

18. RESEARCH AND DEVELOPMENT

Scientific discovery, technological breakthroughs, and innovation are engines for expanding the frontiers of human knowledge and are vital for responding to the challenges and opportunities of the 21st century. As we face unprecedented challenges and opportunities at this moment in American history, President Biden is committed to refreshing and reinvigorating our Nation's science and technology enterprise and creating good-paying jobs for American workers. Our aim is to harness the full power of science and technology on behalf of the American people.

Federal funding for research and development (R&D) is essential to maximize the benefits of science and technology to respond to COVID-19 and prevent future pandemics, end cancer as we know it, tackle the climate crisis and advance health, prosperity, security, environmental quality, equity, and justice for all Americans. Simply supporting R&D is not sufficient; Federal agencies are ensuring that R&D results are made widely available to other scientists and the public to facilitate understanding and decisions, in addition to innovators and entrepreneurs who can translate them from the lab into the businesses and products that will improve all of our lives. They also are committed to using R&D results to inform decision-making within the Federal Government to support the Administration's prioritization of evidence-based policymaking. In addition, R&D investments are helping to create more than just cutting-edge technology; they are also leading to the domestic manufacture of new products by U.S. workers.

Federally funded R&D investments are enabling control of the COVID-19 pandemic and promoting domestic manufacturing, job creation, national security, and economic prosperity in the United States. These positive impacts must be equitably distributed to ensure those

investments include communities and institutions that have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality.

The Biden-Harris Administration once again prioritizes investment in R&D at historic levels in the President's 2023 Budget, providing \$204.9 billion for Federal R&D¹, a 28 percent increase over the 2021 enacted level. Reflecting the high priority that the President places on the longer-term investments necessary to mount a successful science-first approach to tackling societal challenges, the FY 2023 Budget also includes \$81.7 billion, available over five years, at the Department of Health and Human Services (HHS) in new funding for pandemic preparedness, including significant investments in R&D, and \$16.9 billion in discretionary funding for climate innovation. In addition, the Budget builds upon the Biden-Harris Administration's strong commitment to fostering Science, Technology, Engineering and Mathematics (STEM) education with an effort to broaden participation and build capacity in underserved institutions. This includes \$343 million at the National Science Foundation (NSF) to broaden STEM opportunities for historically underrepresented groups and \$260 million for Department of Energy (DOE) initiatives to build science and technology capacity in underserved institutions, including minority-serving institutions. Furthermore, in alignment with the Biden-Harris Administration's whole-of-government equity agenda, the Budget prioritizes R&D investments in programs with strong potential to advance equity for all. This includes \$400 million at the National Institutes of Health (NIH) to expand health disparities research.

¹This total includes the conduct of R&D and investments in R&D facilities and equipment (see Table 18-1). Detailed definitions and discussion are available in Section II below.

I. PRIORITIES FOR FEDERAL RESEARCH AND DEVELOPMENT

The 2023 Budget provides support for a broad spectrum of research and development, including multidisciplinary research and high-risk research proposals. Investing in these exploratory and transformative research areas will fundamentally improve our understanding of nature, revolutionize fields of science, and lead to the development of new technologies. Maintaining our leadership in cutting-edge research areas is key to our global standing, especially relative to competitors such as China, and to the creation of well-paying jobs right here in the United States. Federal Government funding for R&D is essential to address societal needs in areas in which the private sector does not have sufficient economic incentive to make the required investments. Key among these are basic and applied research that have been hallmarks of the American research enterprise and a powerful driver

of surprising new technology. The 2023 Budget provides \$110.9 billion for basic and applied research, an increase of \$24.8 billion (29%) from 2021 enacted because such research is a proven source of the new knowledge that drives job creation and lasting economic growth and can contribute to shared prosperity.

