



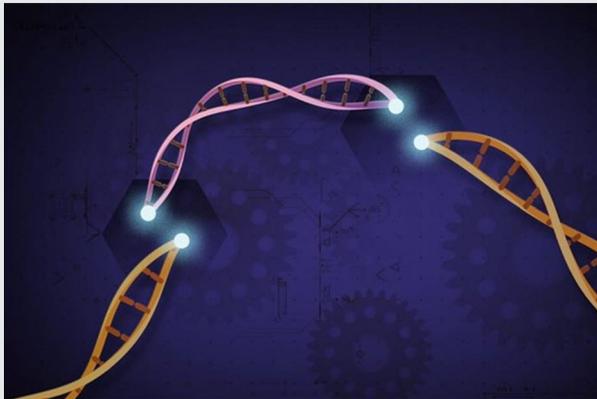
Chapter 1

Management's Discussion and Analysis

Agency Overview

Mission and Vision

The National Science Foundation (NSF) was established in 1950 “to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...”¹ As the only federal agency that invests in fundamental, basic research across all non-medical fields of science and engineering, NSF has played a leading role in helping the U.S. secure and maintain its competitive edge globally. NSF’s annual budget supports groundbreaking research, science, technology, engineering, and mathematics (STEM) education, and the development of the STEM workforce. This support is a critical source of federal funding for fields like biology, computer science, mathematics, the physical sciences, and the social sciences.



Scientists are expanding genome editing and engineering in plants to improve the efficiency of food production. *Credit: National Institutes of Health*

For more information: https://www.nsf.gov/discoveries/disc_images.jsp?cntn_id=302453&org=NSF

New CRISPR technologies enable development of climate and disease resistant crops

Over the past decade, huge leaps forward have been made in CRISPR—the gene editing technology that won the 2020 Nobel Prize in Chemistry. One of the most anticipated applications of CRISPR is the ability to strengthen the food supply by designing crops that are more robust, higher yield, and resistant to pests and climate change. NSF-funded researchers at the University of Maryland have made the next big step toward this goal. They’ve developed new techniques that not only expand the range of what CRISPR can do in plant genomes, but also allow these tools to operate on multiple parts of the genome simultaneously. By making it possible to imbue crops with multiple beneficial attributes at once, researchers are bringing us closer to a more resilient and sustainable food supply.

For over 70 years, NSF-funded research programs and initiatives have advanced knowledge to sustain global leadership and foster innovations that drive the economy, strengthen national security, and enhance the well-being of millions of Americans. NSF supports U.S. researchers as they probe the unknown and seek to understand nature’s great mysteries. These pioneers generate new knowledge and discoveries that transform the understanding of our world and galaxies, while also transforming modern society through technological innovations. NSF supported research essential to the creation of many advances such as the Internet, bar codes found on nearly all products, Magnetic Resonance Imaging, 3-D printing, and the game-changing technology on smart phones—from the liquid crystal display and multi-touch screen zoom to the lithium battery and the much relied on mapping software and GPS.

This report is focused on fiscal year (FY) 2021, a year in which NSF was engaged in the larger national effort to manage and begin to emerge from the COVID-19 pandemic. NSF’s principal role has been to continue funding the groundbreaking research that has long been its hallmark, and it has also fostered

¹ National Science Foundation Act of 1950 (Public Law [P.L.] 81–507).

and catalyzed efforts to help the U.S. science, engineering, and STEM education communities rebound from unprecedented disruptions brought by the pandemic. From equipment delays and reagent shortages to lost training time and missed field research, the pandemic has strained research projects in unique and indelible ways. NSF has deployed funds from the American Rescue Plan (ARP) Act to support groups and institutions most affected by the pandemic, with a special focus on transition points in an individual's educational and research trajectory that are most vulnerable to disruption.

CyberCorps Scholarship for Service: Secure Embedded Systems

From large scale and high-profile ransomware attacks to more pervasive vulnerabilities in consumer technology and online systems, the need to strengthen the nation's cybersecurity workforce only continues to grow. To help accomplish that, Morgan State University (MSU), a Historically Black College and University (HBCU) in Baltimore, Maryland, has launched the Secured Embedded Systems Scholarship Program (SES2). Supported by funding through NSF's CyberCorps® Scholarship for Service and the American Rescue Plan, this is an initiative to recruit, mentor, and financially support cybersecurity students at every level of higher education. The program focuses on connected embedded systems—products that have network technology built in, such as baby monitors, smart cars, and even critical infrastructure like power grids. By focusing on this specific area, and by supporting participants ranging from pre-freshmen through doctorate students, MSU is building the next generation of cybersecurity professionals.



In the SES2 program, MSU students follow an innovative curriculum in secure embedded systems, experience challenging research opportunities, and receive peer and professional mentoring. Credit: MSU

https://www.nsf.gov/awardsearch/showAward?AWD_ID=2042700

NSF's FY 2021 research priorities were guided by a set of cutting-edge goals to enable rapid advances across such areas as artificial intelligence, quantum information science, advanced manufacturing, advanced wireless, biotechnology, and climate change and clean energy. In June, NSF announced the establishment of a geographically distributed Network for Advanced Nuclear Magnetic Resonance (NAN). NAN will advance biomolecular research to gain insights about how life has adapted to the world, allowing scientists to harness those adaptations to biotechnologies and spur a future U.S. bioeconomy. Also, in FY 2021, NSF supported research to better understand natural disasters and improve resilience in civic infrastructure, such as the power grid, that is vulnerable to natural hazards. Researchers have found that incorporating nanomaterials into traditional cement improves water and fracture resistance and can be used to build more durable roads and cities. NSF-funded researchers in the social, behavioral, and economic sciences gained insights into how to design systems and policies for meaningful impact on improving peoples' well-being and strengthening our communities. At the same time, NSF-funded engineers worked on developing the next generation of software for space weather modeling, while scientists using supercomputer-driven simulations discovered the mechanism that allows the coronavirus to enter and infect healthy human cells; this discovery holds the potential for opening avenues for new therapeutics to counter SARS-CoV-2 infection.

To sustain the Nation's scientific enterprise, NSF supports a wide array of research infrastructure throughout the country and around the world, including research stations in the Arctic and Antarctica. These investments provide the infrastructure needed to advance discovery, learning, and exploration, and include ships, aircraft and autonomous airborne platforms, ground-based telescopes, and other infrastructure and state-of-the-art tools. In 2021, astronomers gained insights into the existence of supermassive black hole pairs and galaxy mergers in the early universe by combining data from several space and ground-based telescopes, including the NSF-funded National Optical-Infrared Astronomy Research Laboratory (NOIRLab). Also in 2021, a high-resolution ocean model simulation at the NSF-supported National Center for Atmospheric Research has given scientists a look into the life cycle of endangered loggerhead turtles and could help inform conservation efforts. Each year, hundreds of U.S. scientist and engineers use NSF-funded Frontera, one of the most powerful supercomputers in the world, to tackle complex scientific and engineering challenges. The Foundation's long-term commitment to steady advancements and upgrades to research facilities enables this kind of ground-breaking research.



DES photographed the night sky using the Dark Energy Camera on the Victor

: Reidar Hahn, Fermilab

For more information: https://nsf.gov/discoveries/disc_images.jsp?cntn_id=302871&org=MPS

Dark Energy Survey releases the most precise look at the universe's evolution

Results from the Dark Energy Survey (DES) are giving researchers new insights into some of the universe's most mysterious phenomena. While we can't see dark energy or dark matter directly, we can watch as it shapes the structure and motion of galaxies through gravitational effects. The DES mapped more than 226 million galaxies over seven years—creating the largest and most precise map of the universe ever made—which is allowing astronomers to see the influence of dark energy and dark matter on a massive scale and with new precision. The DES is part of a new era of astronomy powered by massive surveys of the sky, and with the help of supercomputers (and even artificial intelligence), DES and similar projects are enabling huge leaps forward in our understanding of the structure of the universe.

The translation of NSF-funded science and engineering discoveries into innovative technologies and solutions in the market and society is also a long-standing priority for NSF, led by programs such as Partnerships for Innovation, NSF Innovation Corps (I-Corps™), and Small Business Innovation Research and Small Business Technology Transfer. These programs support researchers in prototyping, technology demonstration, and scaling-up their work, including the licensing of NSF-funded research outcomes and providing entrepreneurial education to help researchers with customer discovery. This has led to startups and new small businesses with impacts affecting entire market sectors.

The duality of NSF's investment strategy – the combination of basic and translational research that generates a steady flow of new knowledge with the support for STEM education and workforce development at all levels – is central to the U.S.'s standing in the global research enterprise. As mentioned earlier, as part of the national effort to recover from the COVID-19 pandemic, NSF received funding from the ARP Act to help individuals and institutions in the U.S. science, engineering, and STEM education communities most significantly affected by the pandemic recover. NSF's sustained funding supports innovative STEM education and keeps the Nation's workforce competitive and ready to take on future challenges. These

STEM education and training programs attract talented scientists and engineers from every corner of our Nation—from remote rural areas to the largest urban centers. NSF's Louis Stokes Alliances for Minority Participation program, for example, builds institutional alliances that assist universities and colleges in developing and retaining STEM talent from underrepresented communities so that students can more successfully transition from community colleges to four-year universities and on to graduate programs. These investments in people are a critical means by which NSF achieves its mission; transformational breakthroughs are shaped by a wide range of perspectives.

NSF's support for the Graduate Research Fellowship Program (GRFP) is an important component of its STEM workforce portfolio. Since 1952, NSF has funded approximately 64,000 Graduate Research Fellows, many of whom go on to become leaders in their chosen fields and make groundbreaking and important discoveries in STEM research. NSF also has funded the research of 253 individuals who have gone on to win the Nobel Prize, along with 43 individuals who have gone on to win the ACM² A.M. Turing Award, often referred to as the "Nobel Prize of Computing." NSF strives to provide every aspiring scientist and engineer access to the resources they need to prepare for a career in science or engineering.

Sitting Bull College's Native American Prairie Ecosystems Research Center (PERC)

NSF's Tribal Colleges and Universities Program (TCUP) is a critical STEM pathway for broadening participation, strengthening science and engineering capabilities, and increasing STEM opportunities in tribal communities. At Sitting Bull College (SBC) in Fort Yates, North Dakota, PERC is leveraging diverse research expertise and local indigenous ecological knowledge to study challenges in prairie ecosystems and help design new solutions and approaches in soil science, water quality, wildlife and plant ecology, microbiology, molecular ecology, and engineering. SBC and PERC are leading the way in North Dakota as the primary center for tribal knowledge about the Great Plains region.

For more information: https://nsf.gov/awardsearch/showAward?AWD_ID=2055064&HistoricalAwards=false



PERC leverages the resources and faculty of SBC and local reservation communities to solve issues that arise in the community using practices that align with cultural traditions and have a direct impact on tribal communities in the Great Plains. Credit: U.S. Dept of the Interior

The partnerships that NSF undertakes represent another way that the agency adds value to the research enterprise. In addition to increasing access to research infrastructure and building broader communities of researchers, partnering can accelerate scientific discovery as well as the translation of research into products and services that benefit society. In July, the establishment of 11 new NSF National Artificial Intelligence (AI) Research Institutes was announced, building on the first round of seven institutes funded in 2020. Led by NSF, and in partnership with the U.S. Department of Agriculture, U.S. Department of Homeland Security, Google, Amazon, Intel, and Accenture, the National AI Research Institutes will act as connections in a broader nationwide network to pursue transformational advances in a range of economic sectors, and science and engineering fields — from food system security to the next-generation of cyber-infrastructure. Also, in partnership with 29 institutions, NSF has announced the launch of SpectrumX, an NSF Spectrum Innovation Center, that will address the growing demand for usage of the radio spectrum and catalyze innovation to solve radio spectrum challenges that are critical for the nation. The investment in SpectrumX is part of the Spectrum Innovation Initiative, a collaboration between NSF, the National

² ACM: Association for Computing Machinery

Telecommunications and Information Administration, and the Federal Communications Commission to promote dynamic and agile spectrum utilization while ensuring innovation and security for all users.

