FIRST ANNUAL REPORT ON PROGRESS TOWARDS IMPLEMENTATION OF THE AMERICAN PANDEMIC PREPAREDNESS PLAN

A Report by the

White House Steering Committee for Pandemic Innovation

of the

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

September 2022

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976 to provide the President and others within the Executive Office of the President with advice on the scientific, engineering, and technological aspects of the economy, national security, health, foreign relations, the environment, and the technological recovery and use of resources, among other topics. OSTP leads interagency science and technology policy coordination efforts, assists the Office of Management and Budget (OMB) with an annual review and analysis of Federal research and development in budgets, and serves as a source of scientific and technological analysis and judgment for the President with respect to major policies, plans, and programs of the Federal Government.

About the National Science and Technology Council

The National Science and Technology Council (NSTC) is the principal means by which the Executive Branch coordinates science and technology policy across the diverse entities that make up the Federal research and development enterprise. A primary objective of the NSTC is to ensure science and technology policy decisions and programs are consistent with the President's stated goals. The NSTC prepares research and development strategies that are coordinated across Federal agencies aimed at accomplishing multiple national goals. The work of the NSTC is organized under committees that oversee subcommittees and working groups focused on different aspects of science and technology.

About the Steering Committee for Pandemic Innovation

In December of 2021, the White House COVID-19 Response Team and the OSTP Pandemic Preparedness Team formed the Pandemic Innovation Task Force (PITF) to narrow gaps in innovation and pandemic preparedness and identify priority areas for investment. Between January 2022 and May 2022, the PITF served a coordinating function across the U.S. Government to identify innovations needed to advance these priorities, many of which are highlighted in this document. The PITF demonstrated the need for an institutionalized, interagency group focused on pandemic preparedness through innovation, with a scope that extends beyond COVID-19. The White House Steering Committee for Pandemic Innovation (SCPI) was established in June of 2022 to institutionalize and extend the PITF mission. The SCPI is a U.S. Government interagency body of experts convened under the National Science and Technology Council (NSTC). The purpose of SCPI is to establish a unified, interagency committee to manage, integrate, and ensure accountability for U.S. pandemic preparedness science and technology (S&T) goals.

About this Document

This document, released on the one-year anniversary of the public release of *American Pandemic Preparedness: Transforming our Capabilities*, provides the first annual report outlining progress towards implementation of relevant capabilities, highlights priority actions that are ongoing and needed across departments and agencies in the U.S. Government and the private sector, and identifies S&T opportunities to fill gaps and ensure that the Nation is properly prepared for emerging pandemic threats.

Copyright Information

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

Chair
Alondra Nelson
Deputy Assistant to the President and
Performing the Duties of Director
White House Office of Science and Technology Policy

Executive Director
Kei Koizumi (Acting)
Principal Deputy Director for Policy
White House Office of Science and Technology Policy

WHITE HOUSE STEERING COMMITTEE ON PANDEMIC INNOVATION

Co-Chair
Matthew Hepburn
Senior Advisor to the OSTP Director for Pandemic Preparedness
White House Office of Science and Technology Policy

Co-Chair
Nahid Bhadelia
Senior Policy Advisor for Global COVID-19 Response
White House COVID-19 Response

Members

Departments and Agencies
Department of Agriculture
Department of Commerce
Department of Defense
Department of Energy
Department of Health and Human Services
Department of Homeland Security
Department of State
Department of Veterans Affairs
Environmental Protection Agency
National Science Foundation
U.S. Agency for International Development

Executive Office of The President
Council of Economic Advisers
Domestic Policy Council
National Economic Council
National Security Council
Office of Management and Budget
Office of Science and Technology Policy
White House COVID-19 Response

Table of Contents

Abbreviations and Acronyms

ACT-A	Access to COVID-19 Tools Accelerator
ACTIV	Accelerating COVID-19 Therapeutic Interventions and Vaccines
ACTT	Adaptive COVID-19 Treatment Trial
AFFOA	Advanced Functional Fibers of America
AI	Artificial Intelligence
AP3	American Pandemic Preparedness Plan
APP	Antiviral Program for Pandemics
ASPR	Administration for Strategic Preparedness and Response
AViDD	Antiviral Drug Discovery
AR	Anti-Microbial Resistant
ASF	African Swine Fever
ATP	Advanced Technology Platforms
BAA	Broad Agency Announcements
BARDA	Biomedical Advanced Research and Development Authority
BioMAP	National Biopharmaceutical Manufacturing Partnership
BRaVE	Bio-preparedness Research Virtual Environment
BTO	Building Technologies Office
CBDP	Chemical & Biological Defense Program
CDC	Centers for Disease Control and Prevention
CEPI	Coalition for Epidemic Preparedness Innovations
CET–RAIDR	Countering Emerging Threats Rapid Acquisition and Investigation of Drugs for Repurposing
CFA	Center for Forecasting and Outbreak Analytics
CIC	COVID Information Commons
CISA	Clinical Immunization Safety Assessment Project
COP	Community of Practice
COVAX	COVID-19 Vaccines Global Access
COVID-19	Coronavirus Disease 2019
CTAP	Coronavirus Treatment Acceleration Program
DARPA	Defense Advanced Research Projects Agency
DFC	U.S. International Development Finance Corporation
DHS	Department of Homeland Security
DMI	Data Modernization Initiative
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
EAGER	Early-Concept Grants for Exploratory Research
eCR	Electronic Case Reporting
ED	Department of Education
EEI	Embedded Entrepreneurship Initiative
EHA	Economy and Health Dialogue of the Americas
EHR	Electronic Health Records
EPA	Environmental Protection Agency
EUA	Emergency Use Authorization
EZ BAA	Easy Broad Agency Announcement
FDA	Food and Drug Administration
FIF	Financial Intermediary Fund
FTA	Federal Transit Administration
GHIC	Global Health Investment Corporation
GHSA	Global Health Security Agenda
Global VAX	Global Vaccine Access
GUIDE	Generative Unconstrained Intelligent Drug Engineering
GUV	Germicidal Ultraviolet
H-CORE	HHS Coordination Operations and Response Element
HHS	Department of Health and Human Services
IAA	Interagency Agreement
IC	Innovation Center
ICATT	Increasing Community Access to Testing
IFR	Interim Fielding Capabilities
IHR	International Health Regulations
IP	Intellectual Property
IRB	Institutional Review Board
ITAP	Independent Test Assessment Program
JPEO-CBRND	Joint Program Executive Office for Chemical Biological, Radiological and Nuclear Defense
JSTO-CBD	Joint Science & Technology Office for Chemical & Biological Defense
LED	Light-Emitting Diode
LMIC	Low- and Middle-Income Countries
mAB	Monoclonal Antibody
MCM	Medical Countermeasure
ML	Machine Learning
MTF	Military Treatment Facilities
MRSA	Methicillin-Resistant Staphylococcus Aureus
MUSA	Manufacturing USA
N3C	National COVID Cohort Collaborative
NBIC	National Biosurveillance Integration Center
NCATS	National Center for Advancing Translational Sciences
NCP	National Center for Health Promotion and Disease Prevention
NGS	Next-Generation Sequencing

