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

HEARING CHARTER

"*The State of U.S. Science and Technology: Ensuring U.S. Global Leadership*"

Wednesday, February 5, 2025
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

On Wednesday, February 5, 2025, the House Science, Space, and Technology Committee will hold a hearing to assess the current condition of the United States's science and technology enterprise and its vital role in the global innovation race. By examining the United States' public and private investments, the Committee will also have the opportunity to discuss key objectives and strategies for maintaining U.S. leadership in driving future advancements.

- **The Honorable Heather Wilson**, President, University of Texas El Paso, former Secretary of the United States Air Force
- **The Honorable Walter Copan**, Vice President for Research and Technology Transfer, Colorado School of Mines, former Director of the National Institute of Standards and Technology
- **Dr. Sudip Parikh**, Chief Executive Officer and Executive Publisher, American Association for the Advancement of Science
- **Mr. Samuel Hammond**, Chief Economist, Foundation for American Innovation

Overarching Questions

- What is the current state of U.S. leadership in science and technology (S&T), and what is the outlook for continued leadership, particularly in areas of S&T that will help drive economic competitiveness and national security in the coming decade?
- Why is it important for the U.S. to maintain leading capabilities in both fundamental research and technology development and what are the consequences of loss of leadership, especially to China?
- What makes the U.S. S&T ecosystem of government, academia and industry unique in the world, and how can we continue to use that system to our competitive advantage?
- How has the relationship between the federal government and private industry for supporting science and technology changed in the last decade? How should we look to improve this cooperation in the future?

U.S. RESEARCH & INNOVATION LANDSCAPE

Background

Since the 18th century, the relationship in the United States between science, technology, research and development has been a close one, as Americans created a decentralized system for the advancement of scientific innovation by combining federal government backing of basic research with university and privately funded research. For decades, that system has helped America lead the world in science and technology innovation, driving economic growth, addressing national priorities, and improving the health and quality of life.

A primary driver of future economic growth and job creation will be innovation that is made possible through advances in science and engineering.[1] Scientific discovery has also allowed the U.S. to maintain a strategic military advantages. The U.S. investment in research and innovation allowed the U.S. to become the strongest economy in the world.[2] The federal government supports scientific and technological advancement directly by funding and performing R&D and indirectly by creating and maintaining policies that encourage private sector efforts.

Research is generally categorized as either "basic" or "applied," with the former seeking to produce new knowledge without any specific application in mind, and the latter focusing on addressing a more specific problem or need. According to the American Academy of Arts and Sciences, basic research lies behind every new product brought to market, every new medical device or drug, every new defense and space technology, and many innovative business practices.[3]

U.S. R&D Expenditures

The most recent estimate of total U.S. research and development (R&D) spending was $885.6 billion in 2022,[4] an amount greater than any other country and more than a third of the global total. In 2022, basic research activities comprised $129.4 billion (15%) of the total of U.S. R&D expenditures, whereas $159.9 billion (18%) and $596.2 billion (67%) was spent on applied research and experimental development, respectively.[5] While the private sector funds and performs the majority of U.S. R&D since 1980, the Federal government has been the leading source of support for basic research, often funding R&D in areas that industry lacks strong incentives to fund as well as areas of critical importance to national security. In 2022 the federal government funded 40 percent of domestic basic research while private industry accounted for 37 percent.[6] The remainder of R&D funding comes from state and local governments, foundations, nonprofit organizations, and universities' institutional funds.

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[1] Vest, C.M., 2010, *Rising Above the Gathering Storm Revisited: Rapidly Approaching Category 5*, National Academy of Sciences at https://www.nap.edu/read/12999/chapter/2

[2] Tripp, Simon, 2013, *The Impact of Genomics on the U.S. Economy*, Batelle Memorial Institute, at https://www.unitedformedicalresearch.org/wp-content/uploads/2013/06/The-Impact-of-Genomics-on-the-US-Economy.pdf

[3] Restoring the Foundation: The Vital Role of Research in Preserving the American Dream. (n.d.). Retrieved from https://www.amacad.org/sites/default/files/publication/downloads/AmericanAcad_RestoringtheFoundation.pdf

[4] National Science Board, National Science Foundation. 2024. *Science and Engineering Indicators 2024: The State of U.S. Science and Engineering*. NSB-2024-3. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb20243.