Wireless research for universal and affordable rural broadband

Iowa State University and the areas surrounding Ames, Iowa are the latest testbed for largescale wireless technology research that is extending the reach of broadband and other communications platforms. Known as the Wireless Living Lab for Smart and Connected Rural Communities, it is an \$8 million public-private partnership funded by NSF, the U.S. Department of Agriculture, and an industry consortium that is exploring how cutting-edge communications technology can be deployed to enable high-speed, universal, and affordable rural broadband connectivity. With a special emphasis on agricultural applications in crop and livestock farms, the wireless research platform will be an extensive collaboration between researchers, students, communities, industry partners, and state and local governments, working together to connect the unconnected.

More information https://www.nsf.gov/news/special_reports/announcements/062221.jsp



Iowa State University researchers installed hardware to drive innovation in rural broadband connectivity.
Credit: C Gannon.

NSF's vision is to ensure that the U.S. remains the global leader in research and innovation. NSF's core values of excellence, public service, learning, inclusion, collaboration, integrity, and transparency articulate the essential qualities that staff are encouraged to embody in support of the agency's mission and vision. These core values guide staff in making decisions, setting priorities, addressing challenges, managing tradeoffs, recruiting and developing personnel, and working together with awardee recipients. These are embodied in the goals established in the NSF strategic plan for FY 2018 – 2022, *Building the Future: Investing in Discovery and Innovation*:³ (1) expand knowledge in science, engineering, and learning; (2) advance the capability of the Nation to meet current and future challenges; and (3) enhance NSF's performance of its mission.

It can take many years for the new knowledge gained through basic research to realize its potential for benefitting society, but the benefits are undeniable, and the strategy of investing in high-risk, foundational research is a sound one that shapes and secures the future of our Nation. NSF supports 24 percent of all federally-sponsored basic scientific research conducted by America's colleges and universities; and the share of NSF's support increases to 57 percent when medical research supported by the National Institutes of Health is excluded.⁴ NSF also has well-established programs that accelerate the translation of fundamental science and engineering discoveries into new technologies that have the potential to impact society. Advancing the frontiers of science and technology ensures the U.S. economy stays strong, that Americans remain safe and secure, and that the Nation continues to pursue knowledge and understanding on scales ranging from the subatomic to the cosmic.

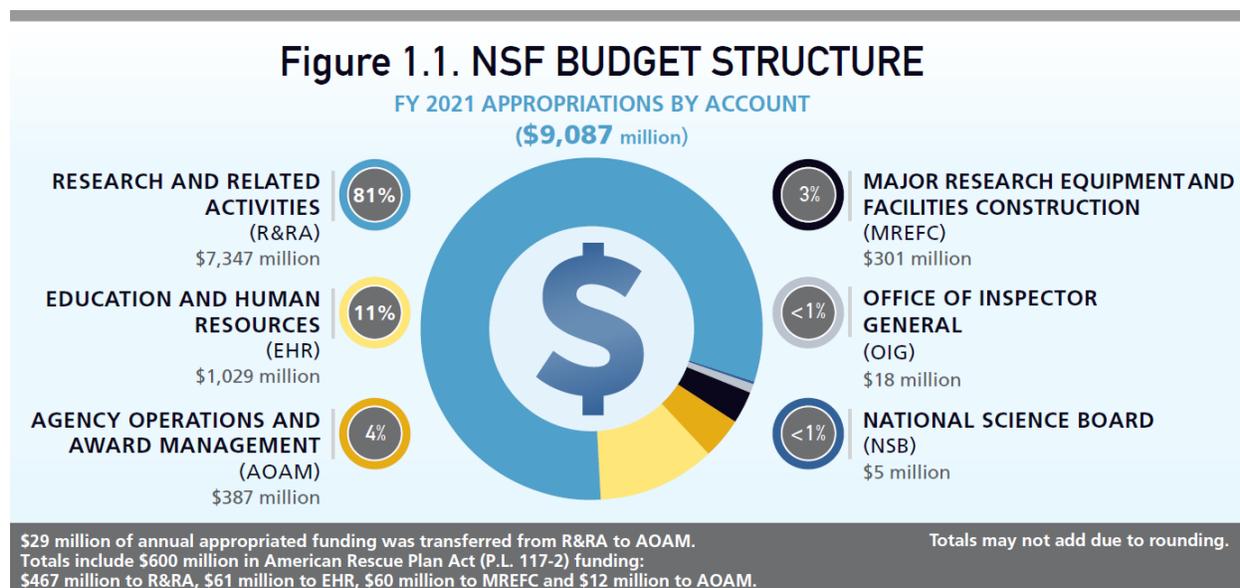
³ NSF Strategic Plan FY 2018 – 2022: <https://www.nsf.gov/pubs/2018/nsf18045/nsf18045.pdf>

⁴ National Center for Science and Engineering Statistics Survey of Federal Funds for Research and Development Fiscal Years 2019–2020: <https://nces.nsf.gov/pubs/nsf21329>

NSF by the Numbers

NSF is funded primarily through congressional appropriations that are provided to six accounts: Research and Related Activities (R&RA), Education and Human Resources (EHR), Major Research Equipment and Facilities Construction (MREFC), Agency Operations and Award Management (AOAM), the National Science Board (NSB), and the Office of Inspector General (OIG). Appropriations in these six accounts in FY 2021 totaled \$9,087 million,⁵ an increase of approximately 9 percent over the FY 2020 appropriations level of \$8,354 million. R&RA, EHR, and MREFC appropriations fund the agency's programmatic activities and accounted for 95 percent of NSF's total appropriations in FY 2021.

Figure 1.1 provides details on NSF's FY 2021 appropriations. As noted in the Figure 1.1 footnote, the amounts include \$600 million in supplemental funding received under the ARP Act and a transfer between R&RA and AOAM. The *COVID-19 Activities* section provides details on ARP Act funding by account.



- R&RA supports research and education activities in science and engineering, including high-risk and transformative research. This appropriation accounted for 81 percent of FY 2021 funding. The FY 2021 R&RA funding level of \$7,347 million was \$558 million higher than the FY 2020 appropriation of \$6,790 million.
- EHR, which supports activities to develop a diverse and well-prepared U.S. STEM workforce and a scientifically literate citizenry, is NSF's second largest appropriation and is over 11 percent of the agency's budget. EHR's FY 2021 funding level of \$1,029 million was \$86 million above the FY 2020 EHR appropriation of \$943 million.

⁵ Amount shown is NSF's FY 2021 discretionary appropriations. This amount does not include Donations and H-1B Nonimmigrant Petitioner Receipts. These amounts are included in NSF's appropriations shown in the Statement of Budgetary Resources (SBR). The SBR is on page Financials-17 of this *Agency Financial Report (AFR)*.

- FY 2021 AOAM funding of \$387 million supported NSF agency operations and award management activities through which NSF's science and engineering research and education programs are administered. AOAM was over 4 percent of NSF's total FY 2021 appropriations. AOAM increased by \$29 million from the FY 2020 level of \$358 million.
- The MREFC appropriation supports the acquisition, construction, and commissioning of major and mid-scale infrastructure that provide unique capabilities at the frontiers of science and engineering. This account was over 3 percent of the agency's total appropriations in FY 2021. The FY 2021 MREFC funding level of \$301 million was \$58 million above the prior-year appropriation of \$243 million.
- Separate appropriations support the activities of the OIG and the NSB; each accounted for less than 1 percent of NSF's total FY 2021 appropriations. The FY 2021 OIG appropriation of \$17.9 million increased \$1 million over the FY 2020 appropriation. The NSB received an appropriation of \$4.5 million in FY 2021, equal to the previous year's funding level.



View of the Minneapolis skyline captured from Prospect Park Water Tower. Scientists affiliated with a new NSF-funded LTER site based in Minneapolis-St. Paul will examine how socioeconomic disparities, pollution, habitat loss and climate change interact to affect the environment in the Twin Cities. Credit: Michael Hicks

For more information: https://www.nsf.gov/news/special_reports/announcements/031021.01.jsp

New NSF Long-Term Ecological Research site will study dynamic and diverse relationships between urban nature and people

Mayors and city councils spend a lot of time thinking about the systems that their towns and cities rely on. It can be an intricate network of infrastructure, from roads and the water supply to electric grids and sewers. But there are also ecological and environmental systems to consider—rivers and streams, parks, waterfronts, green space, and even individual gardens and yards are all part of the anatomy of cities and towns. With funding from NSF, researchers at the Minneapolis-St. Paul Urban Long-Term Ecological Research Program (LTER) are studying urban nature to better understand these environments and how they interact with the complex matrix of infrastructure and social systems that make up urban areas. This research will provide long-term environmental data collection, analysis, and interpretation to examine, among many issues, the interface between climate change and social disparities. Just as civil engineers help local governments improve infrastructure and services that residents depend on, this research is going to expand the understanding of urban ecology to help city planners strengthen the benefits of natural landscapes that are important to the Twin Cities and their residents. All data are publicly accessible across the LTER network and beyond.

More than 33,000 members of the science and engineering community participated in the merit review process as panelists and proposal reviewers.⁶ Awards were made to over 1,900 institutions located in all 50 states, the District of Columbia, and four U.S. territories. These institutions employ many of America's leading scientists, engineers, and educators; and they train the leading innovators of tomorrow. In FY 2021, approximately 318,000 people were directly involved in NSF-funded programs and activities. Beyond these figures, NSF programs indirectly impact millions of people, reaching K-12 students and

⁶ For more information about NSF's merit review process, see https://www.nsf.gov/bfa/dias/policy/merit_review/ and *NSF's Merit Review Process, FY 2019 Digest* (NSB-2020-13) at https://www.nsf.gov/nsb/publications/2020/merit_review/FY-2019/nsb202038.pdf

teachers, the general public, and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of innovative instructional resources and teaching methods.

New filtering method promises safer drinking water

Most people know that adding fluoride to public water systems helps promote healthy teeth and prevent tooth decay. But in some places, the problem isn't too little fluoride in the water, it's too much. Where fluoride occurs naturally in water systems, communities have to be careful to limit the level of fluoride in drinking water in order to avoid health problems that can arise from prolonged exposure to excess fluoride. Until now, removing excess fluoride has required expensive high-pressure filtration systems or burdensome water treatment methods. But with funding from NSF's Small Business Innovation Research program—known as America's Seed Fund, researchers at Tufts University have developed a new, inexpensive filtering technology inspired by biology that can separate fluoride with twice the selectivity of other methods. Their novel and affordable polymer membranes can help protect community water systems and support public health throughout the nation and around the globe.



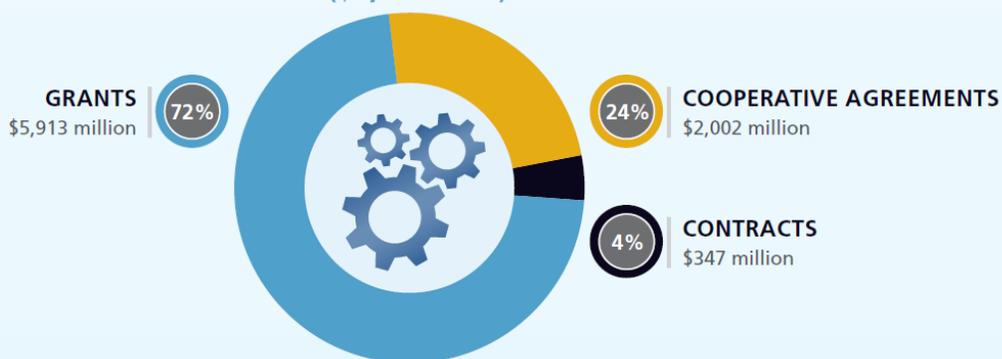
A new filtering method promises safer drinking water for tens of millions of people. Credit: Jenny Downing, CC by2.0

For more information: https://www.nsf.gov/discover-ies/disc_summ.jsp?WT.mc_id=USNSF_1&cntn_id=303584&utm_medium=email&utm_source=govdelivery

During FY 2021, NSF evaluated over 43,600 proposals through a competitive merit review process and made more than 11,300 new competitive awards, mostly to academic institutions. In addition to these proposals, GRFP reviewed approximately 13,000 applications for fellowships. As shown in Figure 1.2, the Award Mechanisms chart, NSF's award funding was used primarily for financial assistance to carry out a public purpose through grants and cooperative agreements. Grants can be either standard awards, in which funding for the full duration of the project is awarded in a single fiscal year, or continuing awards, in which funding for a multi-year project is awarded in increments. Cooperative agreements are used when the project requires substantial agency involvement (such as research centers and multi-use facilities). Contracts are used to acquire products, services, and studies, such as program evaluations, required for NSF or other government use.