To support additional transformative and, high-risk research approaches to tackling societal challenges, the Budget once again proposes funding for breakthroughs based on the unique and successful model of the Defense Advanced Research Projects Agency (DARPA). For example, the Budget provides \$5 billion for the Advanced Research Projects Agency for Health (ARPA-H) to drive biomedical breakthroughs – ranging from molecular to societal – that would provide transformative solutions for all patients. The Budget also proposes \$700 million for the

Advanced Research Projects Agency-Energy (ARPA-E), in the Department of Energy (DOE), while proposing legislation to expand the authority to develop new climate resilience technologies, and \$3.2 million for the planning and development of the new Advanced Research Projects Agency-Infrastructure (ARPA-I) in the Department of Transportation (DOT). The DOT's ARPA-I effort will accelerate the transformative transportation goals of the Infrastructure Investment and Jobs Act (Pub. L. 117-58).

Research investments in the most promising areas for future industry, scientific discovery, and job creation are being addressed through multi-agency research activities coordinated through the National Science and Technology Council (NSTC) and other interagency forums, since some of these challenges cannot be addressed effectively by a single agency. This section highlights the Administration's R&D priorities and 2023 Budget's support of research toward those priorities.

Pandemic Preparedness and Prevention

COVID-19 has claimed more than 900,000 lives in America and cost trillions of dollars, demonstrating the devastating effects of pandemics on society. As the Nation emerges from this historic event, there is broad recognition that the risk of future pandemics is increasing. It is more important than ever to resist becoming complacent about ensuring our readiness for emergent pandemics, and to work with urgency now to accelerate transformative capabilities that will prevent future COVID-scale catastrophes. The Budget builds upon previous R&D investments in early warning systems, diagnostics, therapies, and vaccine development and manufacturing to prevent and respond to pandemic and other biological threats, both domestically and globally. Priority areas include: accelerating vaccine design, testing, production, manufacturing, distribution, and administration, with an emphasis on population-scale "programmable" technology platforms; rapidly developed, easy to use, and affordable diagnostic technologies; antiviral therapeutics, including protein inhibitors, neutralizing antibodies, and immune modulators; and data and technology investments to support real-time monitoring, including pathogen genomic sequencing, viral variant tracking, and environmental surveillance (such as through wastewater sampling).

The 2023 Budget includes proposals totaling \$81.7 billion, available over five years, at HHS to address the Nation's preparedness for both the current COVID-19 pandemic and future threats. These proposals bolster pandemic preparedness across HHS public health agencies, and include several key investments in R&D. The Budget provides \$40 billion to the Office of the Assistant Secretary for Preparedness and Response (ASPR), including investments in advanced development and manufacturing of vaccines, therapeutics, and diagnostics for high priority viral families. The Budget provides \$28 billion for the Centers for Disease Control and Prevention (CDC), including support for domestic and global threat surveillance and public health laboratory capacity. The Budget provides \$12.1 billion to the National Institutes of Health

(NIH), including funding for research and development of vaccines, therapeutics, and diagnostics for high priority viral families, biosafety and biosecurity, and expansions of laboratory capacity and clinical trial infrastructure. The Budget also includes \$1.6 billion for the Food and Drug Administration (FDA) including investments to expand and modernize regulatory capacity, and laboratory infrastructure to support the evaluation of medical countermeasures. In addition, the Budget provides \$1.3 billion in R&D funding for Department of Defense (DOD) Chemical and Biological Defense Program (CBDP) biodefense and pandemic preparedness priorities. The Budget's enhancements for CBDP biodefense activities will expand DOD's ability to develop and manufacture targeted medical countermeasures and support expedited surveillance and pathogen characterization for a broader range of future biological threats.

In the broader health and biomedical R&D portfolio, the Budget provides \$49 billion for NIH, of which \$5 billion would be devoted to ARPA-H. At the Department of Veterans Affairs (VA), the medical and prosthetic research budget includes \$916 million encompassing direct R&D funding to support VA's intramural research initiatives. These investments support several cutting-edge clinical priorities, including: suicide prevention; pain management and opioid use; traumatic brain injury; post-traumatic stress disorder; Gulf War illness and military toxic exposures; and cancer, with a focus on precision oncology. Further, the Budget encourages development of innovative antimicrobial drugs through advance market commitments for critical-need antimicrobial drugs, and provides \$11 billion in funding for HHS to support this program.

