorable France A. Córdova is an astrophysicist and the 14th director of the National Science Foundation (NSF). Córdova was nominated to this position by the President of the United States in 2013 and subsequently confirmed by the U.S. Senate. NSF is a $8.3B independent federal agency; it is the only government agency charged with advancing all fields of scientific discovery, technological innovation, STEM education, and STEM workforce development.

Córdova has been a leader in science, engineering and education for more than three decades. She has a distinguished career in both higher education and government; her contributions in multi-spectrum research on x-ray and gamma ray sources and space-borne instrumentation have made her an internationally recognized astrophysicist.

She is the only woman to serve as president of Purdue University, where she led the university to record levels of research funding, reputational rankings, and student retention and graduation rates. She focused her tenure on launching tomorrow's leaders, translating research to application and meeting global challenges. She established a new College of Health and Human Sciences at Purdue, as well as a new Global Research Policy Institute, and participated in state-wide initiatives to boost public-private research collaborations.

Córdova is also chancellor emerita of the University of California, Riverside, where she was a distinguished professor of physics and astronomy. There she laid the foundation for a new medical school, California's first public medical school in over 40 years, and focused on student diversity and inclusion. At the University of California, Santa Barbara, where Córdova was vice chancellor for research and professor of physics, she led a campus-wide effort to support convergence in blue-sky research areas.

Previously, Córdova served as NASA's chief scientist, representing NASA to the larger scientific community and infusing the activities of the agency -- including the International Space Station, then under construction -- with the scientific goals of the broader community. She was the youngest person and first woman to serve as NASA's chief scientist and was awarded the agency's highest honor, the Distinguished Service Medal.

Prior to joining NASA, she was on the faculty of the Pennsylvania State University where she headed the department of astronomy and astrophysics. Córdova was also deputy group leader in the Earth and space sciences division at Los Alamos National Laboratory. She received her Bachelor of Arts degree from Stanford University and her doctorate in physics from the California Institute of Technology.

More recently, Córdova served as chair of the Board of Regents of the Smithsonian Institution and on the board of trustees of Mayo Clinic. She also served as a member of the National Science Board (NSB), where she chaired the Committee on Strategy and Budget. As NSF director, she is an ex officio member of the NSB.

Córdova's scientific contributions have been in the areas of observational and experimental astrophysics, multi-spectral research on x-ray and gamma ray sources and space-borne instrumentation. She has published more than 150 scientific papers. She was co-principal investigator for a telescope experiment that is currently flying on the satellite XMM-Newton, a cornerstone mission of the European Space Agency.

For her scientific contributions, Córdova has been awarded several honorary doctorates, including ones from Purdue, Duke and Dartmouth Universities. She was honored as a Kilby Laureate, recognized for "significant contributions to society through science, technology, innovation, invention and education." Córdova was elected to the American Academy of Arts and Sciences and is a National Associate of the National Academies and an Honorary Member of the Royal Irish Academy. She is also a fellow of the American Association for the Advancement of Science (AAAS) and the Association for Women in Science (AWIS).

Córdova is married to Christian J. Foster, a science educator, and they have two adult children and a grandchild.