Figure 1.2. NSF AWARD MECHANISMS

FY 2021 OBLIGATIONS FOR RESEARCH AND EDUCATION PROGRAMS
(\$8,262 million)



NSF Research and Education programs include Research and Related Activities, Education and Human Resources, and Major Research Equipment and Facilities Construction appropriations. Totals may not add due to rounding.

As shown in Figure 1.3, the Institutions Funded chart, 80 percent of support for research and education programs (\$6,594 million) was provided to 822 different colleges, universities, and academic consortia. Private industry, including small businesses and non-profit organizations, accounted for 13 percent (\$1,047 million), and support to Federally Funded Research and Development Centers accounted for approximately 4 percent, or \$298 million. Other recipients (federal, state, and local governments; and international organizations) accounted for almost 4 percent (\$322 million) of support for research and education programs.

Figure 1.3. INSTITUTIONS FUNDED BY NSF

FY 2021 OBLIGATIONS FOR RESEARCH AND EDUCATION PROGRAMS
(\$8,262 million)



NSF Research and Education programs include Research and Related Activities, Education and Human Resources, and Major Research Equipment and Facilities Construction appropriations. Totals may not add due to rounding.

COVID-19 Activities



Members of La Colaborativa, a Massachusetts non-profit that used science to help address vaccine hesitancy in their local community.

Credit: La Colaborativa/Darlene DeVita

Societal Experts Action Network helps community leaders save lives

How can state and local leaders and decision-makers draw on the vast research in social and behavioral sciences to help make better policy in their communities and effectively navigate an emergency like the COVID-19 pandemic? To respond to this need, the National Academies of Sciences, Engineering, and Medicine teamed up with NSF to assemble a network of scientists dedicated to helping local leaders translate decades of research into human behavior into clear and helpful guidance for public health and safety. Known as SEAN, the Social Experts Action Network, it's a compilation of accessible resources that local leaders and officials can use to keep their communities informed about COVID-19 and deploy evidence-based approaches for handling the public health emergency.

For more information:

<https://beta.nsf.gov/science-matters/camden-south-carolina-chelsea-massachusetts-behavioral-science-helps-community>

As part of the ARP Act, NSF received \$600 million to “fund or extend new and existing research grants, cooperative agreements, scholarships, fellowships, and apprenticeships, and related administrative expenses to prevent, prepare for, and respond to coronavirus.”⁷ In addition, NSF drew from its FY 2021 base appropriations and other available funds to support research related to COVID-19. NSF’s FY 2021 COVID-19 activities funded nearly 8,000 awards to over 12,000 principal investigators in 50 states and the District of Columbia. Table 1.1 shows the FY 2021 obligations related to COVID-19 activities.⁸ NSF’s coronavirus information webpages provide information on NSF’s response to the pandemic.⁹

Table 1.1 FY 2021 COVID-19 Activity Awards and Obligations

	ARP Act	All COVID-19
Number of Awards	756	7,996
FY 2021 Obligations (\$ in Millions)		
<i>Total</i>	\$240.5	\$1,775.9
<i>R&RA</i>	\$195.5	\$1,411.5
<i>EHR</i>	\$24.0	\$291.4
<i>MREFC</i>	\$8.9	\$10.5
<i>AOAM</i>	\$12.0	\$12.0
<i>Other funding</i>	-	\$50.5

Total may not add due to rounding.

Organizational Structure

NSF is an independent federal agency headed by a director who is appointed by the President and confirmed by the U.S. Senate.¹⁰ As shown in Figure 1.4, NSF’s organizational structure aligns with the major fields of science and engineering.¹¹

The NSF Director and the 24-member NSB jointly pursue the goals and functions of NSF, including the duty to “recommend and encourage the pursuit of national policies for the promotion of research and education in science and engineering.”¹² The NSB identifies issues critical to NSF’s future and helps chart the strategic direction of NSF’s budget and programs. NSB members are appointed by the President and are prominent contributors to the STEM research and education community.¹³ NSF’s Director is a member *ex officio* of the Board. The Director and the other NSB members serve 6-year terms.

The NSF Director leads a workforce that included 1,456 federal employees in FY 2021.¹⁴

⁷ American Rescue Plan Act: <https://www.congress.gov/bill/117th-congress/house-bill/1319/text>

⁸ Additional information on COVID-19 activities by appropriation is on page Financials-33 of this AFR.

⁹ NSF Coronavirus Information page: [https://www.nsf.gov/news/special_reports/coronavirus/ARP & COVID-19 Response Update:](https://www.nsf.gov/news/special_reports/coronavirus/ARP%20&%20COVID-19%20Response%20Update)

https://www.nsf.gov/about/congress/toolkit_images/NSF%20ARP%20Update%20Sept.%202021.pdf

¹⁰ The Director’s biography: https://www.nsf.gov/staff/staff_bio.jsp?lan=spanchan&from_org=

¹¹ NSF’s organization chart: https://www.nsf.gov/staff/organizational_chart.pdf

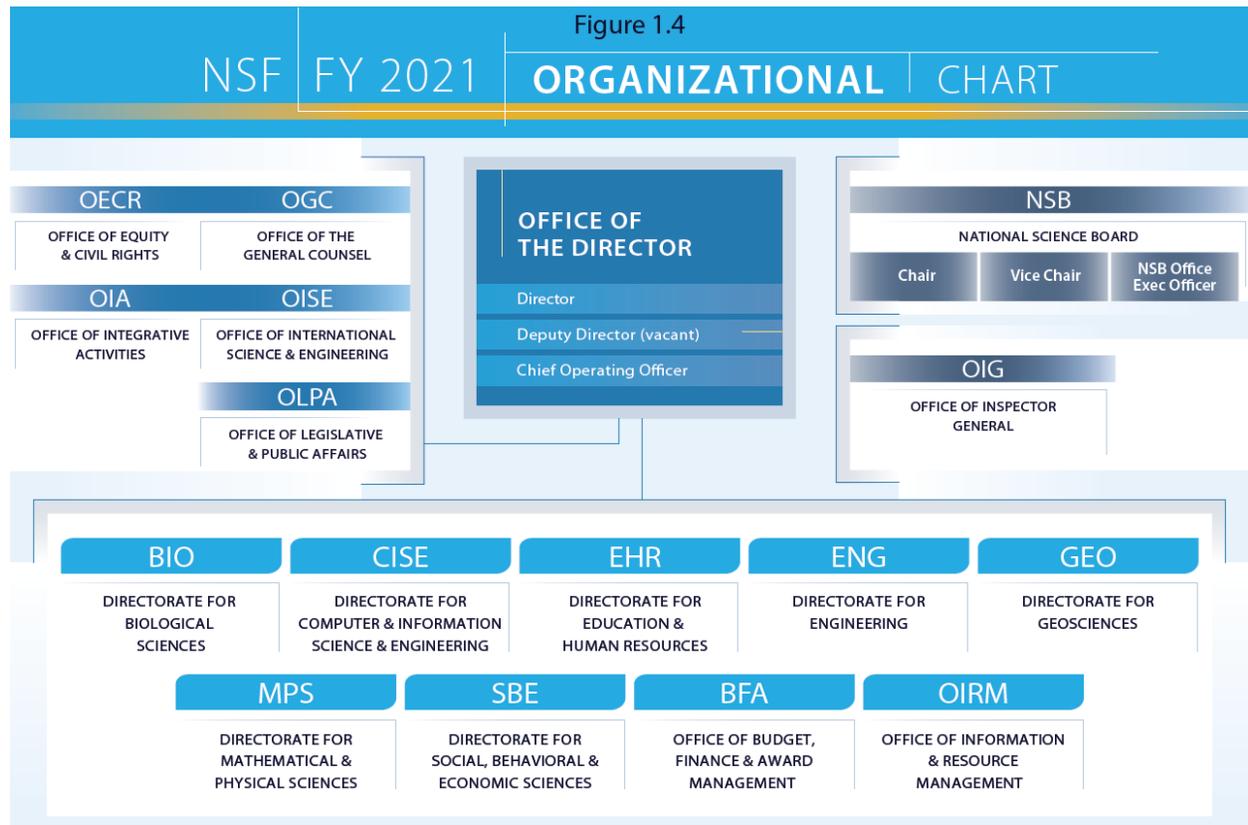
¹² 42 U.S. Code 1862(d): <https://www.law.cornell.edu/uscode/text/42/1862>

¹³ NSB members during FY 2021 are shown in Appendix 10 of this AFR

¹⁴ Full-time equivalents (FTEs) include the federal employee workforce for NSF, the NSB, the OIG, and U.S. Arctic Research Commission

NSF regularly recruits scientists, engineers, and educators through the Intergovernmental Personnel Act (IPA) who work at NSF for up to 4 years. These “rotators” bring fresh perspectives from across the country and across all fields of science supported by NSF, helping explore new directions for research in science, engineering, and education, including emerging interdisciplinary fields. On returning to their home institutions and from across academia, rotators bring knowledge of NSF programming and leading research from a national perspective. As of September 30, 2021, there were 195 temporary appointments under the IPA program.

In addition to the Foundation’s headquarters in Alexandria, Virginia, NSF maintains an office in Christchurch, New Zealand, to support the U.S. Antarctic Program USAP. During FY 2021, the OIG had an office in Denver, Colorado.



Management Challenges

In October 2020, the OIG identified six areas representing challenges for the agency for FY 2021: (1) Providing Oversight of Major Multi-User Research Facilities, (2) Providing Oversight of Grants During a Pandemic, (3) Managing the Intergovernmental Personnel Act Program, (4) Providing Oversight of the Antarctic Infrastructure Modernization for Science (AIMS) Project, (5) Increasing Diversity in Science & Engineering Education and Employment, and (6) Mitigating Threats Posed by Foreign Government Talent Recruitment Programs.¹⁵

Management's report on the significant activities undertaken in FY 2021 to address these challenges is in the *Appendix 2B: Management Challenges – NSF's Response* of this Agency Financial Report (AFR). The report also discusses activities planned for FY 2022 and beyond. Some of the agency's significant actions and planned next steps to address the challenges are highlighted in the following text.

Providing Oversight of Major Multi-User Research Facilities

NSF understands the importance of its role in overseeing current grant recipients' on-going management of major facilities, and of assessing prospective recipients' capabilities for managing major facilities prior to award. Over the past several years, NSF has greatly strengthened its oversight policies and procedures in response to prior OIG audits and four GAO reviews related to its oversight of projects funded from the MREFC account.

NSF leadership continues to show its commitment to major facilities oversight through appointment of the Chief Officer for Research Facilities (CORF) and through the annual Major Facilities Portfolio Risk Assessment process. Further, NSF has taken significant actions in recent years to mitigate the risks inherent in the major facilities portfolio, including the unprecedented degree of complexity and uncertainty resulting from the COVID-19 pandemic. Such actions include, but are not limited to: (1) completing the major facilities portfolio workforce gap analysis and beginning development of a training plan tied specifically to the major facility oversight competency model, (2) producing a regular report on COVID-19 impacts on major facilities in both the operations and construction stages for review by NSF leadership, and (3) revising standard operating guidance for NSF grants and agreements officers on the pre-award review process, which includes business and financial reviews, in line with GAO guidance. In addition, NSF took action to address the unique risks presented by the COVID-19 pandemic, including potential improper use of budget contingency funds, by developing internal and external guidance for major facility programs and recipients. The controls developed for COVID-19 will be more widely applicable to other unforeseen events, such as when the shipyard constructing the Regional Class Research Vessels experienced a direct hit from Hurricane Ida in August 2021. NSF is confident that its current and planned controls related to major facility oversight adequately consider and balance risk, resources, benefit to the science community, and stewardship of federal funds.

Going forward, NSF will finalize the *Major Facilities Oversight Reviews* standard operating guidance and provide it to OIG and GAO for consideration in closing remaining recommendations. NSF will also complete development and implementation of the training plan for the major facilities oversight workforce and monitor progress through periodic self-assessment surveys or other means.