Tackling Climate Change

The United States and the world face a profound climate crisis with a narrow moment to pursue action to avoid the most catastrophic impacts and to seize the opportunities that tackling climate change presents. President Biden has directed a whole-of-government approach to reduce climate pollution in every sector of the economy, increase resilience to the impacts of climate change, and protect public health, while creating good-paying jobs that provide a free and fair chance to join a union and bargain collectively.

The Budget prioritizes R&D investments that advance understanding of climate change and the development of mitigation and adaptation solutions. The Budget also promotes innovation to bring clean technologies to scale. Innovation will spur the technology and transformations necessary to reduce emissions and adapt to climate change at scale, while also creating new economic opportunities to build the industries of the future. The Budget provides \$44.9 billion for climate change expenditures, an increase of \$16.7 billion from the FY 2021 enacted level, including \$16.9 for climate innovation.

The Administration is committed to advancing climate science to improve understanding of Earth's changing climate, including changes that pose the greatest risk to

society. Beyond advancing understanding, we are placing increased emphasis on research needed to inform climate policies, including mitigation, adaptation, and measurement and monitoring of greenhouse gas emissions. The Budget provides \$5.0 billion for climate science activities, primarily coordinated through the U.S. Global Change Research Program (USGCRP), including \$913 million for NSF, which includes investments to understand the role of human actions in climate change, \$383 million for climate-related research in the Biological and Environmental Research (BER) portfolio in the DOE Office of Science and \$2.0 billion for climate research and space-based observations at the National Aeronautics and Space Administration (NASA). The NASA Budget includes over \$300 million for development of a future land-imaging satellite mission and an Earth System Observatory that will create a 3D, holistic view of Earth. Additionally, the Budget provides \$300 million for USDA climate science, including \$43 million for the Forest Service's Forest and Rangeland Research program.

The Budget supports innovation, commercialization, and deployment of clean energy and climate technologies, including those to lower the cost and decrease emissions in the power, buildings, transportation, industrial, and agricultural sectors; supporting achievement of a 50-52 percent reduction from 2005 levels in economy-wide net greenhouse gas pollution in 2030 and carbon pollution free electricity by 2035. To support U.S. preeminence in developing innovative technologies that accelerate the transition to a clean energy economy, the Budget invests more than \$11.9 billion in clean energy research, development, and demonstration, an increase of more than 32 percent over the 2021 enacted level. Notably, the Budget includes \$700 million for ARPA-E (energy) at the Department of Energy (DOE), which will expand its activities into adaptation and mitigation, and \$200 million to launch a new Solar Manufacturing Accelerator focused on research, development and demonstration that will help create a robust domestic manufacturing sector capable of meeting the Administration's solar deployment goals without relying on imported goods manufactured using unacceptable labor practices. Budget also includes \$500 million for clean energy technologies research at NSF. Looking toward future clean energy solutions in the coming decades, the Budget proposes \$204 million to build on DOE's Energy Earthshots with critical fundamental research in the Office of Science. The Budget also includes \$723 million for the Office of Science Fusion Energy Sciences research in enabling technologies, advanced computing and simulation, materials, and new partnerships with private fusion efforts. Within this total is \$240 million for the ongoing construction of ITER, the world's largest experimental fusion facility designed to demonstrate net positive energy production.

In addition to funding for climate science and clean energy, the Budget also tackles climate change through a myriad of other approaches. For example, the Budget provides \$58 million for a DOE-wide Net Zero Lab Initiative, to support moving DOE national laboratories towards net zero Greenhouse Gas (GHG) emissions. The Budget

also supports enhancement of greenhouse monitoring and measurement capabilities, which is needed to track the effectiveness of domestic GHG reduction policies, to inform local mitigation efforts, to support international climate engagement, and to monitor changes in emission from biotic sources such as thawing permafrost. Moreover, the Budget supports innovative mechanisms to incentivize the adoption of climate-smart agricultural practices, open new markets for climate-smart commodities, and gather data on carbon sequestration and GHG reduction benefits to quantify conservation outcomes, as exemplified in USDA's new Partnership for Climate Smart Commodities.