NIAID	National Institute of Allergy and Infectious Diseases
NIH	National Institutes of Health
NIIMBL	National Institute for Innovation in Manufacturing Biopharmaceuticals
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NOW	Nucleic Acids On-Demand Worldwide
NSF	National Science Foundation
NSTC	National Science and Technology Council
NVBL	National Virtual Technology Laboratory
NWSS	National Wastewater Surveillance System
OCONUS	Outside the Continental United States
OSTP	Office of Science and Technology Policy
PANTHR	Probabilistic Analysis for National Threats Hazards and Risks
PITF	Pandemic Innovation Task Force
POC	Point of Care
PPB	Personalized Protective Biosystem
PPE	Personal Protective Equipment
PPR	Pandemic Prevention, Preparedness and Response
PPT	Personal Protective Technology
PREMISE	Pandemic Response Repository through Microbial and Immunological Surveillance and Epidemiology
QR	Quick Response
RADx	Rapid Acceleration of Diagnostics
RAPID	Rapid Response Research
RAPTER	Rapid Assessment of Platform Technologies to Expedite Response
RECOVER	Researching COVID to Enhance Recovery
RESPOND	Rapid Execution of Scaling Production of Needed Designs
RSV	Respiratory Syncytial Virus
RWE	Real-World Evidence
S&T	Science and Technology
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SAVE	SARS-CoV-2 Assessment of Viral Evolution
SBIR	Small Business Innovation Research
SCCT	Supply Chain Control Tower
SCPI	Steering Committee for Pandemic Innovation
SIG	SARS-CoV-2 Interagency Group
SPHERES	Sequencing for Public Health Emergency Response, Epidemiology, and Surveillance
SSRC	Social Science Research Council
STI	Sexually-Transmitted Infections
U.S.	United States
USAID	U.S. Agency for International Development
USPTO	U.S. Patent and Trademark Office
UV	Ultraviolet Light
VAERS	Vaccine Adverse Event Reporting System
VAMP	Vaccine Acceleration by Modular Progression
VHA	Veterans Health Administration
VRE	Vancomycin-Resistant Enterococcus
VSD	Vaccine Safety Datalink
WHO	World Health Organization

Executive Summary

At the time of publication of this report, coronavirus disease of 2019 (COVID-19) has taken the lives of over 1 million Americans—and more than 6.4 million around the world—with many recovered patients living with long-term effects. As staggering as the losses of the last nearly 3 years have been, COVID-19 was a moderate pandemic, and as a result of a number of factors (e.g., climate change, human behavior, increased global travel), there is a high likelihood of future pandemics.

Due to continued advances in science and technology, the United States has the unique opportunity to transform future pandemic preparedness capabilities. The U.S. Government must seize the moment to transform its scientific capabilities in preparation for the increasing frequency of biological threats on the horizon.

On September 3, 2021, the American Pandemic Preparedness: Transforming our Capabilities Plan (AP3) was released, outlining a bold vision to achieve the transformational capabilities needed to directly address future threats. AP3 includes five pillars:

I. **Transforming Our Medical Defenses** by dramatically improving medical countermeasures (MCMs) to include vaccines, therapeutics, and diagnostics.
II. **Ensuring Situational Awareness** about infectious-disease threats, for both early warning and real-time monitoring.
III. **Strengthening Public Health Systems** – including workforce support, training, and development – in the United States and internationally to respond to emergencies, with a particular focus on protecting the most vulnerable communities.
IV. **Building Core Capabilities**, including innovation in personal protective equipment (PPE), restoring and expanding stockpiles and building resilient supply chains, acceleration of biosafety and biosecurity innovation, and improvement in regulatory capacity and both global and domestic clinical trial networks.
V. **Managing the Mission**, with a seriousness of purpose, commitment, and accountability.

Since AP3's release 1 year ago, the U.S. Government has worked diligently to advance progress towards implementing a number of the transformational capabilities outlined in the plan, though additional investments are needed to fully realize the needs outlined in all five pillars.

The enclosed report summarizes progress made towards advancing AP3 capabilities while also providing priority areas for investment and additional efforts needed in the year ahead. As a key component of future response, the U.S. Government acknowledges that simply transforming our capabilities in pandemic preparedness will not be enough to achieve our goals of reducing the burden of pathogens on the world, especially in vulnerable communities. Scientific and technological advances must be paired with public engagement, trust building, and recognition and resolution of previous harms and challenges in public health. All of these foundational areas are addressed here and must be advanced if the Nation and the world are to be prepared for future threats.

Purpose and Background

This document, released on the 1-year anniversary of the publication of AP3, provides the first annual report outlining progress towards implementation of capabilities outlined in AP3, while also highlighting priority science and technology (S&T) actions needed across departments and agencies in the U.S. Government and the private sector to ensure the Nation is properly prepared for emerging pandemic threats.

This report recognizes that significant progress has been achieved throughout the past 3 years of the pandemic. This progress has not only advanced the COVID-19 pandemic response, but also created opportunities that can lead to enduring capabilities against a wide range of biological threats. This document also aims to accurately describe the critical research needed to address gaps in understanding as well as how to accelerate future response options.

American Pandemic Preparedness: Transforming Our Capabilities

AP3 aims to fundamentally transform the ability of the United States to prevent, detect, and respond to pandemics and high consequence biological threats. AP3 provides context regarding the needs for this investment, along with clear metrics to assess progress towards achieving these ambitious goals. The hallmark of this effort is breakthrough innovation and how the U.S. Government can rapidly translate these breakthroughs for health impacts. The goal of AP3 is to leverage the creativity and energy from all aspects of our society. The Nation's ongoing experience with the COVID-19 response continues to identify what is needed to be adequately prepared for future response, including:

- Seamless, integrated public-private collaboration with a clear strategy to drive action;
- Strong top-down leadership with clear decision-making authority that is operational in nature;
- "Rules of engagement" with clear roles and responsibilities established for each stakeholder;
- Effective program management and sufficient resources for product development processes to occur in parallel and optimize timelines;
- Sustained investment in basic science and research to enable innovative MCM development;
- Clear regulatory guidance to set expectations for accelerated reviews and feedback;
- Development of medical products and public health interventions simultaneously with community engagement processes to build trust and foster social acceptance of the innovation process and to reduce health inequities; and
- Mechanisms to engage and serve vulnerable communities.

White House Steering Committee for Pandemic Innovation

In December of 2021, the White House COVID-19 Response Team and the OSTP Pandemic Preparedness Team collaborated to form the Pandemic Innovation Task Force (PITF) to narrow gaps in the Nation's COVID-19 response largely brought on by the rise of the Delta and Omicron variants. This group was tasked with identifying priority areas for investment to yield improved preparedness for future variants. Between January 2022 and May 2022, the PITF served a coordinating function across the U.S. Government to identify innovation priorities, many of which are published in this document. The PITF demonstrated the need for an institutionalized, interagency group focused on pandemic preparedness through innovation, with a scope that extends beyond COVID-19.

Given this need, the White House Steering Committee for Pandemic Innovation (SCPI) was established in June of 2022 to institutionalize and extend the PITF mission. The SCPI is a U.S. Government interagency body of experts convened under the National Science and Technology Council (NSTC). The

purpose of SCPI is to establish a unified, interagency committee to manage, integrate, and ensure accountability for U.S. pandemic preparedness S&T goals, including those outlined in AP3. SCPI will assess and publicly report on mission progress and encourage execution of periodic exercises to evaluate national pandemic preparedness. The SCPI is a focal point for coordinating Federal pandemic preparedness S&T priorities with the global community, including support of the 100 Days Mission and other relevant U.S. and international scientific initiatives. The enclosed document outlines successful implementation of pandemic response and preparedness activities since publication of AP3, as well as forward-looking priorities for the acceleration of science and technology innovations.

The SCPI membership created the content described in the Progress section, as well as formulated and shaped the Goals section. As such, the Progress section outlines an extraordinary amount of effort across the U.S. Government, as numerous departments/agencies with thousands of experts devoted themselves to progress on pandemic innovation over the last few years. The Progress section is not intended to be comprehensive; rather, these selected efforts demonstrate the best of U.S. Government actions and leadership in innovating to address the enormous challenges of pandemic response.

This document is organized based upon the AP3 pillars (Figure 1), which will enable innovation in pandemic preparedness and public health response and will ensure that the transformative capabilities developed are accessible and available to all populations, especially vulnerable communities, to reduce the lives lost from public health threats.