[5] National Science Board, National Science Foundation. 2024. Research and Development: U.S. Trends and International Comparisons. *Science and Engineering Indicators 2024*. NSB-2024-6. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb20246/.

[6] *Id.*

The business sector has accounted for most of the growth in total U.S. R&D over the last decade. According to the National Center for Science and Engineering Statistics (NCSES) at the National Science Foundation (NSF), in 2010, businesses invested $248 billion in R&D, compared to $127 billion by the Federal government. In 2019, these numbers rose to $673 billion and $160 billion, respectively, which means the business sector now accounts for 78 percent of all U.S. R&D.[7]

Global R&D Expenditures and U.S. Competitiveness

The global total of R&D expenditures continues to rise at a substantial pace. The NCSES's latest estimate puts the worldwide total at $2.6 trillion (current purchasing power parity dollars) in 2021.[8] In 2018, the global total expenditure was $2.1 trillion, up from an estimated $1.416 trillion in 2010, $722 billion in 2000. This threefold expansion over 25 years reflects, in part, the escalating knowledge intensity of economic competition among the world's nations—as well their individual desires to harness advances in science and technology to improve their own economies and indicators of their societal well-being.[9] Asian countries, most notably China, have heavily contributed to the overall increase in worldwide R&D expenditures – a notable shift in the global concentration of R&D performance from the United States and Europe to East-Southeast Asia and South Asia.[10]

While the U.S. remains the largest R&D performer, its share of global R&D has declined substantially. From 1960 to 2020, the U.S. share of global R&D fell from 69 percent to 31 percent.[11] This decline resulted from rapid growth in public and private R&D spending by other nations, even as U.S. R&D expenditures since 1960 have grown more than 37 times in current dollars. However, China has rapidly become the second largest R&D performer, accounting for 24.8 percent of global R&D in 2020, up from 4.9 percent in 2000.[12]

China poses an especially formidable and growing strategic challenge. The Chinese Communist Party (CCP) has exhibited dramatic growth in its investment in R&D in the last two decades, including a 14 percent increase from 2020 to 2021.[13] The CCP is pursuing aggressive plans to dominate the next generation of technology. National policies—such as the Made in China 2025 Plan, the Thousand Talents Plan and it's offshoots—are concerted efforts to cultivate indigenous technological innovation, backed by commitments for hundreds of billions of dollars in investment. According to the Australian Strategic Policy Institute (ASPI) Critical Technology Tracker, China's global lead extends to 37 out of the 44 technologies that it is now tracking, covering a range of crucial technology fields spanning defense, space, robotics, energy, the environment, biotechnology, artificial intelligence (AI), advanced materials and key quantum technology areas.[14]

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[7] *Id.*
[8] *Id.*
[9] National Science Board, National Science Foundation. 2020. *Science and Engineering Indicators 2020: The State of U.S. Science and Engineering*. NSB-2020-1. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb20201/.
[10] National Science Board, National Science Foundation. 2022. *Science and Engineering Indicators 2022: The State of U.S. Science and Engineering*. NSB-2022-1. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb20221
[11] U.S. Congressional Research Service, (2022, September 14). *Global Research and Development Expenditures: Fact Sheet*. (CRS Report No. R44283). https://crsreports.congress.gov/product/pdf/R/R44283.
[12] *Id.*
[13] National Science Board, National Science Foundation. 2024. *Research and Development: U.S. Trends and International Comparisons. Science and Engineering Indicators 2024*. NSB-2024-6. Alexandria, VA. Available at https://ncses.nsf.gov/ pubs/nsb20246/.
[14] Jennifer Wong Leung, Stephan Robin, Danielle Cave, *ASPI's two-decade Critical Technology Tracker: The rewards of long-term research investment*, ASPI, Canberra, August 2024. https://www.aspi.org.au/report/critical-technology-tracker