To manage the risks that all Americans face, the Budget continues to invest in disaster mitigation and climate adaptation and resilience. The Budget proposes major investments in hazard mitigation and adaptation at the Department of Homeland Security (DHS), including \$37 million to partner with State, local, tribal, and territorial (SLTT) organizations to increase the level of national preparedness by establishing community resilience testbeds, streamlining disaster recovery tools, and enhancing the predictive models and analytical services related to flooding. The Budget also requests \$86 million for Climate Adaptation Science Centers (CASCs) at the U.S. Geological Survey. The CASCs fund research projects that help understand and address the impact of climate change on the Nation's land, water, fish, wildlife, and cultural resources. In addition, the Budget includes \$92 million for competitive climate research at the National Oceanic and Atmospheric Administration, which will support a range of activities including improvements to ocean ecosystem modeling and prediction, and enhancements to climate projections and their accessibility for decision-makers.

Catalyzing Research and Innovation in Critical and Emerging Technologies

The Budget promotes world-leading research and innovation boosting American industries and quality American jobs in critical and emerging technologies, including artificial intelligence (AI), quantum information science (QIS), advanced communications technologies, microelectronics, high-performance computing, biotechnology, advanced materials, robotics, and space technologies. Agencies will coordinate to leverage these technologies to ensure the sharing and use of the vast troves of Federal Government datasets to enable large-scale data analysis, and high-fidelity, high-resolution modeling and simulation to address critical challenges in public health, climate science, and disaster resilience.

The Budget provides \$10.5 billion for the National Science Foundation (NSF), an increase of \$2 billion from the 2021 enacted funding level. The new Directorate for Technology, Innovation, and Partnerships would receive \$880 million to accelerate the transformation of research into new technologies and solutions to societal and economic challenges. The 2023 Budget will also support existing and new National Artificial Intelligence Research Institutes, which are national hubs that bring together

interdisciplinary groups from universities; federal, state, and local agencies; private industry; nonprofits; and civil society to advance AI research and workforce development in order to pursue transformational advances in a range of economic sectors and science and engineering fields — from food-system security to the next-generation networks that will power advanced technologies like autonomous vehicles and virtual-reality simulators.

At the Department of Energy's Office of Science, the Budget provides \$7.8 billion, an increase of 11% from the 2021 level. This includes \$176 million for AI research and \$293 million for QIS R&D. AI and machine learning investments alongside DOE's world-leading computing capabilities are essential in integrating computing and data and accelerating innovations in earth and environmental system modeling, extracting signals from increasingly large volumes of experimental data from the scientific research facilities, and future clean energy technologies. The Budget also supports DOE's National QIS Research Centers, quantum networking R&D, and testbeds for the research community. The Advanced Scientific Computing Research program in 2023 will begin to enable the sustainability of critical exascale computing software for these emerging technology testbeds.

At the National Institute of Standards and Technology (NIST), the Budget provides \$975 million for scientific and technical research and services, an increase of \$187 million above 2021 enacted. These resources will be used to develop standards to support a wide range of critical and emerging technologies with a focus on artificial intelligence, quantum science, and cybersecurity.

At NASA, the Budget will help further spur U.S. leadership in space technology with increased funding for the agency's Space Technology R&D portfolio to \$1.44 billion, a \$338 million increase above 2021 enacted. This investment will support new technologies to help the commercial space industry grow and create good-paying American jobs, enhance mission capabilities, and reduce costs. The Budget also provides \$882 million to develop a mission to return geologic samples from Mars to Earth for analysis. This mission includes technologies that will enable the first ever launch off another planet.

Innovation for Equity

The Biden-Harris Administration has implemented a whole-of-government equity agenda. The Budget prioritizes R&D investments in programs with strong potential to advance equity for all, including people of color and others who have been historically disadvantaged, marginalized, and adversely affected by persistent poverty and inequality. As part of this focus, the Budget supports programs, including community-level capacity building and training, that expand equitable inclusion in Federal science and technology programs and the use of scientific and technological innovation to advance equitable outcomes.