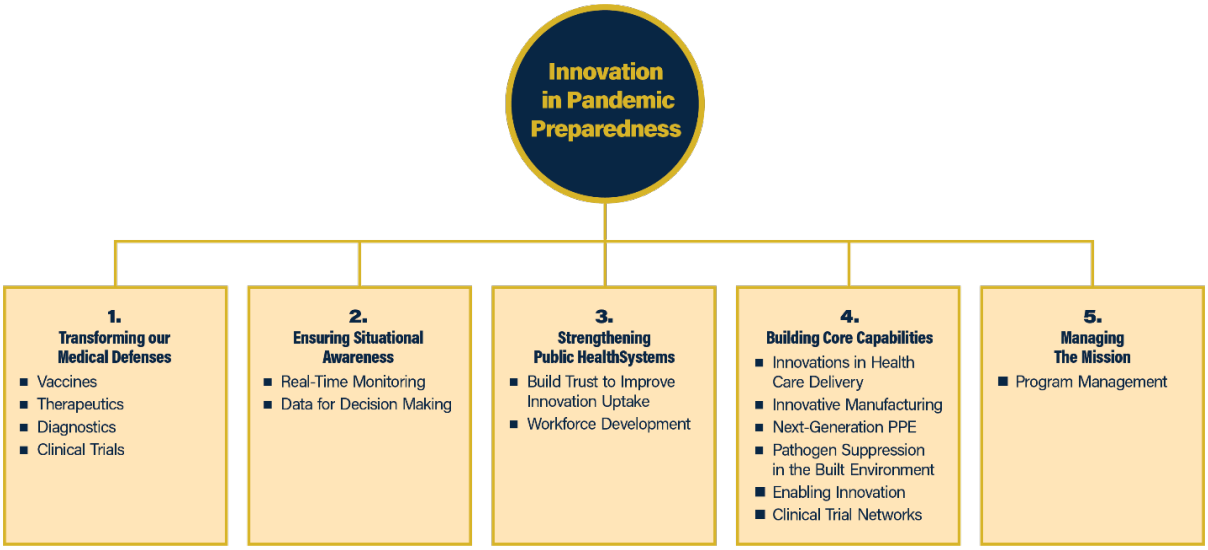

Figure 1. Core Capabilities of the American Pandemic Preparedness Plan That Will Enable Transformative, Life-Saving Innovation in Pandemic Preparedness

Progress Towards Implementation of Transformational Capabilities

I. Transforming Our Medical Defenses

AP3 Goal: Have the ability to rapidly make effective vaccines against any viral family. Have a range of therapeutics suitable for any virus family, available before a pandemic or readily created during a pandemic. Have simple, inexpensive, high-performance diagnostic tests available at a large scale within weeks after the recognition of an emerging pandemic threat.

Vaccines

The COVID-19 vaccine investments by the U.S. Government demonstrated unprecedented acceleration of safe and effective vaccine development. Investments in six vaccines yielded positive clinical trial results, with four of the six vaccines receiving Emergency Use Authorization (EUA) and two receiving pediatric authorizations. The U.S. Government continues to expand its capabilities for development of next-generation COVID vaccines and vaccines against other high-priority viruses.

Next-Generation Vaccine Design, Development, and Manufacturing

- In January 2020, the National Institute of Allergy and Infectious Diseases (NIAID) rapidly generated a stabilized SARS-CoV-2 spike protein for use in COVID-19 vaccine development. This crucial breakthrough in structure-based vaccine design resulted from years of investment in basic research and led to development of safe and effective COVID-19 vaccine candidates in less than one year.
- In November 2021, NIAID organized and hosted a virtual workshop with subject matter experts to identify scientific gaps and determine prototype pathogens for 10 viral families of pandemic risk. In December 2021, NIAID released its Pandemic Preparedness Plan outlining strategies to leverage research infrastructure to drive innovation in vaccine, therapeutics, and diagnostic development. Since publication of this plan, NIAID researchers, utilizing the prototype pathogen approach, initiated a phase 1 clinical trial of a Nipah virus vaccine.
- NIAID's sustained investment in universal influenza vaccines has produced multiple candidates in advanced preclinical and early clinical development.
- The Department of Defense (DoD) Chemical & Biological Defense Program (CBDP) Joint Science & Technology Office for Chemical & Biological Defense (JSTO-CBD) leveraged the priority pathogen approach and is developing the Rapid Assessment of Platform Technologies to Expedite Response (RAPTER) to establish a predictive capability for prophylactic platform technology.
- The Biomedical Advanced Research and Development Authority (BARDA) established the Beyond the Needle program, awarding $6.8M to 10 small biotechnology companies and universities to accelerate development and commercialization of alternative routes of vaccine administration (e.g., microneedle skin patches, intranasal, and oral vaccines).
- The DoD CBDP Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense (JPEO-CBRND) Vaccine Acceleration by Modular Progression (VAMP) program and BARDA have partnered to co-fund multiple vaccine development efforts to deliver vaccines against diverse viral families, including through alternative routes of administration.
- The NIST-funded National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) established a Vaccine Analytics and Assays Center of Excellence to support vaccine manufacturing, including improved production and quality and lessened cold chain requirements. NIIMBL catalyzed progress across key areas outlined in this report, summarized in their annual report.

Equitable Delivery and Uptake of Vaccines

- The Federal Retail Pharmacy Program, a partnership between the Centers for Disease Control and Prevention (CDC) and 21 pharmacy organizations, administered more than 284 million COVID vaccine doses, including in communities of color and other underserved populations.
- The U.S. Initiative for Global Vaccine Access (Global VAX) was established to increase uptake of COVID-19 vaccines. As the leading U.S. Government agency for Global VAX, the U.S. Agency for International Development (USAID) is supporting execution and expansion of national vaccination campaigns; launching mobile vaccination capacity for hard-to-reach populations; assisting countries in vaccine policymaking and planning for strategic health care workers and resource

deployment; investing in cold chain and supply logistics to safely store and deliver vaccines; fighting mis- and dis-information about COVID-19 vaccines; and supporting the development of health information systems to better evaluate vaccine distribution equity and monitor safety.

- CDC improved vaccine uptake through funding a number of on-the-ground social mobilization efforts and distributing the COVID-19 State of Vaccine Confidence Insights Reports.
- To support faster access to vaccines in low- and middle-income countries (LMICs), especially in Africa, USAID has partnered with the U.S. International Development Finance Corporation (DFC) to invest in regional vaccine manufacturing capacity.
- The U.S. Patent and Trademark Office (USPTO) established a pilot program for prioritized examination of patent applications from small and micro entities that are directed to a product or process subject to an applicable Food and Drug Administration (FDA) approval for COVID-19 uses, such as applications directed at vaccines, diagnostics, therapeutics, and PPE.

Vaccine Safety and Efficacy Monitoring and Real-World Evidence

- CDC and its partners used systems to detect and assess potential safety concerns with COVID-19 vaccines, such as: Vaccine Adverse Event Reporting System (VAERS), v-safe, v-safe Pregnancy Registry, Vaccine Safety Datalink (VSD), Clinical Immunization Safety Assessment Project (CISA).
- DoD leveraged Military Treatment Facilities (MTF) to assess vaccine efficacy, monitor for breakthrough infections from variants, and monitor for other respiratory infections.

Therapeutics

The design and development of therapeutics, such as monoclonal antibodies (mABs) and antivirals, have been critical for the response to COVID-19 and are instrumental in preparation for future threats.

Therapeutics Design, Development, and Manufacturing

- The National Institutes of Health (NIH) and BARDA launched the Antiviral Program for Pandemics (APP), developing oral anti-viral medications against pandemic threats. NIAID established nine multidisciplinary Antiviral Drug Discovery (AViDD) Centers for Pathogens of Pandemic Concern. The National Center for Advancing Translational Sciences (NCATS) began high-throughput screening of compounds to identify potential drugs.
- The NIH ACTIV and ACTT programs are evaluating COVID-19 therapeutics (anti-virals, antibodies, immune modulators, anticoagulants, additional repurposed drug), leading to remdesivir licensure and license extension for baricitinib; evaluations include product safety and effectiveness.
- The FDA Coronavirus Treatment Acceleration Program (CTAP) sped review of drug development programs and clinical trials, leading to 2 fully-approved treatments and 13 treatments with EUA.
- The Department of Health and Human Services (HHS) launched a number of research programs to understand, treat, and prevent the post-acute sequelae of SARS-CoV-2 infection, such as the NIH Researching COVID to Enhance Recovery (RECOVER) Initiative. These research programs are described in the National Research Action Plan for Long COVID, released in August 2022.
- The DoD Countering Emerging Threats Rapid Acquisition and Investigation of Drugs for Repurposing (CET – RAIDR) program tested five therapeutics for repurposing against COVID-19.
- The CBDP JSTO-CBD made significant investments in broad-spectrum anti-viral drug discovery and development; investments yielded two COVID-19 treatments, remdesivir and molnupiravir.