However, the R&D priorities of the U.S. and the CCP are very different. In 2021, the United States spent 15 percent of total R&D expenditures on basic research compared to only 6.5 percent in China.[15] The CCP is much more focused on experimental development R&D which accounts for 83 percent of their domestic expenditure compared to only 66 percent in the United States.[16] This focus on technology development resulted in China surpassing the U.S. in 2011 to lead in knowledge- and technology-intensive manufacturing output.[17]

Federally Funded Research and Development Centers (FFRDCs)

FFRDCs, which includes the Department of Energy National Laboratories and the National Aeronautics and Space Administration's Jet Propulsion Laboratory (JPL), play an important role in our R&D enterprise, supporting large-scale, long-term R&D, including through the construction of major user facilities in key technology areas, including computing, aerospace, and biotechnology. The work conducted at the FFRDCs covers a wide spectrum of applications as well, from truly open basic research to highly classified national security projects. Some of the fastest supercomputers in the world are housed in the DOE National Laboratory Complex, providing insight into some of today's most pressing scientific questions. The missions and instruments built or managed by JPL have visited every planet in our solar system and the sun. FFRDCs are privately operated R&D organizations that are exclusively or substantially funded by the federal government. In FY 2023, the federal government funded $29.3 billion (98.5%) of R&D expenditures across 42 FFRDCs.[18] Because they are distributed across the country, including states and regions that are generally not among the highest in research and innovation capacity, they also serve an important role in local economic development and in providing STEM education and research experiences to students who might otherwise not have such access.

University R&D Investment

The United States has long been home to many of the world's leading research institutions. In FY 2023, U.S. universities performed a total of $108.8 billion in R&D from all sources, including $59.6 billion in Federally funded R&D.[19] Other sources of funding include institutional funds, industry, and foundations. University research advances foundational knowledge in science and technology. Universities are also the source of thousands of spin-off companies that contribute to regional economic development and job creation, thanks in large part to the Bayh-Dole Act. The Bayh-Dole Act established a uniform federal patent policy that allows funding recipients, such as Universities, to retain patent rights on inventions made with federal funding, subject to certain conditions.[20]. As of 2022, the Act had led to over $1.3 trillion in U.S. economic growth, created more than 4.2 million jobs across the country, and contributed to the success of over 11,000 new startup companies from universities throughout America[21].

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[15] OECD, *Gross domestic expenditure on R&D by sector of performance and type of R&D*, accessed January 23, 2025, https://data-viewer.oecd.org?chartId=3e75bc68-ab48-4cf5-9cb1-53144f8deb7e.
[16] *Id.*
[17] National Science Board, National Science Foundation. 2022. Science and Engineering Indicators 2022: The State of U.S. Science and Engineering. NSB-2022-1. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb20221.
[18] Gibbons MT; National Center for Science and Engineering Statistics (NCSES). 2024. *Federally Funded R&D Centers Report 13% Increase in R&D Spending in FY 2023.* NSF 22-330. Alexandria, VA: National Science Foundation. Available at https://ncses.nsf.gov/pubs/nsf24330.
[19] Gibbons, MT; National Center for Science and Engineering Statistics (NCSES). 2024. *Higher Education R&D Expenditures Increased 11.2%, Exceeded $108 Billion in FY 2023*. NSF 25-313. Alexandria, VA: U.S. National Science Foundation. Available at https://ncses.nsf.gov/pubs/nsf25313.
[20] Patent and Trademark Act Amendments of 1980 (P.L. 96-517)
[21] Gabrielle Athanasia, CSIS. (2022, January 12). *The Legacy of Bayh-Dole's Success on U.S. Global Competitiveness Today. Available at: https://www.csis.org/blogs/perspectives-innovation/legacy-bayh-doles-success-us-global-competitiveness-today*.