The Budget provides \$343 million for NSF programs that aim to broaden participation of historically underrepresented groups in STEM, including Alliances for

Graduate Education and the Professoriate, Centers of Research Excellence in Science and Technology, Historically Black Colleges and Universities – Excellence in Research and Undergraduate Program, Hispanic Serving Institutions program, Louis Stokes Alliances for Minority Participation, Tribal Colleges and Universities Program, and Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES). The Budget also provides \$50 million for a new initiative at NSF that will build administrative capacity at emerging research institutions to help them more effectively compete for research funding.

The Budget also provides \$260 million for DOE initiatives to build science and technology capacity in underserved institutions, including minority-serving institutions. This includes the Minority Serving Institution (MSI) Partnership Program, doubling funding for the Reaching a New Energy Sciences Workforce, and the following new programs and projects: the Funding for Accelerated Inclusive Research grant program, a MSI Science, Technology, Engineering and Mathematics (STEM) Challenge, and a university research nuclear reactor via a MSI-focused consortium. The DOE's Office of Energy Efficiency and Renewable Energy MSI STEM Challenge will provide dedicated prizes, assistance, and research funding to minority serving institutions to leverage and build renewable energy-related research capacity among faculty and students.

In addition, the Budget provides \$315 million through the Department of Agriculture in agriculture research, education and extension grants to build capacity in underserved institutions, including Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges and Universities.

Furthermore, the Budget provides \$400 million to expand health disparities research at seven NIH Institutes, including for infrastructure at the National Institute on Minority Health and Health Disparities to support clinical research in ambulatory settings within the Research Centers in Minority Institutions program.

National Security and Economic Resilience

The Budget supports the research, development, and application of technologies that protect American security and strengthen our economic resilience. Investments in security prioritize the reduction of catastrophic biological, nuclear, and cyber risks, including investments in technologies supporting: biosecurity and biosafety; nuclear nonproliferation, defense modernization, arms control and treaty verification, measures that lower the risk of nuclear accidents and miscalculation, measures that enhance strategic stability; and new capabilities for defending critical infrastructure and sensitive networks against cyberattacks and supply chain attacks, including improved authentication mechanisms, zero-trust architectures, and better intrusion detection capabilities. The Budget also emphasizes technologies that ensure safe, clean, and reliable access to critical products, materials

and minerals, including new manufacturing and biomanufacturing processes that can cost-effectively produce key goods on demand.

The Budget provides over \$83 billion for the Department of Defense's (DOD) R&D programs, with increases for hypersonics R&D, QIS R&D, and AI research, including security and safety. The Budget provides \$4.1 billion for DOD's DARPA. To enable access to measurably secure state-of-the-art defense microelectronics, this budget provides \$950 million. To strengthen and safeguard the domestic bioeconomy, this budget also provides \$357 million to grow biomanufacturing capacity to support a more resilient defense manufacturing supply chain. To train the STEM-capable workforce needed for national security, the Budget provides \$132 million for DOD's National Defense Education Program (NDEP). The Budget also provides more than \$7 billion for National Nuclear Security Administration research programs to sustain a safe, secure, and effective nuclear deterrent; facilitate nonproliferation efforts and arms control verification; and power the U.S. Navy.

In addition, at DHS, the Budget provides \$592 million for Research, Development, Technology & Evaluation activities, including continued funding for cyber data analytics to support the Cybersecurity & Infrastructure Security Agency's mission to manage and reduce the risk to the Nation's cyber infrastructure. The Budget also includes investments to counter emerging chemical, biological, radiological, and nuclear threats, most prominently through the Probabilistic Analysis of National Threats, Hazards, and Risk (PANTHR) program, which supports the Homeland Security Enterprise's programs to prevent, prepare for, and mitigate potential threats. In addition, the Budget includes \$89 million for R&D infrastructure funding, an increase of \$81 million, to refurbish and modernize DHS's laboratories to better support first responders and transportation security, and more effectively defend the Nation against biological threats.