Antibody Discovery | Pandemic Prevention Platform (P3)

DARPA launched the Pandemic Prevention Platform (P3) program in 2018 to address the need for rapid response to emerging pathogens of pandemic potential through antibody development. The platforms were successfully deployed during the COVID-19 pandemic and will continue to be strengthened through additional technology investment to ensure a rapid and robust response to future threats.

- The Department of Energy (DOE) Office of Science stood up the National Virtual Technology Laboratory (NVBL), which deployed its high-performance computing and structural biology capabilities to support development of therapeutics and three licensed COVID-19 vaccines.
- BARDA pivoted an existing partnership for antibody development to create a mAB cocktail to treat COVID-19, achieving EUA in less than 11 months.
- BARDA Division of Research, Innovation, and Ventures (DRIVe) initiated investments in host-directed therapeutics that have potential to modulate an individual's defense mechanism to a pathogen and mitigate severe outcomes of disease.
- Through the Small Business Innovation Research (SBIR) Phase II program, National Science Foundation (NSF) funded research on automated infectivity assays to accelerate vaccine and antiviral drug development.
- DoD and DOE partnership leveraged a powerful computational biology system that can refine complex quality attributes for accelerated antibody development through a program called Generative Unconstrained Intelligent Drug Engineering (GUIDE).
- A DoD-BARDA joint effort in accelerated antibodies applied lessons learned from the COVID-19 response to de-risk and accelerate the discovery, manufacturing, and evaluation of mABs across diverse threat families, with two infectious disease products in development.
- NIIMBL led an industry coalition to establish an end-to-end process intensification testbed for mAB therapeutics. NIIMBL-funded projects also include the use of alternative antibody expression systems for intensified yield to enable broader access.

Equitable Delivery and Uptake of Therapeutics

- The U.S. Government launched the test-to-treat initiative to enable rapid diagnosis and early treatment with anti-viral medication as a cornerstone of the pandemic response.
- USAID is leading implementation of a test-to-treat strategy in roughly 10 countries, ensuring access to rapid diagnosis and oral antivirals, technical assistance, and delivery models leveraging local community and health systems.

Diagnostics

Through U.S. Government support and public-private partnerships, many diagnostic tests for SARS-CoV-2 were rapidly developed during the COVID-19 pandemic.

- BARDA leveraged pre-COVID-19 investment in molecular diagnostics platforms to accelerate the availability of SARS-CoV-2 tests and combination SARS-CoV-2 plus influenza tests across laboratory, point-of-care, home-use, and limited testing resource settings (e.g., nursing homes and clinics). To date, 29 EUAs have been supported by BARDA funding; BARDA efforts have supplied more than one- fifth of the total molecular lab test volume.
- NIAID launched a funding initiative to support development of tests for immediate antigen detection (<1 min); faster third-generation nucleic

NIH Rapid Acceleration of Diagnostics (RADx)

NIH launched the RADx initiative to speed innovation in the development, commercialization, and implementation of technologies for COVID-19 testing, with future potential to address other pathogens such as influenza and respiratory syncytial virus (RSV).

A key contribution of the RADx has been a partnership with the FDA on the Independent Test Assessment Program (ITAP). The effort accelerated review and availability of high-quality, accurate, and reliable over-the-counter COVID-19 tests to the public.

The RADx Tech/Advanced Technology Platforms (ATP) programs have supported the production of more than 3 billion tests and test products, 44 FDA EUAs, over 100 companies, and brought the first OTC test for at-home use through the diagnostic pipeline. Additional RADx programs created a Variant Task Force to monitor test performance against coronavirus "variants of concern," reduced barriers to test reporting, and aimed to reduce testing disparities in underserved populations.

acid and protein sequencing for pathogen identification; and methods for rapid design and development of analyte capture moieties to shorten the path to test validation and regulatory authorization.

- The U.S. Government has supported the landscape of self-testing for SARS-CoV-2 at home. Over 70 million households visited COVIDTests.gov to order at-home tests.
- BARDA DRIVe launched programs to use next-generation sequencing (NGS) to develop pathogen-agnostic diagnostics and advance new home diagnostic platforms, including five partnerships with biotech companies and academics, totaling $3.4 million in investment.
- BARDA expanded investments in host-based diagnostics, devices, and electronic health record (EHR)-integrated algorithms for pre-symptomatic detection, prediction of severe outcomes from infection, and detection of long-term disease.
- CBDP JSTO-CBD invested in synthetic binders for utilization on home-use testing platforms and continues development of a home diagnostic platform for pre-symptomatic infection indication.
- BARDA initiated development of pan-coronavirus diagnostic test panels to ensure preparedness for highly probable future coronavirus outbreaks.
- BARDA invested in expanding or onshoring domestic diagnostics manufacturing capacity at six sites in the United States, greatly increasing domestic capacity.

Equitable Delivery and Uptake of Diagnostics

- CDC's Increasing Community Access to Testing (ICATT) Program provides equitable access to COVID-19 testing with a focus on higher-risk communities and the uninsured.

II. Ensuring Situational Awareness

AP3 Goal: Have the ability to detect viruses that pose a pandemic threat soon after they emerge in humans and produce and publicly share the full genome sequence. When an emerging pandemic threat has been detected, have the ability to monitor the spread and evolution of the virus.

Early Warning Systems

The rise in cases and rapid spread of COVID-19 created the need for improved global early warning systems to provide better detection and awareness of where the virus and/or variants were emerging and when. This led to a number of innovations including wastewater surveillance.

- HHS established the SARS-CoV-2 Interagency Group (SIG) to rapidly characterize emerging variants and actively monitor their potential impact in real-time on EUA-approved MCMs.
- CDC's National Genomic Surveillance System continuously monitors and analyzes SARS-CoV-2 evolution and the emergence of variants domestically.
- Through the employment of numerous national projects, wastewater has been increasingly utilized as a potential early warning signal for spikes in COVID-19 cases in a community.
    - CDC launched the National Wastewater Surveillance System (NWSS) in September 2020 to build the Nation's capacity to track virus in wastewater samples nationwide, tracking more than 1,000 testing sites and covering approximately 40% of Americans (as of July 2022).
    - Environmental Protection Agency (EPA) developed, evaluated, and applied methods for concentrating and quantifying SARS-CoV-2 virus with molecular and live assays in wastewater.

- NIAID created the SARS-CoV-2 Assessment of Viral Evolution (SAVE) risk-assessment pipeline for SARS-CoV-2 variant viruses. SAVE provides a comprehensive real-time risk assessment of emerging mutations in SARS-CoV-2 that could impact transmissibility, virulence, and susceptibility to infection- or vaccine-induced immunity.

Real-Time Monitoring

Real-time monitoring of COVID-19 spread became a critical tool in the U.S. response to the pandemic, providing both decision makers and the general public with timely data.