¹⁵ Inspector General's Management Challenges for NSF in FY 2021:
https://nsf.gov/oig/_pdf/NSF_Management_Challenges_FY2021.pdf

Providing Oversight of Grants During a Pandemic

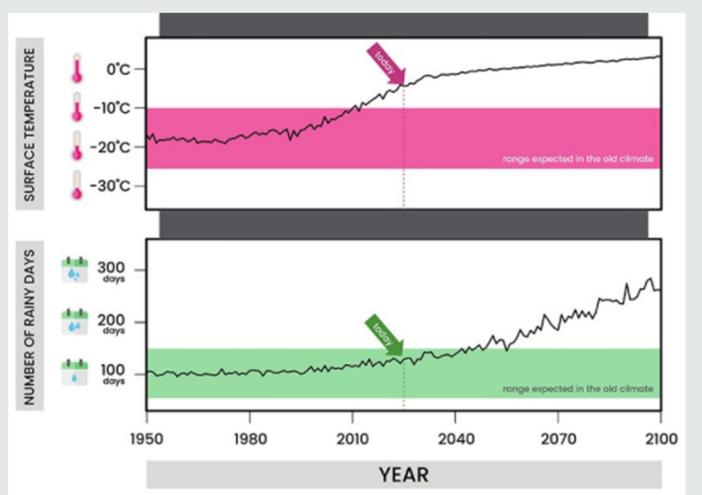
Throughout the COVID-19 pandemic, the research community has faced unprecedented challenges that have tested the people and infrastructure that make up the U.S. scientific research enterprise. Given these challenges, NSF recognized there may be heightened risk in grants programs compared to prior years, and that existing oversight processes may not align with challenges presented by the pandemic. In response to these risks, NSF demonstrated strong commitment to ensuring continued operations and maintenance of oversight functions, including ensuring sufficient people and resources to operate in a pandemic, and established processes to monitor spending of pandemic-related funding. NSF was able to maintain advanced monitoring and oversight activities through virtual site visits, desk reviews, targeted assessments, audit resolution, and new analytic approaches focused on the grant and cooperative agreement award portfolio.

In FY 2021, NSF demonstrated progress in addressing the challenges created by the COVID-19 pandemic in the following areas: (1) policy and outreach, including disseminating new guidance on the NSF Coronavirus webpage for the grants community to address emerging NSF and government-wide COVID-19 policies; (2) grants oversight, including implementation of internal NSF dashboards to monitor potential grant risk factors around expenditure patterns and post-award adjustments; and (3) risk management and internal controls, including conducting annual testing of grant award expenditures covering April 2020 through March 2021 to update the improper payment risk baseline, which indicated a similarly low risk level as in prior year testing results.

Going forward, NSF will continue to assess and minimize risk through activities such as issuing updated guidance as necessary, monitoring compliance through site visits and desk reviews, updating and enhancing financial reporting, and issuing a final improper payment risk assessment report.

Fast-warming Arctic transitioning to new climate state

The Arctic is experiencing climate change at a rapid and dramatic pace, leading to significant uncertainty about what regional weather patterns will look like in the future. With NSF funding, researchers from the National Center for Atmospheric Research—the Nation's premier research center for meteorology, climate science, and atmospheric research, headquartered in Boulder, CO—are working to understand how changes in sea ice cover will affect the future of the Arctic environment. Sea ice plays a critical role in climate and meteorology by reflecting heat and light, but when light-colored Arctic ice melts, it is replaced by darker ocean water, which absorbs more heat and accelerates the changes taking place. By improving our ability to measure sea ice, researchers are enabling better climate models that will help us navigate the enormous changes in the Arctic and better understand what they mean for the global climate.



The Arctic is transitioning to a new climate state because of rapid warming. Credit: Simmi Sinha/UCAR

For more information and a larger image: https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=301270

Managing the Intergovernmental Personnel Act (IPA) Program

NSF provides the opportunity for scientists, engineers, and educators to rotate into the Foundation on a temporary basis, bringing fresh perspectives from across all fields of science and engineering (S&E) supported by the agency. OIG has noted risks related to these rotators remaining involved in their professional research and development activities while working at NSF; and the COVID-19 pandemic has brought new and unique challenges to this program, including recruiting, onboarding, and managing IPAs in a remote work environment. NSF takes a proactive approach to the management of the IPA Program to appropriately consider and mitigate inherent risks associated with its execution, including through an IPA Steering Committee that advises the Foundation's senior leadership on matters that directly concern policy on the use of the IPA Program. NSF engages in continuous improvement of its management of the IPA Program, addressing the management challenges identified by the OIG as well as other agency-identified risks and challenges.

In recent years, NSF has completed numerous actions to address the management challenges identified by the OIG related to the IPA program. Through these actions, NSF is confident it has reduced the inherent risk substantially, such that the residual risk is acceptable to the agency. Specific accomplishments in FY 2021 include (1) migrating Program Director and Executive IPAs to the USA Performance system for managing performance plans; (2) facilitating a focus group of IPAs who onboarded during COVID, to help identify new and unique challenges associated with onboarding in a remote work environment; and (3) establishing a plan to collect and analyze FY 2021 data on IPA recruiting, onboarding, and costs attributed to the COVID-19 pandemic to be included in the FY 2021 IPA Annual Report.

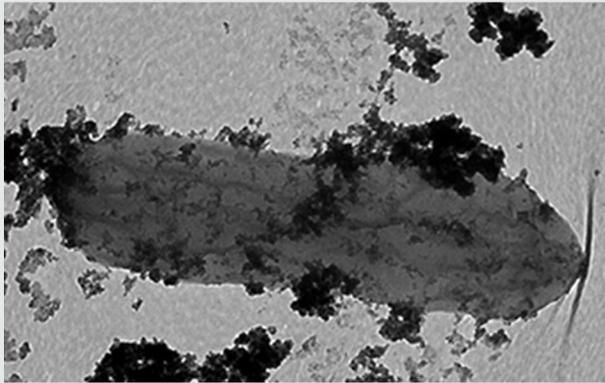
Going forward, NSF will continue to monitor risk and manage the IPA program through actions such as providing annual training for independent research/development (IR/D) experts; collecting quarterly data on IR/D time and travel by both permanent and rotating staff for oversight by NSF senior management; and using the Federal Employee Viewpoint Survey and other mechanisms to help identify challenges to the program, including recruiting, onboarding, and managing IPAs in a remote work environment.

Providing Oversight of the Antarctic Infrastructure Modernization for Science (AIMS) Project

NSF—through the Office of Polar Programs in the Directorate for Geosciences—funds and manages the USAP which supports the United States' research and national policy goals in the Antarctic. USAP has two major construction projects to replace multiple outdated structures and consolidate key functions for more streamlined and efficient operations, one of which is the AIMS project. The OIG identified the AIMS project as one that will require continued vigilance, as it will stretch agency resources and may present additional challenges. While NSF agrees there are inherent risks associated with Antarctica's remote location, extreme environment, and the short period of time during which the continent is accessible, NSF has mitigated risk through actions such as extensive planning and coordination to meet equipment delivery dates.

The global pandemic associated with COVID-19 resulted in significant changes to program and construction project plans as deployed construction crews were brought home due to health and safety concerns. In accordance with NSF policy, the magnitude of these impacts will require re-baselining of the AIMS project and the Office of Polar Programs is actively engaged with the contractor; the Office of Budget, Finance, and Award Management; and the Office of the Director for that purpose. In FY 2021, NSF acquired no-cost access to long-term storage for materials, and convened NSF leadership to evaluate options for project re-baselining and to develop a new path forward that transitions AIMS to a long-term Antarctic Infrastructure Recapitalization program.

Going forward, NSF will continue to monitor and oversee AIMS, under established internal management and project execution plans, while working to re-baseline the project cost and schedule. NSF will also conduct quarterly NSF integrated project team meetings to ensure the status of AIMS developments is communicated and to solicit expert feedback.



This *Geobacter* cell is speckled with cobalt minerals that would be toxic to many organisms. Image Credit: Hunter Dulay

For more information: https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=302049

'Iron Man' bacteria could help protect the environment

Researchers at Michigan State University have shown that microbes found in soil and sediment, known as *Geobacter*, are capable of a feat that could help reclaim a valuable natural resource and soak up toxic pollutants. The researchers found that *Geobacter* microbes were resistant to the toxic effects of cobalt. Cobalt is a metal used in lithium-ion batteries—it is rare and valuable, and toxic to living things, including humans and microbes. When *Geobacter* microbes encountered rust containing cobalt, they were able to extract the cobalt without it penetrating their cells and causing harm. Cobalt nanoparticles instead formed a protective layer around the microbes. The research is an exciting proof-of-concept that *Geobacter* microbes could be an important tool for cleaning up a range of toxic metals and for efficiently reclaiming valuable resources like cobalt.

Increasing Diversity in Science & Engineering Education and Employment

Efforts to increase diversity in S&E education and employment have been a hallmark of NSF since its founding, and throughout its history. The agency has pursued a variety of program and policy approaches to increasing diversity in S&E. Broadening participation is the focus or emphasis of a number of programs, and this emphasis is demonstrated within the entire NSF portfolio through the broader impacts criterion used in the merit review process. This challenge remains a priority for NSF: while there have been noteworthy areas of progress, such as increases in the shares of individuals in S&E occupations from racial and ethnic groups historically underrepresented in STEM,¹⁶ the groups and communities that have been underrepresented and underserved in the STEM arena for decades remain so today.

NSF recognizes that its efforts to advance diversity and promote inclusion warrant unprecedented urgency, in keeping with the national imperative outlined by the Administration and its Racial Equity Executive Order¹⁷ (Executive Order 13985) and the global trends in science as outlined by the NSB in the *Vision 2030* report.¹⁸ Efforts to address this challenge span across every NSF Directorate and Office. Specific actions in FY 2021 to increase diversity in S&E education and employment included (1) the release of the 2021 Women, Minorities, and Persons with Disabilities in Science and Engineering report, providing data on participation of these groups in S&E education and employment; (2) organizational changes within NSF to streamline processes and procedures related to equity and civil rights issues; and (3) releasing new

¹⁶ Underrepresented minorities in S&E occupations: <https://nces.nsf.gov/pubs/nsb20201/figure/8>

¹⁷ Racial Equity Executive Order link: <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/>

¹⁸ The NSB's *Vision 2030* report is available at <https://www.nsf.gov/nsb/publications/2020/nsb202015.pdf>

funding opportunities related to broadening participation and to assessing the impacts of COVID-19 on students from groups historically underrepresented in STEM.¹⁹

Going forward, NSF will focus attention on milestones in line with its operational and strategic objectives in the area of increasing diversity, including: (1) continuing implementation work to strengthen the engagement of Historically Black Colleges and Universities (HBCUs) in NSF's programs, in line with a recent Executive Order, (2) continuing to examine the challenges of limited data on certain groups of individuals known to be underrepresented in STEM, and (3) in keeping with the agency's response to Executive Order 13985, finalizing the strategic framing of efforts to ensure accessibility and inclusivity in the NSF Strategic Plan for FY 2022-2026, and its associated performance activities, with public release scheduled for February 2022.

Mitigating Threats Posed by Foreign Government Talent Recruitment Programs

NSF seeks to maintain a vibrant science and engineering community for the benefit of the Nation. Participation in this community relies on individuals to uphold core principles and values such as openness, transparency, reciprocity, collaboration, and integrity. However, open scientific exchange and research face a challenge from some foreign governments through the use of talent recruitment programs. Some of these programs deliberately disregard these core principles and incentivize participants to misappropriate U.S.-funded scientific research prior to its open publication. These programs target scientists, engineers, and educators of all nationalities working or educated in the United States.

In FY 2021, NSF took multiple actions to demonstrate progress on this issue. The agency (1) developed and released training for NSF staff on assessing disclosures required as part of the proposal process; (2) conducted outreach to the academic community to raise awareness of the risks to research security including those posed by foreign government talent recruitment programs; (3) co-chaired the subcommittee that developed the "Recommended Practices for Strengthening the Security and Integrity of America's Science and Technology Research Enterprise" released by the White House, and (4) collaborated with OIG to address threats posed by foreign government talent recruitment programs, including recouping or preventing the loss of millions of taxpayer dollars through actions to suspend or terminate awards.