Furthermore, USDA's research programs develop and transfer solutions to problems of high national priority. Building a more sustainable, resilient food system is critical to our national security; ensuring high-quality, safe food, assessing the nutritional needs of Americans, sustaining a competitive agricultural economy and enhancing the natural resource base and the environment so all Americans thrive.

STEM Education and Engagement

The Biden-Harris Administration is committed to fostering the engagement and motivation of our country's students in STEM, the instructional and institutional

environments for STEM learning, and the training and talent development for our future STEM workforce. The Budget supports these values. The Budget supports strategies to promote diversity, inclusion, equity, and accessibility across all R&D focus areas, while building supportive STEM education and engagement ecosystems founded on equity.

The Budget provides significant STEM investments across a broad array of agencies, including \$1,377 million for NSF's Education and Human Resources Directorate, \$150 million for NASA's Office of STEM Engagement, and \$106 million for USDA's STEM programs. At NSF, the Budget provides an increase of \$100 million to a suite of fellowship programs across the agency. At NASA's Office of STEM Engagement, the Budget supports broadening participation in STEM and includes a more than 70% increase in NASA funding for the Global Learning and Observations to Benefit the Environment (GLOBE) program to significantly expand this international science and education program that engages the STEM professionals of tomorrow. At USDA, the Budget doubles the funding level for the Women and Minorities in STEM program compared to the FY 21 enacted level. The Budget also continues funding for USDA programs that provide support for research, education and teaching, and extension projects for historically under-resourced minority populations. Funds for these programs include but are not limited to projects at many Historically Black institutions, Land Grant Universities, Hispanic Serving Institutions, and programs in rural and insular areas.

At the Department of Education, the Budget provides \$350 million for a new grant program to build the R&D infrastructure capacity at 4-year Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), and Minority-Serving Institutions (MSIs). These investments will help more of these post-secondary institutions have state-of-the-art facilities that will allow them to compete for additional research funding. The Budget includes an additional \$350 million, for a total of \$514 million, for the Education Innovation and Research program, which the Department of Education would direct toward identifying and scaling models that improve recruitment and retention of staff in education, in particular STEM education, career and technical education, special education, and multilingual education. These new funds would enhance support for teachers and improve effectiveness through expanded access to leadership opportunities and professional learning communities so educators can address common challenges and share best practices.

INFRASTRUCTURE INVESTMENTS AND JOBS ACT

In addition to the 2023 Budget, important R&D investments are being made in the Infrastructure Investments and Jobs Act (IIJA). For example, at the Department of Energy, IIJA established a new Office of Clean Energy Demonstrations with an appropriation of \$21.5 billion over five years to accelerate the transition to a clean energy economy. In partnership with industries and communities across the country, the new office will fund demonstration projects that address scale-up and commercialization risks for the breakthrough technologies that will prove a net zero emission economy is achievable by 2050. At the Department of Transportation's Federal Transit Administration, IIJA calls for transit research programs to support public transportation innovation through research, demonstrations, and deployment of new technologies and best practices on mobility as well as transportation research conducted by the National Academy of Sciences. At the Departments of the Interior and Agriculture, IIJA appropriates \$20 million over 5 years for the Joint Fire Science Program, with funding split evenly between the two departments, to fund scientific research on wildland fire to aid policymakers, fire managers and practitioners in decision making. At the Department of Homeland Security (DHS), \$158 million is appropriated to the Science & Technology Directorate for critical infrastructure security and cybersecurity, including for electromagnetic pulse and geo-magnetic disturbance resilience; developing tools with industry for positioning, navigation, and timing capability and resilience; and to enhance the cybersecurity of industrial control and internet of things (IoT) systems. The IIJA funding also provides DHS the ability to begin understanding, analyzing, and identifying open-source software security and private marketplace gaps to mitigate risks, informing which areas are best suited for future Federal prototype development efforts. In addition, this funding supports the interoperability, integrity, and security of critical communications systems for DHS and first responders. The aforementioned are just a couple of illustrative examples of R&D supported by IIJA and not meant to be exhaustive.