Public-Private Partnerships

There are many partnerships between the government (including national labs), universities, and the private sector, and the Committee on Science, Space and Technology often explores the nature of those partnership models - what works, what can be expanded, and what new models may be viable. Such partnerships require sustained commitment by all parties and new ways of partnering as new challenges and opportunities arise. As Congress looks to support and invest in public-private partnerships, it will also need to examine how it can reduce regulatory red tape and reform tax policy and intellectual property laws to encourage technological advancements and increase America's return on investment.

Beyond the overall investment figures, key policy issues and challenges present barriers to capitalizing on R&D expenditures. According to the American Academy of Arts and Sciences, the pace of American innovation–translation of discoveries and inventions from laboratory research to products must accelerate in order for the U.S. to remain competitive[22]. Closer cooperation among industry, government, and academia could increase technology transfer, stimulate innovation, lead to new products and processes, and expand markets.[23]

U.S. STEM Workforce

Since World War II, the United States has benefitted from the social, economic, health, and military advances made possible, in part, by a highly skilled STEM workforce. Today, a wide range of U.S. occupations in STEM and non-STEM fields either requires or benefits from workers with STEM skills and knowledge. Science and technology skills will continue to be as important in the future as they were in the past, if not more so. As such, widespread STEM literacy, as well as specific STEM expertise, is critical human capital competencies for the 21st century. The COVID-19 pandemic led to serious disruptions in student learning across the United States, leading to a decline in average math scores for fourth and eighth graders from 2019 to 2022.[24]

To remain competitive, the U.S. needs flexible STEM-capable workers at every education level. The need for U.S. workers with STEM skills is heightened in today's global economy and is projected to increase in the future. According to the Science and Engineering Indicators Report of 2024, the STEM workforce in the United States—made up of occupations like software developers, computer system analysts, chemists, mathematicians, economists, research scientists, STEM teachers and engineers—has grown rapidly and now constitutes 24% (36.8 million) of all U.S. jobs.[25] Over half of the domestic STEM workers are members of the skilled technical workforce who use science and engineering expertise and technical knowledge but do not hold bachelor's degrees or higher.[26]

The National Science Board, in its Vision 2030 report, has concluded that to maintain its global leadership in science and technology research and development, the United States must continue to cultivate a diverse workforce by expanding domestic talent and continuing to attract and retain global talent. The pressure on the U.S. talent pipeline is heightened by the rapid increase in the CCP's STEM workforce. In 2020, the

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[22] Moore, J., & Wilson, I. (2021, January 04). *Decades of basic research paved the way for today's Covid-19 vaccines*. Retrieved February 22, 2023, from https://www.statnews.com/2021/01/05/basic-research-paved-way-for-warp-speed-covid-19-vaccines/.

[23] Congressional Research Service, RL32076, *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*, (Dec. 2012).

[24] National Science Board, National Science Foundation. 2024. Research and Development: U.S. Trends and International Comparisons. *Science and Engineering Indicators 2024*. NSB-2024-6. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb20246/.

[25] *Id.*

[26] National Science Board, National Science Foundation. 2019. *The Skilled Technical Workforce: Crafting America's Science & Engineering Enterprise*. NSB-2019-23. Alexandria, VA. Available at https://www.nsf.gov/nsb/publications/2019/nsb201923.pdf.

United States awarded 900,000 science and engineering (S&E) first university degrees, similar to a bachelor's degree. In the same year, China produced 2 million S&E first university degrees,[27] growing from 359,000 degrees in 2000.[28]

In addition, it has been well documented that the CCP is making a deliberate effort to recruit top foreign talent, particularly from U.S. universities, industry and the federal government. The Department of Energy warned that talent programs were offering scientists at U.S. national labs hundreds of thousands, and in some cases millions, of dollars to conduct research in China.[29] Federal investigators identified 23 U.S. academics and dozens of industry scientist with financial ties to China.[30] The Chinese Talent Program Tracker, a project run by Georgetown University's Center for Security and Emerging Technology, estimates over 250 CCP-sponsored programs were active in 2020.[31] To address this threat, the House Science Committee worked to ensure the CHIPS and Science Act of 2022[32] included a prohibition of federal employee participation in foreign talent programs and a prohibition for all federally funded research grantees from being a member or participating in a malign foreign talent recruitment program.