Tracking Public Health Threats

- CDC's SARS-CoV-2 Sequencing for Public Health Emergency Response, Epidemiology, and Surveillance (SPHERES) is a national genomics consortium for large-scale rapid genomic sequencing and includes over 1,650 scientists from over 250 institutions across the United States.
- The NSF-funded COVID-19 Dashboard at Johns Hopkins University continues to provide real-time tracking of COVID-19 cases and deaths globally, while innovating data collection and curation.
- CDC COVID Data Tracker presents updated data from across the COVID-19 response, such as cases, deaths, and vaccinations.
- The National Biosurveillance Integration Center (NBIC) within the Department of Homeland Security (DHS) Countering Weapons of Mass Destruction Office tracked and consolidated global open-source reporting on COVID-19 trends, research, and epidemiology into daily reports for Congress, Federal Departments and Agencies, and State and Local public health partners. An in-depth Biosurveillance Event Report on COVID-19 is published monthly and weekly during surges.
- NCATS created the National COVID Cohort Collaborative (N3C) to monitor and conduct research with over 15 million EHRs in near-real-time to inform urgent public health questions
- NIAID established the Pandemic REsponse REpository through Microbial and Immunological Surveillance and Epidemiology (PREMISE) to conduct virologic and immunologic screening of targeted and broad cohorts to detect reactivity against viruses of pandemic potential. PREMISE will also sequence samples from zoonotic reservoirs and symptomatic humans for virus identification. Analyses will be shared to pre-emptively generate reagent and data resources for early detection and diagnosis, and to identify mABs and immunogens for vaccine discovery and development. PREMISE will serve as a translational vehicle to integrate serologic and cellular immune discovery, targeting a broad array of pathogens, into product development.

Modeling for Decision Making

- CDC established the Center for Forecasting and Outbreak Analytics (CFA), which seeks to enhance the Nation's ability to use data, models, and analytics to enable timely, effective decision making in response to public health threats.
- DOE's Office of Science established the Bio-preparedness Research Virtual Environment (BRaVE) for decision makers through emphasis on data assimilation for computational modeling.
- DHS's Science and Technology Directorate broadened the focus of its Probabilistic Assessment of National Threats, Hazards and Risks (PANTHR) Program to include modeling and risk assessment of naturally-occurring disease threats to the U.S. homeland.

Data Reporting and Sharing

- CDC's Data Modernization Initiative (DMI) is currently helping States upgrade their data systems, develop workforce training in data informatics, and integrate Electronic Case Reporting (eCR).

Before the COVID-19 pandemic, only 187 healthcare facilities were able to use eCR for COVID-19 reports. As of July 7, 2022, 13,800+ healthcare facilities in 49 States can send COVID-19 eCRs.

- HHS Protect was developed as a comprehensive, unified data platform for transparently reporting, integrating, and analyzing critical COVID-19 pandemic data.
- NIH created a COVID-19 OpenData Portal to openly and quickly share COVID-19-related drug repurposing data and experiments for all approved drugs. NCATS and other partners at NIH have incorporated variant-specific information into the OpenData Portal.

III. Strengthening Public Health Systems

AP3 Goal: Modernize public health infrastructure, domestically and internationally, to effectively prevent, respond to, and contain biological threats. Establish the international infrastructure and financing needed for pandemic preparedness.

Building Trust and Designing for Health Behavior Uptake

Trust in government and public health systems is critical for the uptake of life-saving vaccines and treatments. Building trust requires an understanding of areas where lack of trust exists as well as effective communication methods to rebuild trust.

- NSF established a new partnership with the Social Science Research Council (SSRC) to advance knowledge about public health guidance and its impact on health and well-being.
- The U.S. Surgeon General's Office published an advisory on Building a Healthy Information Environment, providing recommendations for addressing the challenge of health misinformation.
- CDC's Vaccine Task Force created an Insights Unit that collects data from 24 sources on the public's questions, concerns, frustrations, and the circulation of misinformation that affects vaccine confidence—then works with partners to mitigate impact through communication strategies.
- Through Global VAX, the U.S. government works with international and local partners and host-country governments to better understand vaccine hesitancy and how to educate and encourage individuals to get vaccinated against COVID-19. Health care worker education is a specific example.
- The Veterans Health Administration (VHA) launched three national Rapid Response Teams of implementation scientists to work with the VHA's National Center for Health Promotion and Disease Prevention (NCP), to collect real-time qualitative and quantitative data on veterans' and employees' acceptance of and hesitancy toward COVID-19 vaccines. Data from these 6-month projects informed enterprise-wide communication strategies that could be used during conversations with trusted health care providers and colleagues to increase vaccine uptake.

Say Yes! COVID Test

From April 2021 through January 2022, NIH and CDC launched the "Say Yes! COVID Test" program. The program aimed to provide multiple communities with up to 1,000,000 free at-home rapid antigen COVID-19 diagnostic tests through online orders and community distribution, and to evaluate the feasibility and impact of large-scale home test distribution. At its conclusion, this innovative community health initiative deployed in 10 communities delivered over 6.8M tests across the country in 10 different states. This information contributed to the design of the large Federal free home test program that the Biden-Harris Administration launched in January 2022.

Data Equity Efforts for Public Health

Innovative state and local health departments have been using real-time data to identify and describe underlying disparities that were exacerbated by the COVID-19 pandemic. Public health leaders used these data to inform the allocation of MCMs, including diagnostics,

vaccines, therapeutics, and PPE to at-risk communities and regional healthcare workers.

- The Presidential COVID-19 Health Equity Task Force published their Final Report and Recommendations, outlining actions to mitigate health inequities caused or worsened by COVID-19 and prevent such inequities in the future.

Training Frontline Workers Across Sectors

Frontline workers across many occupational sectors have a high potential for exposure to pathogens and require training to increase their understanding of how to protect themselves and maintain a safer work environment. Many of these workers do not receive health and safety training specific to infectious diseases and represent vulnerable communities.

- Through the National Institute of Environmental Health Sciences Worker Training Program, NIH has trained tens of thousands of frontline workers (e.g., construction workers, day care workers, healthcare workers, first responders, etc.) on COVID-19 health and safety issues such as PPE, environmental controls, and vaccines. Training reached vulnerable communities through community partnerships, delivery of training in multiple languages, and use of in-person or virtual training as needed. Extensive COVID-19 health and safety resources are available.

Strengthening International Infrastructure and Financing

International infrastructure and financing are critical to improve capacity for the production of MCMs and to ensure equitable access to resources during a public health response.

Strengthening International Pandemic Response

- The United States and other World Health Organization (WHO) member states continue to work together on a range of measures to strengthen pandemic prevention, preparedness, and response approaches and reform and strengthen the WHO to improve accountability, transparency, efficiency, and global cooperation during responses, and to promote timely and consistent voluntary sharing of novel biological materials.
- CDC provided countries with emergency risk management and crisis communication resources, offering international public health leadership and partner outreach for improved disease surveillance systems.
- The United States partnered with over 40 countries, including 19 Global Health Security Agenda (GHSA) countries, investing more than $2 billion since 2015 to provide operational and technical assistance to address domestic gaps and build their health security capacities.
- G7 leaders committed to provide support until 2027 to help at least 100 Low- and Middle- Income Countries (LMICs) implement core capacities required in the International Health Regulations (IHR).
- On the margins of the Ninth Summit of the Americas, the United States led seven coalition countries in the Western Hemisphere to launch the Economy and Health Dialogue of the Americas (EHA), which will convene ministries of health and finance to build the political will to address multisectoral problems unveiled by COVID-19, and to bolster pandemic preparedness, as a region.

Sustained Financial Support for Pandemic Preparedness

- The United States increased support and partnership with the Coalition for Epidemic Preparedness Innovations (CEPI) through a historic $150 million commitment to stimulate and accelerate research and development for countermeasures against biological threats.
- G20 leaders established a Joint Health and Finance Task Force to enhance cooperation to ensure adequate and sustained financing for pandemic prevention, preparedness, and response.

- The U.S. Government continues to support the World Bank Financial Intermediary Fund (FIF) for Pandemic Prevention, Preparedness, and Response (PPR). USAID and State pledged $450 million to the FIF, which will finance critical investments to strengthen pandemic PPR capacities at national, regional, and global levels, with a focus on LMICs.

Equitable Access to Medical Countermeasures

- USAID improved capacity of national regulatory systems and supply chains in LMICs to accelerate access to quality, safe, and effective vaccines, devices/diagnostics, and therapeutics.
- Through technical and financial assistance, the U.S. Government strengthened the ongoing work of the Access to COVID-19 Tools Accelerator (ACT-A) and partners, including the COVAX facility.
- In May 2022, the World Health Assembly agreed upon a resolution for more equitable clinical trials, channeling investment towards those that are well-designed, effectively-implemented, and transparently-reported.