II. FEDERAL RESEARCH AND DEVELOPMENT DATA

R&D is the collection of efforts directed toward gaining greater knowledge or understanding and applying knowledge toward the production of useful materials, devices, and methods. R&D investments can be characterized as basic research, applied research, development, R&D equipment, or R&D facilities. The Office of Management and Budget (OMB) has used those or similar categories in its collection of R&D data since 1949. Please note that R&D crosscuts in specific topical areas as mandated by law will be reported separately in forthcoming Supplements to the President's 2023 Budget.

Background on Federal R&D Funding

More than 20 Federal agencies fund R&D in the United States. The character of the R&D that these agencies fund depends on the mission of each agency and on the role of R&D in accomplishing it. Table 18–1 shows agency-by-agency spending on basic research, applied research, experimental development, and R&D equipment and facilities.

Basic research is systematic study directed toward a fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. Basic research, however, may include activities with broad applications in mind.

Applied research is systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

Experimental development is creative and systematic work, drawing on knowledge gained from research and practical experience, which is directed at producing new products or processes or improving existing products or processes. Like research, experimental development will result in gaining additional knowledge.

Research and development equipment includes acquisition or design and production of movable equipment, such as spectrometers, research satellites, detectors, and other instruments. At a minimum, this category includes programs devoted to the purchase or construction of R&D equipment.

Research and development facilities include the acquisition, design, and construction of, or major repairs or alterations to, all physical facilities for use in R&D activities. Facilities include land, buildings, and fixed capital equipment, regardless of whether the facilities are to be used by the Government or by a private organization, and regardless of where title to the property may rest. This category includes such fixed facilities as reactors, wind tunnels, and particle accelerators.

Comprehensive Government-wide efforts are currently underway to increase the accuracy and consistency of the R&D budget via a collaborative community of practice of Federal agencies, which have been working to identify best practices and standards for the most accurate classification and reporting of R&D activities.

Table 18-1. FEDERAL RESEARCH AND DEVELOPMENT SPENDING
(Mandatory and discretionary budget authority¹, Dollar amounts in millions)

	2021 Actual	2022 Estimate ²	2023 Proposed	Dollar Change: 2022 to 2023	Percent Change: 2022 to 2023
By Agency					
Defense ³	70,079	65,691	83,769	18,078	28%
Health and Human Services	42,226	42,023	61,816	19,793	47%
Energy	17,788	21,027	23,731	2,704	13%
NASA	12,176	12,279	13,547	1,268	10%
National Science Foundation	7,515	7,065	8,448	1,383	20%
Agriculture	3,031	3,193	3,579	386	12%
Commerce	2,099	1,994	2,918	924	46%
Veterans Affairs	1,445	1,436	1,655	219	15%
Transportation	1,070	1,281	1,498	217	17%
Interior	1,009	1,123	1,443	320	28%
Homeland Security	590	748	681	-67	-9%
Environmental Protection Agency	524	523	614	91	17%
Education	364	405	402	-3	-1%
Smithsonian Institution	324	332	355	23	7%
Other	484	493	480	-13	-3%
TOTAL	160,724	159,613	204,936	45,323	28%
Basic Research					
Defense	2,540	2,296	2,416	120	5%
Health and Human Services	21,051	20,951	31,911	10,960	52%
Energy	5,526	5,623	6,373	750	13%
NASA	5,162	5,490	6,086	596	11%
National Science Foundation	5,974	5,664	6,787	1,123	20%
Agriculture	1,195	1,218	1,381	163	13%
Commerce	260	260	334	74	28%
Veterans Affairs	566	560	645	85	15%
Transportation	16	16	16	0	0%
Interior	84	85	146	61	72%
Homeland Security	53	73	75	2	3%
Environmental Protection Agency .....	.....	.....	.....	.....	.....
Education	51	42	42	0	.....
Smithsonian Institution	290	296	319	23	8%
Other	16	18	13	-5	-28%
SUBTOTAL	42,784	42,592	56,544	13,952	33%
Applied Research					
Defense	6,438	5,625	6,028	403	7%
Health and Human Services	20,876	20,744	29,480	8,736	42%
Energy	6,360	6,130	7,129	999	16%
NASA	2,654	2,684	3,030	346	13%
National Science Foundation	968	879	1,115	236	27%
Agriculture	1,347	1,432	1,582	150	10%
Commerce	1,163	1,167	1,508	341	29%
Veterans Affairs	849	846	976	130	15%
Transportation	749	944	1,138	194	21%
Interior	753	863	1,077	214	25%
Homeland Security	178	238	157	-81	-34%
Environmental Protection Agency	406	406	477	71	17%
Education	198	257	254	-3	-1%
Smithsonian Institution .....	.....	.....	.....	.....	.....
Other	344	342	360	18	5%
SUBTOTAL	43,283	42,557	54,311	11,754	28%
Experimental Development					
Defense ³	61,101	57,750	75,325	17,575	30%
Health and Human Services	56	56	53	-3	-5%