NATIONAL S&T STRATEGY AND QUADRENNIAL REVIEW

The CHIPS and Science Act of 2022[33] directed the Office of Science and Technology Policy (OSTP) to develop a 4-year comprehensive national S&T strategy focused on economic security and consistent with other relevant federal strategies such as the National Defense Strategy and National Security Strategy. Additionally, the legislation requires OSTP to conduct a quadrennial review of the science and technology enterprise to examine the current S&T strategy of the U.S. including recommendations for maintaining global leadership, and guidance for coordination of assets, authorities, budgets, and policies across all federal R&D programs. Combined, these activities will provide useful context for policymakers to shape national priorities and inform the strategic framework for making federal investment decisions – a tactic that many countries already employ. A successful strategy will balance competing ideas from various stakeholders while also identifying ways to ensure buy-in from public and private entities. Both the quadrennial review and the S&T strategy will serve as a tool for furthering U.S. leadership in science and technology.

In September 2024, OSTP released a report titled "Quadrennial Science and Technology Review Report."[34] This report presents a thematic outline of the ongoing S&T efforts across the federal government. It does not include an exhaustive list of all ongoing activities in each thematic area, nor an all-encompassing list of relevant projects or programs. The report does not include any recommendations for coordination of federal agency activities.

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[27] National Science Board, *supra* note 6.
[28] Wolfe, Alexis. January 31, 2018. *Rapid Rise of China's STEM Workforce Charted by National Science Board Report.* American Institute of Physics. Available at https://ww2.aip.org/fyi/2018/rapid-rise-chinas-stem-workforce-charted-national-science-board-report.
[29] Puko, T. & O'Keefe, K. *U.S. Targets Efforts by China, Others to Recruit Government Scientists*. 2019, June 10. Available at https://www.wsj.com/articles/energy-department-bans-personnel-from-foreign-talent-recruitment-programs-11560182546.
[30] Mervis, J. *Trial of Harvard chemist poses test for U.S. government's controversial China Initiative*. Science. (2021, December 2). Available at https://www.science.org/content/article/trial-harvard-chemist-poses-test-u-s-government-s-controversial-china-initiative.
[31] Weinstein, E. November 30, 2020. "Mapping China's Sprawling Efforts to Recruit Scientists." *Defense One*. https://www.defenseone.com/ideas/2020/11/mapping-chinas-sprawling-efforts-recruit-scientists/170373/.
[32] P.L. 117-167
[33] P.L. 117-167, Sec. 10613.
[34] White House Office of Science and Technology Policy. September 2024. *Quadrennial Science and Technology Report.* Available at https://www.govinfo.gov/content/pkg/CMR-PREX23-00190980/pdf/CMR-PREX23-00190980.pdf.

CHALLENGES TO U.S. INNOVATION

Competition with China and U.S. Response

The CCP vowed to turn the nation into a self-reliant technology power.[35] China and the United States take different approaches to R&D. For instance, the CCP mandates the political and economic trajectory of the nation through the publication of Five-Year Plans. In the 14th Five Year Plan, governing 2021 to 2025, President Xi encouraged basic research and discussed the need to fortify the national innovation system.[36] The CCP's Made in China 2025 plan[37] uses government subsidies, state owned enterprises, and intellectual property acquisition to transform China into one of the most powerful high-tech and manufacturing countries in the world.[38]

This top-down policy prescription differs from the United States, which employs mostly a decentralized bottom-up approach to innovation and R&D. While the American government certainly encourages the growth and development of the national innovation system, it by no means dictates precisely how this growth should occur; rather, the federal government largely allows academia and industry to drive this development, providing funding and regulation as necessary.[39] Through this approach, the U.S. has created a S&T ecosystem that fosters innovation, risk taking, and the discovery of new ideas. But Congress must be careful to ensure the federal government's investments are appropriately crafted to meet a national purpose and do not pick winners and losers and unduly influence or inflate specific markets.