Going forward, NSF will continue to work diligently to address the risks of foreign government interference in NSF-funded research. This work will include development of a comprehensive plan of additional actions to address threats from foreign government interference and ensure the integrity and security of NSF-funded research. More specifically, NSF will take steps to (1) enhance awareness of research security risks and protections; (2) implement NSF's enhanced pre-award and post-award disclosure requirements; (3) share information across U.S. government agencies, including OIG; and (4) identify and analyze risks.

¹⁹ The 2021 *Women, Minorities, and Persons with Disabilities in Science and Engineering* report is available at <https://nces.nsf.gov/pubs/nsf21321>

Performance

NSF's Strategic Plan for FY 2018 – 2022, *Building the Future: Investing in Discovery and Innovation*,²⁰ establishes two strategic goals that capture the dual nature of NSF's mission to advance the progress of science while benefitting the Nation: *Expand knowledge in science, engineering, and learning* and *Advance the capability of the Nation to meet current and future challenges*. A third goal, *Enhance NSF's performance of its mission*, directs NSF to hold itself accountable for achieving excellence in carrying out its mission. As shown in the following table, each goal has two strategic objectives which together encompass all areas of agency activity. This goal structure enables NSF to link its investments to longer-term outcomes.

Strategic Goals and Objectives

Strategic Goals	Strategic Objectives
Expand knowledge in science, engineering, and learning	<i>1.1 Knowledge</i> Advance knowledge through investments in ideas, people, and infrastructure.
	<i>1.2 Practice</i> Advance the practice of research.
Advance the capability of the Nation to meet current and future challenges	<i>2.1 Societal Impacts</i> Support research and promote partnerships to accelerate innovation and to provide new capabilities to meet pressing societal needs.
	<i>2.2 STEM Workforce</i> Foster the growth of a more capable and diverse research workforce and advance the scientific and innovation skills of the Nation.
Enhance NSF's performance of its mission	<i>3.1 Human Capital</i> Attract, retain, and empower a talented and diverse workforce.
	<i>3.2 Processes and Operations</i> Continually improve agency operations.

Although reporting on Agency Priority Goals (APGs) was suspended on performance.gov during FY 2021, a Presidential transition year, NSF continued to work towards its Partnerships-focused APG for FY 2020-2021: *Strategically engage in public and private partnerships to enhance the impact of NSF's investments and contribute to American economic competitiveness and security*.^{21,22} The APG stated that by September 30, 2021, NSF would develop and pursue an agency-wide partnerships strategy, components of which would include targeted outreach, implementation of process improvements, and improvement of internal and external communications. NSF achieved this goal, making progress in all three areas. NSF's *FY 2021 Annual Performance Report (APR)* will contain a full accounting of what was implemented. In FY 2021, NSF continued its practice of having agency leaders conduct quarterly data-driven performance reviews, including reporting on the APG, and continued to participate actively in the President's Management Council.

²⁰ NSF Strategic Plan FY 2018 – 2022: <https://www.nsf.gov/pubs/2018/nsf18045/nsf18045.pdf>. The NSF Strategic Plan for FY 2022-2026 will be presented with the FY 2023 Budget in February 2022.

²¹ Agency Priority Goal: https://trumpadministration.archives.performance.gov/NSF/APG_nsf_1.html

²² NSF has strategic public-private partnerships that do not meet the thresholds governing financial reporting, per the Statement of Federal Financial Accounting Standards (SFFAS) 49, "Private Public Partnership: Disclosure Requirements."

Progress Toward Achievement of Performance Goals

Each year, NSF produces an *AFR*, *APR*, and a *Performance and Financial Highlights* summary report. NSF's *FY 2021 APR* will appear in the *FY 2023 Budget Request to Congress* as part of an integrated Performance Plan and Report. This report will provide a complete discussion of NSF's performance measures, including descriptions of the metrics, methodologies, results, and trends, along with a list of relevant external reviews. The topic areas of these goals are listed in the following table. Targets and annual results will be provided in the *FY 2021 APR*. Where appropriate, results will incorporate a discussion about the effects of the COVID-19 pandemic on performance. The *FY 2021 APR* will also provide information about NSF's verification and validation review of performance data, as required by the Government Performance and Results Modernization Act of 2010. NSF's *FY 2021 APR* and *FY 2021 Performance and Financial Highlights* summary report will be posted on the NSF website concurrent with NSF's *FY 2023 Budget Request to Congress* in February 2022.²³

FY 2021 Performance Goals

Goal Short Name	Goal Statement
APG: Public and Private Partnerships	APG: Strategically engage in public and private partnerships to enhance the impact of NSF's investments and contribute to American economic competitiveness and security.
Ensure that Key Program Investments are on Track	Ensure that key NSF-wide program investments are implemented and on track.
Ensure that Infrastructure Investments are on Track	Ensure program integrity and responsible stewardship of major research facilities and infrastructure.
Make Timely Proposal Decisions	Divisions and Offices will make timely proposal decisions.
Improve Review Quality	Improve the quality of written reviews of NSF proposals.
Foster a Culture of Inclusion	Foster a culture of inclusion through change management efforts resulting in change leadership and accountability.
Align Job Requirements with Competencies	Ensure that employee job requirements are aligned with competencies and skills needed for the future.
Improve User Interactions with Information Technology (IT) Systems	Streamline and simplify user interactions with IT systems and functions that support the merit review process, reducing non-value-added steps and reducing the time spent managing the proposal and award lifecycle.

Renewing NSF

In FY 2021, NSF continued ongoing efforts focused on internal agency reform and process improvement, collectively called "Renewing NSF." Renewing NSF aims to enhance performance of NSF's mission and thereby maintain U.S. leadership in research and education across all areas of STEM. This effort is aligned with NSF's history of continuous organizational improvement and the Administration's government-wide agency reform activities, and it will yield an even more agile organization better prepared for future challenges and opportunities. The four focus areas of Renewing NSF are: (1) making information technology work even better for all; (2) adapting the workforce and the work; (3) streamlining, standardizing, and

²³ *FY 2021 Agency Performance Report* (included in the Performance chapter of the *FY 2023 Budget Request to Congress*) and *FY 2021 Performance and Financial Highlights*: <https://www.nsf.gov/about/performance/>

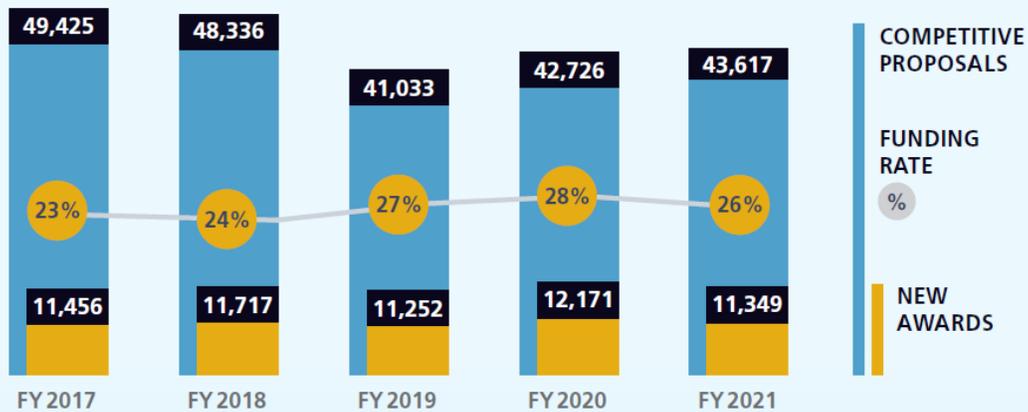
simplifying processes and practices; and (4) expanding and deepening public and private partnerships. NSF has performance goals supporting all four areas. For example, the Renewing NSF emphasis on expanding and deepening public and private partnerships has been directly aligned with the FY 2021 APG on Public and Private Partnerships.

Proposal Workload and Management Trends

NSF continuously monitors key portfolio, proposal workload, and financial measures to understand short- and long-term trends and to help inform management decisions. For an analysis of the long-term trends in competitive proposals, awards, funding rate, and other portfolio metrics, see the *National Science Foundation's Merit Review Process, Fiscal Year 2019 Digest*.²⁴ In FY 2021, NSF introduced a new, interactive dashboard, *NSF by the Numbers*,²⁵ that provides statistical and funding information with filters for viewing NSF funding, award, and proposal data by State, fiscal year, institution-type and other variables.

Figure 1.5 identifies three key portfolio measures: competitive proposals acted upon, new awards, and funding rates.

Figure 1.5. Number of NSF Competitive Proposals, New Awards and Funding Rates



Note: New awards are a subset of competitive proposals.

²⁴ NSF's Merit Review Process, FY 2019 Digest (NSB-2020-38): https://www.nsf.gov/nsb/publications/2020/merit_review/FY-2019/nsb202038.pdf

²⁵ NSF by the Numbers dashboard: <https://beta.nsf.gov/about/about-nsf-by-the-numbers>

Table 1.2 provides proposal workload and management trends over 5 years. Highlights of these indicators are as follows:

- Between FY 2020 and FY 2021, the number of competitive proposal actions increased by 2 percent; from 42,726 to 43,617.
- The number of new awards in FY 2021 was 11,349, a decrease of almost 7 percent from FY 2020.
- The overall funding rate in FY 2021 was 26 percent, a decrease of 2 percentage points. Funding rates differ by directorate and are presented in the agency's annual budget request to Congress.
- The average annual award size of competitive awards was \$231,202, approximately \$18,000 higher than in FY 2020. The average annual award size has been increasing each year.
- The number of employees (FTEs) increased between FY 2020 and FY 2021, 1,421 FTE and 1,456 FTE, respectively.
- The number of active awards increased 2 percent in FY 2021, from 55,239 in FY 2020 to 56,427 in FY 2021. The 5-year average number of active awards is almost 55,000.

Table 1.2 Proposal Workload and Management Trends

Measure		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	Percent Change (FY 2021-FY 2020)	Average (FY 2017-FY 2021)
Portfolio	Competitive proposal actions	49,425	48,336	41,033	42,726	43,617	2.1%	45,027
	Competitive award actions	11,456	11,717	11,252	12,171	11,349	-6.8%	11,589
	Average annual award size (competitive awards)	\$174,533	\$189,418	\$197,530	\$213,280	\$231,202	8.4%	\$201,193
	Funding rate	23%	24%	27%	28%	26%	-2 percentage points	26%
Proposal Workload	Number of employees FTE, usage ¹	1,430	1,417	1,415	1,421	1,456	2.5%	1,428
	Number of active awards ²	54,806	54,386	54,093	55,239	56,427	2.2%	54,990
	Proposal reviews conducted ³	231,691	223,781	192,033	199,526	211,903	6.2%	211,787
Financial	Number of grant payments	22,615	21,727	20,935	22,169	23,794	7.3%	22,248
	Award expenses incurred but not reported at 9/30 (\$ in millions) ⁴	\$397	\$393	\$425	\$390	\$444	13.8%	\$410

Notes:

¹ FTEs shown include the federal employee workforce for NSF, NSB, OIG, and U.S. Arctic Research Commission.

² Active awards include all active awards regardless of whether funds were received during the fiscal year.

³ Includes written reviews, panel summaries, and site visit reports. In FY 2017, system changes implemented additional categories of panelist roles. Beginning in FY 2018, reviews conducted by these roles are included in the review counts, and FY 2017 was revised for historical consistency.

⁴ FY 2021 number reflects an accrual, and all other years reflect the validated estimate for the fiscal year. This metric does not include accruals for SBIR awards.

- All NSF awardee institutions are required to submit payment requests at the award level to the NSF Award Cash Management Service (ACM\$). Award expenses are posted to the NSF financial system at the time of the payment request. Reliance on ACM\$ reduces the burden of manual invoicing and potential for errors or missed payments.
- Since its introduction in FY 2013, ACM\$ has significantly improved the timeliness of grant financial data. Prior to ACM\$, NSF awardee institutions using quarterly expense reporting processes had approximately \$1.7 billion in award expenses that they had incurred but not-yet-reported to NSF on September 30. With the use of ACM\$, the amount of incurred but not-yet-reported award expenses have averaged \$410 million for the last 5 years.