IV. Building Core Capabilities

AP3 Goal: Have effective, comfortable, and affordable Personal Protective Equipment (PPE). Restore and expand the ability of the United States to produce the vital supplies to stop the next pandemic in its tracks. Prevent laboratory accidents and deter bioweapons development. Improve regulatory capacity to support the development of safe and effective vaccines, therapeutics, and diagnostics.

Manufacturing Innovation

Medical Countermeasure Production

- FDA established the Center for Advancement of Manufacturing Pharmaceuticals and Biopharmaceuticals to enhance coordination of science, regulatory, and policy activities for advanced manufacturing.
- BARDA launched the National Biopharmaceutical Manufacturing Partnership (BioMAP) to expand manufacturing capacity for MCMs in the United States.
- The NVBL used DOE expertise in materials and advanced manufacturing to address shortages in N95 masks, test kit supplies, and ventilators and created over 1,000 new jobs.

Manufacturing USA

Manufacturing USA is a national network created to secure U.S. global leadership in advanced manufacturing through large-scale public-private collaboration on technology, supply chain, and workforce development. The 16 manufacturing innovation institutes (sponsored by the U.S. Department of Commerce, Defense, or Energy) cover a broad range of industrial sectors relevant to pandemic response and preparedness, including the DOC-sponsored NIIMBL (biopharmaceutical manufacturing), and the DoD-sponsored BioMADE (bioindustrial manufacturing), AmericaMakes (additive manufacturing), and ARM (advanced robotics). Examples of this effort include two recent announcements of grants for advanced research to address the COVID pandemic.

Nucleic Acids On-Demand Worldwide (NOW)

DARPA launched the Nucleic Acids On-Demand Worldwide (NOW) program to facilitate rapid, distributed manufacturing of nucleic acid-based vaccines and therapeutics. The program aims to develop deployable technologies for the production of 100–1,000s of doses of mRNA or DNA-based vaccines and therapeutics in days, facilitating rapid access to early clinical trial material. Early results indicate that rapid, cell-free production of DNA and mRNA-based vaccines can be generated in under 1 week.

Supply Chain Resiliency

- NSF established the Rapid Execution for Scaling Production of Needed Designs (RESPOND) Network with diverse manufacturing stakeholders to provide a framework for accelerated crisis response and to understand the shared resources, tools, and workforce needed to rapidly pivot manufacturing.

- NSF invested in research to enable resilience during pandemics, such as agile supply networks and manufacturing methods, biomanufacturing, cyber-enabled and remote human-in-the-loop manufacturing, and distributed manufacturing.
- The Administration for Strategic Preparedness and Response (ASPR) established the Supply Chain Control Tower (SCCT) to monitor critical supply chains and inform decision making during a public health response.

Personal Protective Equipment

Rapid advancements in PPE design, manufacturing, processing, and uptake were essential in providing an additional line of defense against COVID-19, especially prior to availability of other MCMs. Previous gaps in technology, fit, and uptake of PPE necessitated innovation.

PPE Design and Innovation

- CDC National Institute for Occupational Safety and Health (NIOSH) released the Protective Clothing Challenge to improve protective clothing designs to address PPE equity issues including fit and performance, especially for women.
- The Defense Advanced Research Projects Agency (DARPA) Personalized Protective Biosystem (PPB) program aims to reduce protective equipment burden while increasing protection against existing and future chemical and biological threats.
- DOE's NVBL rapidly developed a new process for charging melt-blown polymers to produce N95 filter media and develop molds to produce certified respirators, now commercially available.
- The Department of Commerce provided American Rescue Plan funding to two DoD-sponsored Manufacturing USA institutes, Advanced Functional Fibers of America (AFFOA) and AmericaMakes, to innovate PPE production through automation, diversify the supply chain, and mitigate the environmental impact of PPE through development of new high-filtration materials.

PPE Manufacturing and Processing

- VHA, NIH, FDA, and AmericaMakes established the COVID 3D TRUST: Trusted Repository for Users and Suppliers to support manufacturing of PPE or other necessary medical devices through the creation of a 3-D digital stockpile of designs.
- USAID provided technical assistance to PPE producers in LMICs to manufacture and export quality-assured PPE.
- CDC NIOSH prioritized the processing of air purifying respirators (e.g., N95s, elastomerics, powered air purifying respirators), completing 732 respirator approval application decisions and 260 quality assurance audits in 2021 to increase the national inventory of respirators.

BARDA-NIOSH-NIST Mask Innovation Challenge

The Mask Innovation Challenge aims to engage innovators and entrepreneurs to develop innovative designs that overcome common complaints and barriers associated with mask wearing. The challenge is split between two phases: Phase 1 of the Challenge solicited novel designs. Phase 2 of the Challenge required a mature prototype for evaluation in government laboratories against predefined performance criteria. In Phase 1 of the Challenge, 10 winning ideas split $100,000; winners ranged from home innovators and small businesses to leading global companies from the tech and clothing industries. Phase 2 of the Challenge was launched in December 2021, with up to four winning prototypes splitting $400,000. The winners of Phase 2 will be announced in late fall 2022.

Maximizing the Use of PPE

- CDC NIOSH responded to more than 7,900 PPE stakeholder and media inquiries since the start of the pandemic, an increase from an average of 510 annually. In addition, CDC NIOSH published a number of documents and strategies to inform PPE use and distribution:
    - *Strategies for Optimizing the Supply of N95 Respirators*

  - *Release of Stockpiled N95 Filtering Facepiece Respirators Beyond the Manufacturer-Designated Shelf Life: Considerations for the COVID-19 Response*
  - *Decontamination and Reuse of Filtering Facepiece Respirators*
  - *Respiratory Protection in a Time of Crisis: NIOSH Testing of International Respiratory Protective Devices for Emergency Use*
  - *12 Conformity Assessment Notices and Letters to Manufacturers and Interested Parties*
- NSF funded grants for Rapid Response Research (RAPID) and Early-Concept Grants for Exploratory Research (EAGER) on advanced disinfection methods, antiviral/antibacterial coatings and materials, and filtration technologies for PPE.
- CDC funded 14 Broad Agency Announcements (BAA) to advance PPE innovation.
- EPA evaluated methods to disinfect PPE and to assess any impacts to the effectiveness of the PPE; disinfection methods focused on readily available, commercial off-the-shelf cleaning/disinfection products and evaluating effectiveness on PPE such as face coverings, face shields, and clothing.

Reducing Disease Transmission in the Built Environment

The U.S. Government accelerated research and promoted effective implementation of ventilation, filtration, and disinfection tools to improve indoor air quality in the places we live, work, and learn.

Research on Spread and Transmission

- CDC NIOSH continues to conduct and share research on the effects of ventilation, air filtration, and face masks on exposure to robot-simulated respiratory aerosols; CDC conducted research on ventilation in schools by using a nationally representative sample of 420 U.S. K–12 public schools.
- DOE NVBL funded studies to increase understanding of airborne transport impacting SARS-CoV-2 transmission and the roles of surface chemistry and materials science in transmission and spread.
- DOE Building Technologies Office (BTO) funded research to evaluate the efficacy of various methods of reducing viral spread with a specific focus on ultraviolet-C methods.
- Through RAPID and EAGER, NSF funded research that discovered aerosols contain infectious, live SARS-CoV-2 virus and that aerosolized transmission occurs beyond distances of 6 feet.
- The Federal Transit Administration (FTA) awarded projects to transit agencies through the Public Transportation COVID-19 Research Demonstration Grant Program to install and test onboard air filtration and purification technologies on transit vehicles, study aerosol dispersion in transit, and use contactless fare payment to lessen the risk of virus spread.
- EPA conducted research assessing effectiveness of various air treatment technologies, including:
  - Working collaboratively with DHS, Los Angeles County Metropolitan Transportation Authority and New York City Metropolitan Transportation Authority assessed technologies at scale, representative of facility and mass transit vehicle use.
  - Research of products claiming to provide long-lasting, residual disinfection of surfaces against viruses (including SARS-CoV-2), resulted in publication of Interim Guidance for Products Adding Residual Efficacy Claims and addition of products to a supplemental approval list for use against coronavirus (COVID-19).
  - Research of disinfection devices (e.g., UV, ozone, steam) against coronavirus on surfaces.
- The DHS PANTHR program characterized virus survival on surfaces, the potential for those contaminated surfaces to infect additional individuals, and the ability of various disinfection technologies to prevent further infection and transmission.