If the U.S. is to maintain its competitive edge in science and technology, the nation must coordinate across all public and private sectors to expand capacity, participation, and collaboration and allow for strategic investments in research and technology. This is a particularly urgent issue for the U.S. in emerging technology fields that will serve as the main sites for innovation and competitive advantage, and lead to unprecedented national security challenges in the 21st century.

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35 Lietzow, R., Ye, Q., and Tan, S., *A New Era of Chinese Technology and Innovation* at https://china.ucsd.edu/opinion/post/a-new-era-of-chinese-technology-and-innovation.html.

36 McDonald, J., *China's leader vow to become self-reliant technology power* at https://apnews.com/article/technology-beijing-xi-jinping-china-economy-d046181a106413621761248660d47479

37 *Made in China 2025' plan issued.* Retrieved March 31, 2021, from http://english.www.gov.cn/policies/latest_releases/2015/05/19/content_281475110703534.htm.

38 McBride, J., & Chatzky, A. *Is 'made in CHINA 2025' a threat to global trade?* Retrieved March 31, 2021, from https://www.cfr.org/backgrounder/made-china-2025-threat-global-trade.

39 *Id.*

CRITICAL TECHNOLOGIES

Artificial Intelligence (AI): AI includes technologies that allow computers and other machines to learn from experience and complete tasks that have traditionally required human intelligence or reasoning. AI could be one of the most disruptive technologies of the 21st Century and is advancing rapidly. In December 2020, Congress enacted the *National Artificial Intelligence Initiative Act*.[40] This bipartisan legislation, which was led by the House Science Committee, accelerated and coordinated Federal investments and new public-private partnerships in research, standards, and education in trustworthy artificial intelligence. In December 2020, Congress enacted the *AI in Government Act.*[41]. This legislation required the Office of Management and Budget (OMB) to provide government-wide guidance on the use of AI by agencies and their AI governance plans. Additionally, it established an AI Center of Excellence within the General Services Administration (GSA) to offer technical expertise, coordinate AI initiatives, and support agencies in implementing AI solutions. In August, *the Chips and Science Act of 2022* authorized several federal science agencies, including the Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), and the National Institute of Standards and Technology (NIST), to pursue artificial intelligence research and applications. The legislation also broadened NIST's role in AI, with provisions to create testbeds and other related initiatives.[42] In December 2022, Congress enacted the *Advancing American AI Act*.[43] This legislation required certain federal agencies to implement measures that promote the responsible acquisition and use of AI. Multiple bills have been filed to support the advancement of AI.[44,45]

Quantum Information Science (QIS): Through developments in QIS, computers can handle new workloads and solve much more difficult challenges than traditional computers. In 2018, this Committee developed, and the President signed into law, the *National Quantum Initiative Act*[46], which leverages the resources and expertise of U.S. government, industry, and academia to create a unified national quantum strategy that ensures the U.S. continues breakthroughs in QIS. Since those initial actions, Congress has continued to take an active role in structuring critical R&D programs to account for the growing role of QIS. In 2020, Congress passed the National Defense Authorization Act for Fiscal Year 2020[47], which extended QIS R&D directives to the Department of Defense and established QIS research centers to accelerate U.S. capabilities. Multiple bills were filed to prevent exports of quantum technologies to China, with a particular focus on QIS computing. In November 2023, the House introduced and marked up a reauthorization of the National Quantum Initiative Act.[48]

The country that harnesses the power of quantum technology will have a significant national security and economic advantage. The race to reach operational quantum technologies in communications, encryption, and computing will be one of the most important technological efforts of the coming decade for the U.S.