The goal of new research is to develop room temperature superconducting materials. Currently, extreme cold is required to achieve superconductivity, as demonstrated in this photo in which a magnet floats over a superconductor cooled in liquid nitrogen. *Credit: University of Rochester/J. Adam Fenster*

For more information:
https://www.youtube.com/watch?v=onB0w3_Su9I

Room-Temperature Superconductor

Researchers at the University of Rochester have set a new record in the quest to achieve superconductivity at room temperature. Superconducting materials have special properties—including zero electrical resistance—that could revolutionize technology at every level, from microscopic sensors to high-efficiency batteries to medical imaging and mag-lev trains. But until now, superconductivity has only been achieved at extremely low temperatures that are difficult and expensive to accomplish. Supported by NSF, the researchers squeezed a mixture of hydrogen, sulfur, and carbon to intense pressures to produce a tiny dot of superconducting material at 58 degrees Fahrenheit—the kind of temperatures seen in Rochester, NY in October and much easier to achieve than usual superconducting temperatures of hundreds of degrees below zero.

Financial Discussion and Analysis

Financial accountability and effective business processes underpin NSF's programmatic activities and are critical to the achievement of NSF's mission. Following are several important FY 2021 financial management activities that highlight NSF's commitment to fiscal stewardship:

- *Flexibilities and Reporting Requirements related to the American Rescue Plan (ARP) Act of 2021²⁶ and Coronavirus Aid, Relief, and Economic Security (CARES) Act:²⁷* In March 2021, NSF implemented the disaster relief flexibilities in Office of Management and Budget (OMB) Memorandum M-21-20, *Promoting Public Trust in the Federal Government through Effective Implementation of the American Rescue Plan Act and Stewardship of the Taxpayer Resources.*²⁸ The flexibilities applied to NSF recipients with COVID-19 related Federal financial assistance awards, as well as those with assistance awards not related to COVID-19. The flexibilities provided relief in specific administrative, financial management, and audit areas to limit the negative impacts of the pandemic on NSF-funded work without compromising accountability requirements.

To address requirements in the ARP Act, NSF is working to improve the award descriptions reported in USAspending.gov, project reporting, and sub-award reporting. NSF is undertaking these efforts while being mindful to minimize burden on the agency and the research community.

- *Reporting Innovations:* NSF published and utilized several dashboards in FY 2021 to track key indicators for analysis and decision-making related to the management of proposals, awards, and financial closeout.
 - The *ARP Proposal Lifecycle* dashboard provides summary and detailed information to assist NSF staff in reviewing ARP-funded proposals as the proposals move from 'pending' to 'committed' to 'awarded'. The dashboard provides award information by appropriation and division or directorate. Reporting takes advantage of Robotic Process Automation to distribute a daily e-mail with ARP proposal details and summary statistics to key staff involved in ARP proposal review.
 - NSF deployed the *COVID-19 Award Summary* dashboard to track the agency's total efforts related to COVID-19 research and recovery related activities. This dashboard allows NSF staff to explore and analyze COVID-19 grant information for awards funded through ARP, the CARES Act, and base NSF appropriations. The agency also uses the dashboard to support regular reporting to Congress and other external constituents.
 - The *BFA Burn Rate Explorer* dashboard, gives staff a snapshot of expenditures (burn rate) on awards in NSF's grant portfolio. For example, the dashboard helps users identify awards with burn rates that are a different rate from most of the portfolio, thereby identifying potential outliers. The information in this dashboard helps NSF staff monitor grants and provide appropriate and timely outreach.
 - NSF's *Small Business Innovation Research and Small Business Technology Transfer Award Close* dashboard is a valuable tool in managing the workload of awards for closure and aids financial closeout by the program offices.

²⁶ *ARP Act:* <https://www.congress.gov/bill/117th-congress/house-bill/1319/text>

²⁷ *CARES Act:* <https://www.congress.gov/116/bills/hr748/BILLS-116hr748enr.pdf>

²⁸ *OMB M-21-20:* https://www.whitehouse.gov/wp-content/uploads/2021/03/M_21_20.pdf

- **Financial System Upgrades and Innovations:** NSF continued to enhance and upgrade its financial system environment; work toward implementation of government-wide initiatives, such as G-invoicing and Unique Entity Identifiers; seek innovative solutions using robotics process automation; and expand its analytical capabilities to better support NSF's mission. More information on FY 2021 and future financial systems enhancements, initiatives, and innovations is on page MD&A-35.

Synthetic biology startup helps fight COVID

NSF investments sometimes pay off in more ways than one. Take Ginkgo Bioworks as an example. It's a synthetic biology company whose founders received early funding from NSF as Graduate Research Fellows in the early 2000s and then in 2009 through the Small Business Innovation Research (SBIR) program based on research conducted at an NSF Engineering Research Center. Today, Ginkgo Bioworks operates a cell programming platform intended to make biology "easier to engineer" and is valued at billions of dollars—hardly a small business anymore. But when the COVID-19 outbreak began in March of 2020, they knew that beating the pandemic would require scaling up efforts throughout the biotech community. They committed \$25 million of their resources for use by companies and laboratories developing diagnostic tools, drugs, vaccines, and therapeutics—at no cost to the users. They also stepped up to help coordinate matching resources to researchers, including private funding and R&D information. Ginkgo Bioworks shows how NSF investments keep paying off and can deliver returns to society when we need them most.



Image of a laboratory that designs and builds custom microbes and was supported through an SBIR grant. Credit: Ginkgo Bioworks

For more information: <https://seedfund.nsf.gov/awardees/history/details/?company=ginkgo-bioworks>

- **Government-wide Initiative on Unique Entity Identification (UEI):** In 2022, entities doing business with the federal government will use a UEI created in the System for Award Management (SAM.gov) and stop using DUNS numbers. This transition allows the government to streamline the entity identification and validation process, making it easier and less burdensome for entities to do business with the federal government. NSF is successfully moving forward with planned enhancements to iTRAK and certain NSF business applications. In addition, NSF is conducting data cleansing on institution data to ensure a one-to-one link between the institution identification and DUNS number and is also enhancing the consistent usage of SAM data across its externally facing systems. The agency plans to start using and reporting UEI information in February 2022, before the required April 2022 cutover date.
- **Blockchain proof-of-concept:** Blockchain is a type of database that has the potential to increase trust, security, transparency, and the traceability of data that NSF shares across its network. In FY 2021, NSF completed work on a second phase of a blockchain proof-of-concept project in collaboration with the U.S. Department of Treasury. The project team engaged with more than 100 stakeholders, across 15 government organizations and 57 universities to establish a Federal

Demonstration Partnership Exploration Working Group. Planning efforts are underway to begin the next phase of NSF's blockchain efforts.

- *Enterprise Risk Management (ERM)*: ERM supports NSF's mission by promoting and facilitating a risk-aware culture across NSF and enabling risk-informed decision making and resource prioritization. NSF continued to increase the maturity of its ERM capability consistent with the agency's goal to enhance performance of its mission. In FY 2021, NSF Risk Captains met regularly, updated prior year risk profiles, and supported NSF's directorates and offices in identifying emerging risk and opportunity areas. In the interest of ensuring efficient and effective operations, Risk Captains continued a risk dialogue around the threats and opportunities that a large increase to NSF's budget could present at the leadership and operational levels.

In accordance with the Chief Financial Officers (CFO) Act and the Government Management Reform Act of 1994, NSF prepares financial statements in conformity with Generally Accepted Accounting Principles (GAAP) for federal entities. The financial statements present NSF's detailed financial information relative to its mission and the stewardship of resources entrusted to the agency. They also provide readers with an understanding of the resources that NSF has available, the cost of its programs, and the status of resources at the end of the fiscal year. NSF's financial statements have undergone an independent audit to ensure that they are free from material misstatement and can be used to assess NSF's financial status and related financial activities for the year ending September 30, 2021.

NSF received an unmodified audit opinion on its financial statements, and no material weaknesses or significant deficiencies were identified in the internal control program for financial reporting. The Independent Auditor's Report begins on the first page of Chapter 2, *Financials*. Management's response follows the audit report.

Eco-friendlier plastic

Plastic waste is a huge problem. Besides being made from petroleum, a non-renewable resource, most plastic products take a long time to break down, lingering for decades or even centuries in landfills and polluting water systems. Researchers at the FAMU-FSU College of Engineering—a joint engineering program between Florida A&M University and Florida State University—have made important progress on how industry could produce more sustainable plastics from renewable biomass. The researchers' breakthrough is in understanding how sustainable polymers behave when heated and cooled to their final shape. The team found that the polymers derived from biomass have properties very different from similar materials—rapid cooling and slow cooling each produce a different type of material, but mid-range cooling processes prevent the polymer from solidifying at all. Understanding the properties of these sustainable polymers could be a step toward revolutionizing how plastics are produced.



Principal Investigator Dr. Alamo with drawings of new polymer research that may revolutionize how plastics are processed. *Credit: FAMU-FSU*

For more information: <https://www.eng.famu.fsu.edu/index.php/news/alamo-temperature-sustainable-polymers>

Understanding the Financial Statements

The following discussion of NSF's financial condition and results of operations should be read together with the FY 2021 financial statements and accompanying notes, found in Chapter 2, Financials, of this AFR.

In accordance with guidance in OMB Circular No. A-136, *Financial Reporting Requirements*, NSF's FY 2021 financial statements and notes are presented in a comparative format to facilitate analysis of FYs 2021 and 2020. Table 1.3 summarizes the changes in NSF's financial position in FY 2021 relative to FY 2020.

Table 1.3 – Changes in NSF's Financial Position in FY 2021
(Dollars in Millions)

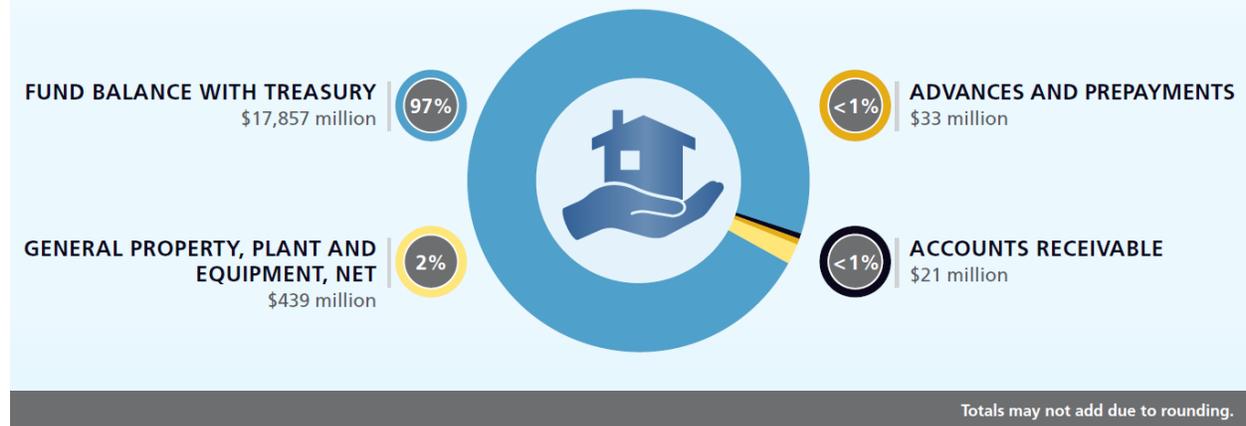
Net Financial Condition	FY 2021	FY 2020	\$ Change	% Change
Assets	\$18,349	\$16,493	\$1,856	11%
Liabilities	\$665	\$633	\$32	5%
Net Position	\$17,684	\$15,860	\$1,824	12%
Net Cost	\$7,376	\$7,355	\$21	<1%

Balance Sheet

The Balance Sheet presents the total amounts available for use by NSF (assets) against the amounts owed (liabilities) and amounts that comprise the difference (net position). NSF's total assets are largely composed of *Fund Balance with Treasury*.

In FY 2021, Total Assets increased 11 percent from FY 2020. The majority of the change occurred in the *Fund Balance with Treasury* account, which increased by \$1,817 million in FY 2021. NSF is authorized to use *Fund Balance with Treasury* to make expenditures and pay amounts due through the disbursement authority of Treasury. The *Fund Balance with Treasury* is increased through appropriations and collections and decreased by expenditures and rescissions.