Guidance and Communications for Improving Indoor Air Quality

- EPA collaborated with other agencies to release the Clean Air in Buildings Challenge, a call to action and set of best practices to reduce risks from airborne viruses and other contaminants indoors.
- CDC published Ventilation in Buildings and Improving Ventilation in Your Home, which describes how indoor air quality can be improved as part of a layered approach.
- EPA, CDC, and DOE worked with the Department of Education (ED) to develop Efficient and Healthy Schools resources and guidance for improving indoor air quality in schools.
- EPA published and maintained a list of more than 500 approved disinfectants for coronavirus (COVID-19) and guidance for manufacturers use in adding electrostatic spray application directions for antimicrobial product registrations.
- In March 2022, OSTP hosted a discussion on COVID and Clean Indoor Air, highlighting the importance of ventilation, air filtration, and air disinfection in the fight against COVID-19.

Enabling Innovation

The widespread critical needs resulted in novel efforts to enable innovation through the biotechnology ecosystem, especially emerging companies and improved contracting in public-private partnerships.

BARDA Ventures

BARDA Ventures extends BARDA's core principle of public-private partnerships to the investment community, creating, for the first time at HHS, a venture-style partnership that can make quick, agile investment decisions, crowd-in private capital, and de-risk commercialization of transformative technologies to be ready for future pandemics. BARDA has collaborated with a nonprofit partner, Global Health Investment Corporation (GHIC), to address gaps in health security as well as meet commercial market needs. GHIC has already closed three investment deals and is preparing to launch global health security fund using BARDA Ventures funds and matching capital from other investors. As investments generate investment returns, proceeds will be used for reinvestment.

Support for Biotechnology Ecosystem

- DARPA developed the Embedded Entrepreneurship Initiative (EEI) with a goal of accelerating innovations, positioned to support over 150 DARPA research teams over the next 5 years. The innovative program provides funding, mentoring, and connections to investors and corporate partners.
- BARDA Accelerator Network supports access to mentors, educational programing, and strategic partners across 13 regions to support academics and small biotech companies.
- Blue Knight, a BARDA partnership with Johnson & Johnson, provides young biotech companies with strategically-aligned mentorship and access to world-class lab and office space to incubate and grow.
- USPTO institutionalized efforts to improve innovation and/or business incentives, including:
    - Partnering with industry in quarterly Biotechnology, Chemical, and Pharmaceutical Partnership meetings to improve innovation incentive products and services.
    - Expanding Patents for Humanity to include a category for those responding to the COVID-19 pandemic that provides business incentives for patent applicants, holders, and licensees whose inventions track, prevent, diagnose, or treat COVID-19.
    - Expanding collaboration with FDA to include initiatives to enhance the robustness and reliability of issued patents to ensure that the patent system incentivizes and protects the investment essential for bringing innovations in pharmaceuticals to market.

Contracting/Federal Government Function

- DoD, in partnership with HHS, developed a process to negotiate large vaccine development and procurement contracts, resulting in delivery of over 1 billion vaccine doses to the U.S. population.
- BARDA established the Easy Broad Agency Announcement (EZ BAA) for rapid award for initial performance to de-risk breakthrough technologies. BARDA EZ BAA awards are up to $750,000 and can be achieved in as little as 11 days.

- USPTO's "Patents4Partnerships" is an IP Market Platform that brings together those who have technology and want to make it available for licensing and those who can commercialize it. The initial Platform release focuses on prevention, diagnosis, and treatment technologies for COVID-19.

V. Managing the Mission

AP3 Goal: Manage this crucial national endeavor with the seriousness of purpose, commitment, and accountability of an Apollo Program and coordinate work with the international scientific community.

Program Management

Over the last year, the U.S. Government strengthened management and accountability of all aspects of pandemic preparedness while galvanizing broad global support.

- In coordination with governmental partners and philanthropies, the United States promoted the establishment of an independent, dedicated Secretariat to assess global progress toward 100 Days Mission goals and other G7 pandemic preparedness commitments. The Secretariat will support an international S&T Expert Group dedicated to driving progress. The United States deepened technical cooperation in support of 100 Days Mission goals with Quad (India, Japan, and Australia) in clinical trials and pathogen genome sequencing.
- NSF established the COVID Information Commons (CIC) in May 2020 to provide an open, accessible database to find research of interest in the fight against COVID-19. The CIC now includes more than 7,800 NSF and NIH awards related to COVID-19.
- HHS stood up a new structure, H-CORE, to provide a long-term coordinating mechanism for vaccine development and distribution for COVID-19 and future pandemics.

Key Goals Towards Implementation of Transformational Capabilities

In the upcoming year, the U.S. Government will drive breakthrough innovation to mitigate the impact of future threats. Some of the top priorities for further action are described in this section, though the ability to fully execute these tasks is subject to the availability of appropriations and the annual President's Budget process. Strategically, two core themes include leveraging and exercising capabilities in addressing current infectious diseases threats, and utilizing an across-the-government-portfolio-approach to maximize the ability of the U.S. Government to foster private sector innovation.

Utilizing Current Infectious Disease Health Challenges to 'Exercise' Pandemic Preparedness

Having familiar technologies, procedures, and processes are critical for organizations to implement effective public health responses. A critical overarching goal is to utilize and demonstrate technology and processes that would be most useful for future pandemic response. Exercising by addressing infections and global health challenges helps to accomplish health goals while improving ability to respond to future threats. Further, an expeditious response in the early days of an outbreak is an effective mechanism to exercise the early development of capabilities and may even prevent an outbreak from becoming a pandemic. We aim to utilize early response and capabilities to address global infectious diseases. This may allow for exercising scale operations—such as hepatitis B vaccination or large-scale test-to-treat responses—that could not be exercised during a limited

outbreak. The following examples are selected because of the potential positive impacts on health, alignment with AP3 goals and priorities, and ability for success with appropriate resources.

1. ***Seasonal/pandemic influenza***: As an annual worldwide viral respiratory pathogen associated with significant morbidity and mortality, influenza remains a top concern as a pathogen that could cause the next pandemic. Development of capabilities for scaled manufacturing and distribution of vaccine, development of universal vaccines, improved masks and indoor ventilation, employment of the test-to-treat concept, and distributed diagnostics are highly applicable to an improved response to influenza.
2. ***Anti-microbial resistant (AR) pathogens, including bacteria and fungi:*** CDC's analysis, *COVID-19: U.S. Impact on Antimicrobial Resistance, Special Report 2022*, demonstrated significant surges in antibiotic use and AR infections during the first year of the pandemic in U.S. hospitals, including a 15% increase in both resistant hospital-onset infections and deaths. Prevention strategies—such as antibiotic stewardship and infection prevention and control activities—remain the first line of defense to stop the emergence and spread of AR, while simultaneously helping prepare for unknown emerging threats in the future. Additionally, improved surveillance and reporting, accurate and rapid diagnostic tests, and accelerated product development for new vaccines, therapeutics, antibiotics and antifungals are all critical needs to address AR.
3. ***Hepatitis viruses B and C:*** As one of the leading etiologic relationships to hepatocellular carcinoma and liver failure, there is great opportunity for global health benefit by improving diagnostics to lead to curative treatment for hepatitis C, and global, universal vaccination for hepatitis B. In particular, developing robust distribution systems for repeated vaccination (for a three-dose series) presents a unique opportunity to exercise global equity in vaccine programs.
4. ***Sexually-transmitted infections (STIs):*** Improvements in distributed, affordable, and accurate diagnostics, coupled with rapid treatment, could have a profound effect on these infections. Progress on at-home diagnostic testing and facilitating test-to-treat by telehealth are two examples of opportunities that could be further developed while addressing STIs.
5. ***African swine fever (ASF):*** By addressing an agricultural pathogen through improved diagnostics, distributed testing, and next-generation vaccines, these capabilities could be exercised to address agricultural threats and reduce economic loss associated with agricultural disease.
6. ***Emerging zoonotic infections:*** The opportunity to better address the increasing threat of zoonotic disease outbreaks through the utilization of a One Health approach that engages Ministries of Health, Agriculture/Livestock, and Environment.