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[40] P.L. 116-283.
[41] P.L. 116-260. "Consolidated Appropriations Act, 2021," 116th Congress, December 27, 2020. Available at: https://www.govinfo.gov/app/details/PLAW-116publ260.
[42] P.L. 117-167, "Chips and Science Act," 117th Congress, August 9, 2022. Available at: https://www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf.
[43] P.L. 117-263, "National Defense Authorization Act for Fiscal Year 2023," 117th Congress, December 23, 2022. Available at: https://www.govinfo.gov/app/details/PLAW-117publ263.
[44] H.R. 5077: CREATE AI Act of 2023. 2023. Congress.gov, https://www.congress.gov/bill/118th-congress/house-bill/5077
[45] H.R. 9497: AI Advancement and Reliability Act of 2024. 2024. Congress.gov, https://www.congress.gov/bill/118th-congress/house-bill/9497
[46] P.L. 115-368.
[47] P.L. 116-92.
[48] H.R. 6213: National Quantum Initiative Reauthorization Act. 2023. Congress.gov, https://www.congress.gov/bill/118th-congress/house-bill/6213.

Advanced Manufacturing: Advanced manufacturing technologies fundamentally alter and transform manufacturing capabilities, methods and practices. These new manufacturing technologies drive U.S. competitiveness by enabling improved productivity, the development of superior products, and has led to the formation of entirely new industries.

Biotechnology (biotech): Biotechnology is a rapidly emerging field with wide-reaching applications for both commercial and military sectors, offering the potential to transform various critical industries. By advancing the understanding of natural systems, biochemistry, and genetics, and leveraging sophisticated tools to manipulate cell structures, biotechnology has led to remarkable breakthroughs. These include the development of improved medicines and therapeutics, agricultural productivity, biofuels and bioenergetic solutions, and substantial progress in material science and manufacturing techniques.

RESEARCH SECURITY

Background

Collaboration and openness have long been pillars of the U.S. scientific enterprise. Broad dissemination of research results and the free exchange of ideas fosters innovation, accelerates scientific discovery, and attracts the best and brightest from the global talent pool. However, this culture of openness presents security challenges, as other nations, notably China, have intensified efforts to acquire U.S. research and technology through both legitimate and illicit means. To maintain its competitive edge, the U.S. must balance the benefits of an open research ecosystem with responsibility to safeguard technological advancements against illegal appropriation.[49]

In recent years, several incidents have led to the concern that other countries are taking advantage of the openness of the academic research environment in the United States. [50] Threats to research security primarily arise from the failure of researchers applying for federal funding to disclose foreign affiliations, conflicts of commitments, and sources of funding that may present a conflict of interest. Because federal science agencies award research grants to institutions, not the individual researcher, institutions are primarily responsible for ensuring compliance with these policies. The academic research community has called for a coordinated and harmonized approach that balances the need to address security risks with the importance of scientific openness, international collaboration, and competing for global STEM talent.[51]Along these same lines, Congress should engage in greater scrutiny of the investments in startups with licensing agreements from technology developed with federal dollars. The lack of transparency in funding sources and the current reporting requirements could provide nefarious actors with an opportunity to steal intellectual property.[52]

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[49] Gannon, J., Meserve, R., & Zuber, M. (2025). Reconsidering Research Security. *Issues in Science and Technology*. Vol XLI, No. 2. https://issues.org/reconsidering-research-security-gannon-meserve-zuber/.
[50] JASON, The MITRE Corporation. *Fundamental Research Security*. December 2019. McLean, VA. Available at https://www.nsf.gov/news/special_reports/jasonsecurity/JSR-19-2IFundamentalResearchSecurity_12062019FINAL.pdf.
[51] Gannon *et al.* Supra note 53.
[52] *Id.*

Legislative and Executive Actions

Over the past five years, the Science, Space and Technology Committee worked to address many of these research security concerns and build a more effective and resilient R&D ecosystem. This Committee consistently strived to balance security risks and the importance of scientific openness and international collaboration. Over the last four years, through the NDAA process and the CHIPS and Science Act, Congress implemented:

- **Securing American Science and Technology Act.** The Fiscal Year 2020 NDAA included the Securing American Science and Technology Act, which established an interagency committee within the White House Office of Science and Technology Policy (OSTP) to coordinate research security across the Federal government.
  - The bill also established the National Science, Technology, and Security Roundtable at the National Academy of Sciences to facilitate collaboration between universities, federal agencies, law enforcement, and other stakeholders.
- **NSPM-33.** In response to the Securing American Science and Technology Act, the Trump Administration released National Security Presidential Memorandum-33 in January 2021 to direct a national response to safeguard the security and integrity of America's R&D enterprise. In January 2022, the Biden administration issued guidance to federal agencies for implementing NSPM-33 focused on five key areas – disclosure requirements and standardization, digital persistent identifiers, consequences for violation of disclosure requirements, information sharing, and research security programs.[53] Despite this additional guidance, the academic community expressed a need for more clarity around the research security program requirements. In response, OSTP released further guidance on July 9, 2024, further clarifying the process for academic institutions to certify the existence of a research security program office.[54]
- **Disclosure Requirements.** The Fiscal Year 2021 NDAA included language that directed all Federal research agencies to require applicants to disclose foreign funding when receiving Federal research awards. This requirement ensures that there is consistent conflict of interest polices across agencies.
- **CHIPS and Science Act.**
  - **Prohibits Malign Foreign Talent Programs.** Title IV prohibits all federally funded research grantees from being a member of a malign foreign talent program or participating in similar activities.
  - **Prohibits Federal Employee's Participation in Foreign Talent Programs.** Title IV prohibits federal agency personnel from participating in foreign talent programs and requires researchers working on federally funded research projects to disclose any participation in foreign talent recruitment programs.
  - **Requires Annual Training on Foreign Threats.** Title IV requires all federally funded grantees to take annual training on research policies and foreign threats and directs OSTP to work with NSF and NIH to develop training for all grantees across the Federal research agencies.

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[53] White House, National Science and Technology Council. *Guidance for Implementing National Security Presidential Memorandum 33 (NSPM-33) on National Security Strategy for United States Government-Supported Research and Development*. January 2022. Available at https://bidenwhitehouse.archives.gov/wp-content/uploads/2022/01/010422-NSPM-33-Implementation-Guidance.pdf.

[54] White House, Office of Science and Technology Policy. *Memorandum for the Heads of Federal Research Agencies: Guidelines for Research Security Programs at Covered Institutions*. July 9, 2024. Available at https://bidenwhitehouse.archives.gov/wp-content/uploads/2024/07/OSTP-RSP-Guidelines-Memo.pdf.

- **Requires Plans to Protect Sensitive Basic Research.** Title III directs NSF to develop a plan to identify research areas that may involve access to classified or controlled unclassified information, and to exercise due diligence processes in granting access to such information.
- **Bans Confucius Institutes.** Title III bans NSF funding from going to organizations hosting Confucius Institutes.
- **Provides New Tools and Resources to Combat Foreign Theft.** Title III creates an Office of Research Security and Policy at NSF and gives the office and the Inspector General additional resources and new authorities to use analytical tools to detect and combat foreign influence, theft, and grant fraud. Title IV gives Federal research agencies the authority to require the submission of supporting documentation and the authority to act on findings that identify undue foreign influence or grant fraud.
- **Requires Institutional Disclosure of Foreign Support.** Title III directs NSF to collect annual summaries of foreign financial support from universities and grants NSF the authority to request copies of contracts or documentation related to such disclosures.
- **Gives Universities Tools to Protect Sensitive Research from Cyber Theft**. Title II directs NIST to assist universities in adopting the Cybersecurity Framework to help mitigate cybersecurity risks related to conducting research. In addition, title III directs the development of a national secure computing enclaves program to protect sensitive research information at American universities from cyber theft.

Further Reading:

- **Science and America's Challenges**
- **Protecting U.S. Technological Advantage**
- **Phase 2: Competing in the Next Economy – Adapting to a Changing World**
- **Defeating China and Saving Democracy**
- **Reconsidering Research Security**
- **Chapter 14 - A Glass Half Empty or Half Full: Challenges and Opportunities for the US Academic Research Enterprise**
- **The Perils of Complacency - America at a Tipping Point in Science & Engineering**