Figure 1.6. FY 2021 ASSETS



In FY 2021, Total Liabilities increased by 5 percent from FY 2020. Driving this change was a \$16 million increase in *Accounts Payable* in addition to an increase of \$13 million in *Accrued Grant Liabilities*. Non-Federal *Accounts Payable* is estimated annually by utilizing historical data based on the actual expenses incurred but not reported, as a percentage of current fiscal year expenses. In FY 2021, NSF modified the Federal portion of *Accounts Payable* by performing outreach to its trading partners and recording offsetting payable accruals for any reported trading partner *Accounts Receivable*. The accrual for standard grants and cooperative agreements is estimated annually by utilizing a linear regression model based on the correlation of NSF grantee's historical unliquidated obligations and expenses incurred but not reported. The accrual for Small Business Innovation Research and Small Business Technology Transfer grants uses a methodology that is based on their unique terms and conditions. In FY 2021, the unliquidated obligations balance for grantees increased, resulting in a higher *Accrued Grant Liabilities* as compared to FY 2020.

Figure 1.7. FY 2021 LIABILITIES



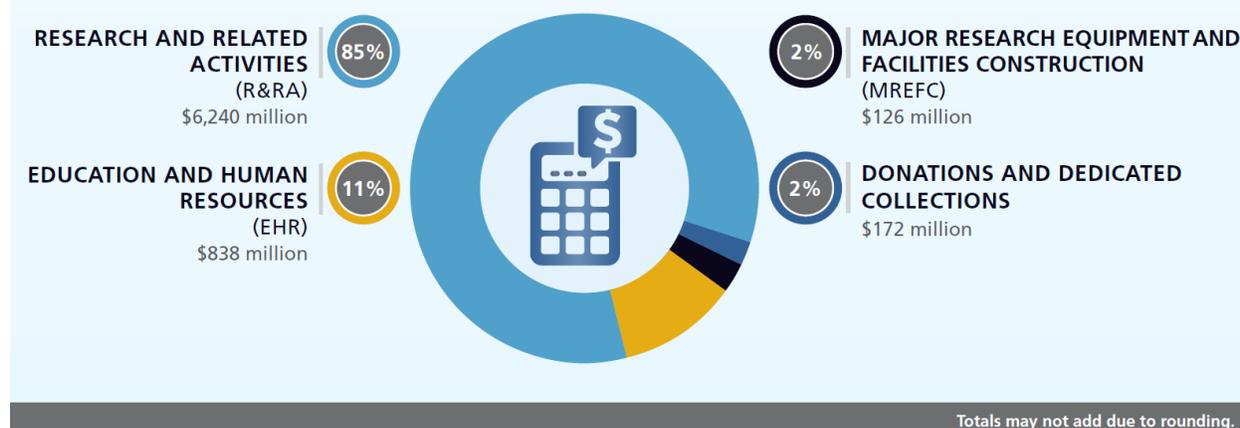
NSF's assets and liabilities were impacted by appropriated funds related to CARES and ARP Act funding primarily in support of R&RA for COVID-19. As of September 30, 2021, NSF had \$596 million in assets and \$10 million in liabilities for COVID-19 related activities.

Statement of Net Cost

The Statement of Net Cost presents the annual cost of operating NSF programs. The net cost of operations of each NSF program equals the program's gross cost less any offsetting revenue. Intragovernmental earned revenues are recognized when related program or administrative expenses are incurred. Earned revenue is deducted from the full cost of the programs to arrive at the *Net Cost of Operations*.

Approximately 95 percent of FY 2021 *Net Cost of Operations* was directly related to the support of R&RA, EHR, MREFC, and Donations and Dedicated Collections. Additional costs were incurred for indirect general operation activities (e.g., salaries, training, and activities related to the advancement of NSF information systems technology) and activities of the NSB and the OIG. These costs were allocated to R&RA, EHR, MREFC, and Donations and Dedicated Collections and account for approximately 5 percent of FY 2021 *Net Cost of Operations* (Figure 1.8). These administrative and management activities support the agency's program goals. Net costs related to the CARES and ARP Act appropriations for R&RA, EHR, MREFC and AOAM were \$50 million, \$4 million, \$8 million, and \$9 million, respectively.

Figure 1.8. FY 2021 NET COST



Statement of Changes in Net Position

The Statement of Changes in Net Position presents the agency's cumulative results of operations and unexpended appropriations for the fiscal year. NSF's *Net Change in Unexpended Appropriations*, increased by \$713 million; and the *Net Change in Cumulative Results of Operations* increased by \$4 million in FY 2021 for a total increase of \$717 million.

Appropriations from the CARES and ARP Act resulted in Unexpended Appropriations of \$14 million and \$572 million in FY 2021, respectively. As NSF continues to provide support for COVID-19 related research, costs will increase, which will lead to a decrease in net position.

Statement of Budgetary Resources

This statement provides information on how budgetary resources were made available to NSF for the year and the status of those budgetary resources at year end. For FY 2021, *Total Budgetary Resources* increased \$893 million from the FY 2020 level. *Budgetary Resources—Appropriations* in FY 2021 for the R&RA, EHR, and MREFC accounts were \$7,347 million, \$1,029 million, and \$301 million, respectively. The combined *Budgetary Resources—Appropriations* in FY 2021 for the NSB, the OIG, and AOAM accounts totaled \$409 million. NSF also received funding via warrant from the Nonimmigrant Petitioner Account (H-1B) in the amount of \$154 million and via donations from foreign governments, private companies, academic institutions, nonprofit foundations, and individuals in the amount of \$32 million. In FY 2021, the *Budgetary Resources—Appropriations* line also included an H-1B sequestration in the amount of \$9 million.

In FY 2021, NSF received \$600 million in ARP Act funding in support of the national response to COVID-19. The supplemental appropriations provided \$467 million for R&RA, \$61 million for EHR, \$60 million for MREFC, and \$12 million for AOAM. Budget authority provided by the ARP Act is available to NSF for obligation through September 2022.

Limitations of the Financial Statements

The principal financial statements are prepared to report the financial position, financial condition, and results of operations, pursuant to the requirements of 31 U.S.C. § 3515(b). The statements are prepared from records of NSF in accordance with Federal generally accepted accounting principles (GAAP) and the formats prescribed by OMB. Reports used to monitor and control budgetary resources are prepared from the same records. Users of the statements are advised that the statements are for a component of the U.S. Government.

Other Financial Reporting Information

Debt Collection Improvement Act of 1996

Net Accounts Receivable totaled \$21 million at September 30, 2021. Of that amount, \$20 million was due from other federal agencies. The remaining \$1 million was due from the public. In accordance with the Debt Collection Improvement Act, as amended by the DATA Act, NSF fully participates in Treasury's Cross-Servicing Program. This program requires NSF to refer debts due from the public that are delinquent more than 120 days to Treasury for appropriate collection action. In accordance with OMB Circular No. A-129, "Policies for Federal Credit Programs and Non-Tax Receivables," NSF writes off delinquent debt that is more than 2 years old. Additionally, NSF seeks Department of Justice concurrence for the write-off of debts greater than \$100,000.

Cash Management Improvement Act of 1990

In FY 2021, NSF had no awards covered under Cash Management Improvement Act Treasury-State Agreements. The timeliness of NSF's payments to grantees through its payment systems makes the issue of timeliness of payment under the Act essentially not applicable to the agency. No interest payments were made in FY 2021.

American lobster genome could aid development of new sensors, support research into aging and immunity

American lobsters are fascinating creatures. They are important to the ecology, culture, and economy of the East Coast of the U.S. and Canada. But now, researchers have discovered there is even more under the surface of these spiny crustaceans! Researchers at the Gloucester Marine Genomics Institute have sequenced the American lobster genome for the first time. The lobster's genetic code is giving researchers new insights into the lobster's highly effective sensory nervous systems, unique immune system, and the biological mechanisms that keep them cancer-free. The lobster genome will be an important resource for ecological management and may contribute to new breakthroughs in how we think about cellular health.



NSF-funded researchers have published the first complete genome sequence of the American lobster. *Credit: NOAA*

For more information: <https://gmgi.org/news/gmgi-news-and-announcements/press-releases/press-release-cracking-the-american-lobster-genome/>

Analysis of Systems, Controls, and Legal Compliance

Management Assurances

The Federal Managers' Financial Integrity Act of 1982 (FMFIA)²⁹ and the OMB Circular A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control*³⁰ require NSF to evaluate annually the effectiveness of agency internal controls and provide reasonable assurance to the President and the Congress on control system adequacy.

NSF assures that its internal control system supports a mature, agile, and sustainable control environment. The approach is proactive and supports effective governance and oversight informed by both internal and external risk. A strong risk-based framework ensures focus on the most consequential management issues and confidence that operations are functioning as intended. The risk-based approach also supports a maturing Enterprise Risk Management Program.

The FY 2021 unmodified Statement of Assurance, with no material weaknesses, provides reasonable assurance as to the overall adequacy and effectiveness of internal controls based upon information that the system of internal control is operating efficiently and effectively.

NSF's internal control assessment provides reasonable assurance that the objectives of FMFIA and the Federal Financial Management Improvement Act of 1996 (FFMIA) were achieved and that the internal control process over financial reporting is effective.

Highlights from NSF's FY 2021 Data Analytics and Assurance Program

For FY 2021, NSF's Data Analytics & Assurance Program (DAAP) completed Enterprise Risk Management (ERM) and internal control activities in support of the agency's statement of assurance. The DAAP utilizes



National Science Foundation

FY 2021 Statement of Assurance

The National Science Foundation (NSF) management is responsible for managing risks and maintaining effective internal control to meet the objectives of Sections 2 and 4 of the Federal Managers' Financial Integrity Act (FMFIA). The NSF conducted its assessment of risk and internal control processes in accordance with OMB Circular No. A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control*. Based on the results of the assessment, NSF can provide reasonable assurance that internal control over operations, reporting, and compliance was operating effectively as of September 30, 2021.

/s/

Sethuraman Panchanathan
Director

November 12, 2021

²⁹ FMFIA: <https://www.congress.gov/bill/97th-congress/house-bill/1526/text>

³⁰ OMB Circular A-123: <https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2016/m-16-17.pdf>

declared enterprise-level and internal control risks leveraged by high-value data analytics and innovative technology to continuously improve the effectiveness of risk monitoring. The DAAP supports the NSF mission by:

- Dealing with the proliferation of data.
- Leveraging artificial intelligence and automation.
- Targeting and reducing the cost of compliance efforts.
- Strengthening management decision-making.

The DAAP's areas of focus for FY 2021 were as follows:

Enterprise Risk Management – NSF continued to mature its ERM program in alignment risk management standards issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) ERM Integrated Framework. Efforts included continued strengthening of ERM governance, increasing the maturity of analytic and risk management tools, supporting the OIG-identified FY 2021 management challenge on grants oversight, and aligning ERM entity level controls to validate internal control practices.

Internal Control – Oversight of NSF's internal controls over financial reporting was conducted to evaluate program integrity in accordance with OMB Circular A-123, the Green Book, and COSO's Internal Control Integrated Framework and Internal Control Over Financial Reporting Compendium of Approaches and Examples through the following key activities:

- Assessed internal control entity level controls (ELC).
- Conducted Biannual Risk and Control Checkpoints related to key risk areas.
- Conducted internal control over financial reporting risk assessment through testing and modernizing the control environment.
- Conducted the triennial improper payments risk assessment, including quantitative (grants payments testing) and qualitative assessments.
- Provided support for the validation of the grant accrual.
- Completed IT General Controls assessment.
- Supported the Statement of Standards for Attestation Engagements (SSAE 18) review cycle.

In FY 2021, DAAP also facilitated organizational change management efforts to productively engage key stakeholders in ERM and internal control strengthening activities. This included knowledge transfer and support in maintaining key control matrices and risk profiles and using data analytics tools to improve risk identification and monitoring.

Management's Responsibility for ERM and Internal Control—OMB Circular A-123 and Management of Reporting and Data Integrity Risks, Appendix A

The GAO "Standards for Internal Control in the Federal Government" and the OMB Circular A-123, "Management's Responsibility for Enterprise Risk Management and Internal Control (A-123)" provide the standards and guidance for a risk-based strategy-setting process to address risks, operations, and reporting objectives. In response to this guidance, NSF has established an effective control environment which provides the methods and tools to evaluate multiple controls, called ELCs. ELCs include both ERM controls and internal controls.