Table 18-1. FEDERAL RESEARCH AND DEVELOPMENT SPENDING—Continued
(Mandatory and discretionary budget authority¹, Dollar amounts in millions)

	2021 Actual	2022 Estimate ²	2023 Proposed	Dollar Change: 2022 to 2023	Percent Change: 2022 to 2023
Energy	3,023	6,501	7,433	932	14%
NASA	4,306	4,048	4,323	275	7%
National Science Foundation .....	.....	.....	.....	.....	.....
Agriculture	307	348	393	45	13%
Commerce	380	210	434	224	107%
Veterans Affairs	30	30	34	4	13%
Transportation	270	282	303	21	7%
Interior	170	173	218	45	26%
Homeland Security	340	418	360	-58	-14%
Environmental Protection Agency	118	117	137	20	17%
Education	115	106	106	0	0%
Smithsonian Institution .....	.....	.....	.....	.....	.....
Other	118	133	107	-26	-20%
SUBTOTAL	70,334	70,172	89,226	19,054	27%
Facilities and Equipment					
Defense	0	20	0	-20	.....
Health and Human Services	243	272	372	100	37%
Energy	2,879	2,773	2,796	23	1%
NASA	54	57	108	51	89%
National Science Foundation	573	522	546	24	5%
Agriculture	182	195	223	28	14%
Commerce	296	357	642	285	80%
Veterans Affairs .....	.....	.....	.....	.....	.....
Transportation	35	39	41	2	5%
Interior	2	2	2	0	0%
Homeland Security	19	19	89	70	.....
Environmental Protection Agency .....	.....	.....	.....	.....	.....
Education .....	.....	.....	.....	.....	.....
Smithsonian Institution	34	36	36	0	0%
Other	6	0	0	0	0%
SUBTOTAL	4,323	4,292	4,855	563	13%

¹ This table shows funding levels for Departments or Independent agencies with more than \$200 million in R&D activities in 2023. Funds for Facilities and Equipment reflect optimization of investments and operations, and are in addition to the funds included in the deficit neutral reserve funds that reflect the President's commitment to working with Congress to enact his plan to lower health care, child care, energy, and other costs for families.

² The FY 2022 Estimate column applies the main 2023 *Budget* volume approach of using annualized appropriations provided by the 2022 Continuing Resolution as well as including enacted legislation as of January 2022 (including P.L. 117-58, the Infrastructure Investment and Jobs Act).

³ As part of the effort to refine DOD's contribution to overall Federal R&D, DOD Research, Development, Test, and Evaluation (RDT&E) Budget Activity 6.6 is now included as part of experimental development. This change is reflected across fiscal years 2021-2023 in the table and accounts for \$8.3 billion in the FY 2023 Budget, which was not previously captured as R&D. Total experimental development spending includes DOD RDT&E Budget Activities 6.3 through 6.6 (Advanced Technology Development; Advanced Component Development and Prototypes; System Development and Demonstration; and Management Support).