Requirements for A Risk Management Framework for Government Charge Card Programs — OMB Circular A-123, Appendix B

In FY 2021, the DAAP team completed a bi-annual risk and control checkpoint to validate the level of risk associated with NSF's government charge card program and the controls in place to mitigate that risk. Due to the pandemic and remote working, charge card activities were limited. Despite low transaction volume, the DAAP team monitored government charge card activity and evaluated and confirmed key controls were in place for charge cards.

Requirements for Payment Integrity Improvement Act (PIIA)—OMB Circular A-123, Appendix C

PIIA requires Federal agencies to complete an improper payments risk assessment for programs with annual outlays equal to or above \$10 million to determine whether the program is likely to have improper payments and unknown payments above the statutory threshold on a triennial basis. The statutory threshold is either (1) 1.5 percent of program outlays and above \$10 million of all program payments made during the FY or (2) \$100 million (regardless of the percentage of annual outlays). An improper payment is any payment that is made to the wrong recipient or in the incorrect amount or does not follow applicable statutes and regulations. In accordance with OMB Circular A-123, Appendix C, PIIA guidance, NSF conducted a FY 2021 quantitative assessment over its Grants and Cooperative Agreements program and qualitative assessment over all in-scope programs and mission support activities in FY 2021. The in-scope programs and mission support activities are Grants and Cooperative Agreements, Contracts and Individual Payments, and Payments to Employees. After conducting the quantitative and qualitative assessments, the results show that NSF is low risk of significant improper payment susceptibility for its program and mission support activities.

Compliance with the Federal Financial Management Improvement Act (FFMIA)—OMB Circular A-123, Appendix D

OMB Circular A-123, Appendix D provides guidance in determining compliance with FFMIA for agencies subject to the Chief Financial Officers Act of 1990. NSF leveraged work previously described under Appendix A, including the IT General Controls assessment and active participation in the SSAE 18 review process. Specifically, the SSAE 18 process as it relates to the NSF financial management system (iTRAK) service provider includes verifying that NSF has the appropriate controls designed and in place to support responsible reliance on the financial system, including Complementary User Entity Controls. NSF's service provider received an unqualified opinion on the Service Auditor Type 2 System and Organization Controls Reports for both Software as a Service and Infrastructure as a Service, and a qualified opinion for Platform as a Service. The service provider took immediate action to resolve the audit qualification and NSF's complementary controls mitigated any risks to NSF. The Independent auditors' opinion addressed the accuracy and completeness of the design of controls and services and is relevant to the internal control over financial reporting. No material non-conformances for FFMIA compliance were identified. Finally, in May 2021, NSF was amongst the first Federal agencies to transition its Financial System's (iTRAK) infrastructure to the cloud, significantly strengthening system security, reliability, and performance.

Other Federal Reporting and Disclosure

Anti-Deficiency Act (ADA): NSF is not aware of any ADA violations that are required to be reported for the year ended September 30, 2021.

Digital Accountability and Transparency Act of 2014 (DATA Act): The DATA Act is a government-wide effort led by OMB and Treasury to enhance and standardize the reporting of Federal contract and financial assistance spending information, enabling taxpayers and policy makers to track Federal spending more effectively. NSF implemented the initial DATA Act requirements in FY 2017. In FY 2020, NSF updated its

reporting processes and controls to meet the requirements of OMB M-20-21, *Implementation of Guidance for Supplemental Funding Provided in Response to the Coronavirus Disease 2019 (COVID-19)* and Treasury's DATA Act Information Model Schema (DAIMS) 2.0. NSF also updated its Data Quality Plan, as required by OMB M-18-16, *Appendix A to OMB Circular No. A-123, Management of Reporting and Data Integrity Risk*, to reflect this new reporting baseline and control environment. In FY 2021, NSF implemented additional process and control changes to meet the requirements of M-21-20, *Promoting Public Trust in the Federal Government through Effective Implementation of the American Rescue Plan Act and Stewardship of the Taxpayer Resources* to provide full transparency over NSF awards funded by the ARP Act. NSF is also finalizing process changes to fully implement Treasury's new DAIMS 2.1 requirements which will take effect in FY 2022, including outlay reporting for all awards.

Pay and Allowance System for Civilian Employees, provided primarily in Chapters 31–50 of Title 5, U.S.C.: The Department of the Interior, Interior Business Center (IBC) Federal Personnel/Payroll System (FPPS) is a Shared Service Provider and performs many of NSF's payroll functions. IBC FPPS's internal control is reviewed annually by auditors under SSAE 18. IBC FPPS's controls are found to be suitably designed and operating effectively for FY 2021. This conclusion is based partly on transactional testing. In addition, NSF verified that its complimentary user entity controls for FPPS were designed and operating effectively and provided adequate coverage for responsible reliance on IBC's payroll services.

Prompt Payment Act: The Prompt Payment Act mandates interest penalties on payments over 30 days. Under OMB Memorandum 17-27, "Reducing Burden for Federal Agencies by Rescinding and Modifying OMB Memoranda," NSF encourages accelerating payments to all contractors within 15 days of a proper invoice being received. This acceleration allows small business contractors to be paid as quickly as possible.

Government Charge Card Abuse Prevention Act of 2012, Pub. L. 112 – 194: The act requires that agencies ensure that appropriate policies and controls are in place or that corrective actions have been taken to mitigate the risk of fraud and inappropriate charge card practices. NSF provides reasonable assurance that internal controls related to the Government Charge Card Programs are operating effectively, and no material weaknesses were identified. Like FY 2020, the volume of charge card transactions in FY 2021 was significantly lower (less than \$4.5 million in FY 2021 outlays) than prior fiscal years due to travel restrictions in place under the COVID-19 pandemic response. Additional information is provided above in subsection *Requirements for A Risk Management Framework for Government Charge Card Programs — OMB Circular A-123, Appendix B*, page MD&A-31.

Provisions Governing Claims of the U.S. Government (31 U.S.C. 3711–3720E) (Including the Debt Collection Improvement Act of 1996): The Debt Collection Improvement Act is addressed on page MD&A-28.

Federal Information Security Modernization Act Management Act of 2014: This topic is addressed above in subsection *Compliance with the Federal Financial Management Improvement Act of 1996—OMB Circular A-123, Appendix D*, page MD&A-31.

Single Audit Act of 1984, Pub L. No. 98-502, and the Single Audit Act Amendments of 1996, P.L. 104-156. (A-136, section II.2.8): In accordance with § 2 CFR 200.501, Subpart F, Audit Requirements, non-federal entities that expend \$750,000 or more during the non-federal entity's fiscal year in federal awards must have a single or program specific audit conducted for that year. Federal agency internal control

standards determine whether award expenditures comply with laws and regulations. NSF, like other federal agencies, is required to review the findings and recommendations of audit reports for funding recipients to determine whether corrective actions (if required) are adequate and implemented. NSF utilizes guidance from the OMB Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance) and Audit Follow-up as a basis for its audit resolution and follow-up activities. During FY 2021, NSF resolved 137 single audit reports.

NSF ensures that its policies and procedures fully align with federal requirements and continually assesses changes in policies and practices may have on NSF's stewardship over its activities. NSF continues to strengthen audit resolution and other oversight functions by deepening the subject matter expertise of its staff and maintaining a formal, ongoing dialogue with the OIG.

Financial System Strategy and Framework

Financial System Strategy

iTRAK is NSF's Oracle-based, commercial-off-the-shelf financial system, hosted off-premise in the 'cloud'. The financial system provides automated business processes, funds management, and reporting capabilities for NSF's external and internal customers, including grantees, financial and administrative staff, and program managers. The financial system, iTRAK, also performs system edit checks and provides an audit trail for financial transactions, thereby strengthening internal controls. iTRAK aligns with NSF's strategic objective 3.2 to continually improve agency operations by enabling efficient, effective execution of financial activities and business operations; and it supports the agency in its stewardship role by providing managers and staff with financial data and reports so they may make informed decisions about the programs they manage and support.

Regulatory Compliance and Internal Control

iTRAK complies with all applicable federal laws and regulations, and authoritative guidance by ensuring that transactions are posted in accordance with the U.S. Standard General Ledger (USSGL) at the transaction level; maintaining accounting data to permit reporting in accordance with Generally Accepted Accounting Principles, as prescribed by the Federal Accounting Standards Advisory Board. iTRAK also complies with OMB Circular A-130, "Managing Federal Information as a Strategic Resource," OMB Circular A-123, Appendix D, "Compliance with the Federal Financial Management Improvement Act of 1996," and many other federal regulations and guidance, such as the CFO Act, FISMA, FMFIA, FFMIA, and the Rehabilitation Act, Section 508.

In FY 2021, an independent accounting firm examined iTRAK's IT controls. The assessment was favorable with no significant findings. Details about the review are on page MD&A-31 in the subsection, *Compliance with the Federal Financial Management Improvement Act of 1996—OMB Circular A-123, Appendix D*.

Upgrades, Innovation, Data Analytics, and Future Initiatives

Upgrades

NSF continues to enhance and upgrade its financial system environment, implement innovative solutions, and expand its analytical capabilities to better support NSF's mission. In keeping with this objective, NSF upgraded iTRAK and its infrastructure as follows:

- NSF upgraded iTRAK to Oracle EBS R 12.2.9 as a prerequisite for G-invoicing.
 - *Benefits:* (1) built-in integration with G-invoicing module; (2) functionality that enables the creation of business dashboards to assist users in prioritizing their work and to give visibility

into actions they need to take; (3) icon-based navigation and new table viewing options on forms and new search functionality; and (4) reduced downtime to apply patches.

- NSF moved its financial system to the Oracle Cloud Infrastructure in May 2021.
 - *Benefits:* (1) enhanced security controls including incident identification and remediation; (2) more efficient iTRAK performance; and (3) improved reliability by ensuring nearly full-time availability to users.

Innovation

- NSF continues to expand its *Robotic Process Automation (RPA)* footprint utilizing financial data from the financial system (iTRAK) to streamline reconciliations, data processing into iTRAK, and financial reporting. Building on the successes of automation in invoice processing, intra-governmental transfers, and accounting system reconciliation, NSF will explore the use of RPA for vendor management and other financial functions.
- Planning efforts are underway to begin the next phase of NSF's blockchain efforts. In anticipation of moving beyond the proof-of-concept, NSF is exploring *Blockchain-as-a Service (BaaS)* technology and its integration with the financial system, iTRAK.

Reporting and Data Analytics

- iTRAK enables financial data to be extracted and loaded into business and visual analytic tools to provide stakeholders with the ability to analyze and present actionable information with metrics, dashboards, graphical displays, and ad hoc reporting.

Future Initiatives

Initiatives on the horizon are summarized as follows with anticipated implementation dates:

- UEI Transition (February 2022): Implementation requires enhancements to iTRAK and certain NSF business applications.
- G-Invoicing (October 2022): NSF is in the design phase of implementing Treasury's new G-Invoicing system which will serve as the front-end application for users to originate and manage interagency agreements. NSF is applying and evaluating required system updates to iTRAK. In addition, recognizing the success of the implementation relies on transparency and communication to stakeholders, NSF has fully engaged Directorate and Office staff across the Foundation in designing the G-Invoicing solution. NSF expects to begin testing during the 2nd quarter of FY 2022.
- Next Generation Financial System (Quarter 3 FY 2022): NSF will begin planning for the next generation of iTRAK, a cloud-based solution that offers a consumer-like user experience, provides financial analytics, utilizes artificial intelligence and machine learning.

Financial Management System Framework

NSF's financial management system framework focuses on the Foundation's financial management systems, standard business processes, data, and information architecture to ensure reliable, timely, and consistent financial information that enables effective management of NSF resources and delivery of mission critical products and services (see Figure 1.9).

NSF's core financial system, iTRAK, interfaces with NSF's awards, grants management, and business process systems including:

- Award Cash Management Service (ACM\$).
- MyNSF Awards (Awards) — NSF's award and award amendment processing, approval, and notification system.
- eJacket — NSF's internal proposal processing system, post-award request tracking and approval system, and document repository.
- Research.gov — Website for the research community that provides quick access to research information and grants management services. Research.gov will replace FastLane.
- Graduate Research Fellowship Program (GRFP) System.
- Guest Travel and Reimbursement System (Guest).

iTRAK also interfaces with external systems operated by Treasury; Citibank and LearnNSF, the Foundation's training system; and with other federal systems such as FPPS, eTravel/Concur, and GSA's SAM.

Figure 1.9—NSF Financial Management System Framework