Achieving a 'Portfolio View' of U.S. Government Pandemic Preparedness Investment to Ensure Readiness and Maximize Impact

Innovation is critical to advancing pandemic preparedness; however, for innovation to reach the end user when needed, innovation must be coupled with readiness and scalability. To ensure readiness, the U.S. Government should view the pandemic innovation ecosystem and pandemic preparedness more broadly as a portfolio, from early investment through scaling. This approach would be driven by SCPI and implemented through a series of meetings and workshops to highlight and synthesize programs and investments relevant to pandemic preparedness across all departments and agencies.

There is significant merit to a holistic approach to ensuring pandemic innovation and technological readiness while reducing duplicative investments and sharing lessons learned. This view would provide

decision makers with the information needed to understand existing and upcoming challenges at the sector level while synthesizing what is needed in the near and long term (e.g., additional/new authorities, budgets, collaborations) to be better prepared as a Nation. This single line-of-sight portfolio approach would focus on strategy and not on tactical operations in order to respect agency autonomy while providing helpful guidance and coordination. The portfolio view would enable efficient and improved short- and long-term response, facilitating the priority actions outlined below.

I. Transforming Our Medical Defenses

Vaccines

Support development and manufacturing of next-generation vaccines, including broader immunity, more flexible administration, and more efficient manufacturing.

Research and Development

- **Progress research and development of improved vaccine candidates that achieve broader protection.** Using computational and experimental approaches, develop vaccine constructs that elicit broad neutralization or targeted conserved T-cell epitopes across threat families to maximize preparedness. This includes research to understand commonalities within pathogen families (including host response) that can be targeted for broad-spectrum prophylactic strategies, as well as research on immune correlates of protection (e.g., universal vaccines, other novel platforms).
- **Identify ways to optimize immune response.** Explore generalizable approaches to engage immune responses—both innate and adaptive—to recognize prototype and related pathogens to achieve maximum protection using new vaccine modalities, adjuvants, and formulation strategies.
- **Develop flexible vaccine administration techniques.** Explore the specificity and functional properties of immune responses elicited by different routes and modalities of vaccine administration to optimize safe, effective, and durable immune response to block transmission and achieve neutralization and rapid clearance of the pathogen rather than just reduction of symptoms.

Clinical Trials

- **Invest in clinical development for next-generation vaccine technologies, including real-world effectiveness and ongoing assessments of safety and efficacy after licensure.** While addressing the next threats of pandemic potential, domestic and global clinical development programs will inform critical performance parameters such as onset to, and duration of, protection ahead of the next outbreak/epidemic/pandemic. This should include strengthening existing global and domestic clinical trials networks and funding continued trials of ongoing infectious disease countermeasure development so that the sites can pivot to the most urgent needs in an emergency.

Manufacturing

- **Support R&D of decentralized on-demand and scaled vaccine manufacturing technologies** to reduce reliance on/risk associated with single manufacturing facilities, reduce costs associated with maintaining vaccine stockpiles, and address logistical challenges associated with distribution.
- **Support regionally diversified vaccine manufacturing capacities for faster access to vaccines in LMICs.** This includes analyzing vaccine supply and demand landscapes and mapping potential market shaping and innovative finance scenarios to help ensure sustainability.
- **Accelerate standard approaches for assays throughout the vaccine manufacturing process, with special emphasis on release testing.** There is substantial opportunity to improve quality and reduce time standardization for rapid and accurate assays in areas such as release testing.

Regulatory Approval

- **Facilitate product development and high-quality regulatory submissions** for selected next-generation vaccine candidates that protect against current and emerging variants; sustainably strengthen national regulatory systems in vaccine-producing LMICs to oversee the production of quality, safe, and effective vaccines.

Therapeutics

Develop and produce a range of therapeutics for treatment and prophylaxis on an accelerated timeline.

Research and Development

- **Accelerate product development of next-generation mAB therapeutics**. Continue to advocate for investment in new technologies including programmable RNAs and investigate formulations for higher concentrations of mAbs in the drug product to enable alternative methods of delivery.
- **Support advanced research and development of broad-spectrum antivirals.** Continue to advocate for investment in broad-spectrum antivirals that target entire viral families, that have an oral route of administration, and that are suitable for treating all populations.
- **Conduct research and development of host-targeted therapeutics.** Continue to advocate for investment in pathogen-agnostic therapeutics and mitigate the host's response to infection, particularly for those hospitalized with an emerging infectious disease and any resulting sequelae.
- **Utilize advanced computational resources to accelerate countermeasure discovery.** Leverage high-powered computational resources, technical databases, and AI/ML to rapidly discover or re-target antibodies or small molecules against known or emerging threats.
- **Develop *in vivo* models of disease for prototype pathogens for viral** families of pandemic potential and conduct fundamental research to understand commonalities within viral threat families, including host response, that can be targeted by broad-spectrum therapeutic technology.
- **Develop multiple, highly effective, broad agents against two or more viral enzymes**, including those that modulate the immune response or restore organ function, such as acute respiratory distress syndromes, vascular injury, sepsis, and other severe outcomes. Support research for therapies that can be utilized as prophylaxis to maintain homeostasis after pathogen exposure.
- **Develop *in vitro*, *in silico*, and animal models and assays** to rapidly evaluate therapeutic candidates as well as in vitro models to assess potency of host directed and immunomodulatory therapeutics to exploit host interdiction points and maximize spectrum of therapeutics.
- **Support sustained research and clinical trials** for expedited assessment of safety and efficacy of therapeutics in humans, including, a) trials in low-income countries, b) combination therapies effective against resistant viral strains, and c) continuing trials as new pathogen variants arise.

Regulatory Review

- **Support a streamlined regulatory process** for approval of broad-spectrum therapeutics for prototype pathogens of pandemic potential.
- **Support platform approaches to rapidly assess already approved or late-stage development therapeutics** for a given indication that could be repurposed for the emerging threat.

Manufacturing and Implementation

- **Support next-generation antibody discovery and biomanufacturing research and enable scaled antibody manufacturing.** De-risk next-generation programs to facilitate rapid, scaled-up deployment and provide researcher/student access to manufacturing-representative testbeds.

- **Increase access to vaccines and treatments with Interim Fielding Capabilities (IFC).** Support the establishment of a repository for medical products, at various stages of development, that can be immediately accessed for further development and use during an emergency.

Diagnostics

Develop distributed, simple-to-use, inexpensive, pathogen–agile, high-performance tests quickly and at large scale, and deploy in multiple settings.

Research and Development

- **Develop pathogen pivoting, multi-pathogen, and pathogen-agnostic capabilities.** Support development of pathogen flexible, multiplex, and pathogen-agnostic diagnostic tests that can be rapidly pivoted to respond to emerging threats. Highly multiplexed tests for known diseases in viral families with high pandemic potential are needed to accelerate availability of testing when a new disease emerges. The ability to rapidly swap new antigens/sequences as variants emerge is needed.
- **Advance host-based diagnostics.** Develop and improve host-based diagnostic approaches to tackle pathogen threats. This can include the development of tools that can be used for triaging, such as a diagnostic tests for pre-symptomatic infection or predictors of illness severity to better align and allocate resources.
- **Identify minimally- or non-invasive testing methods.** Support research to utilize novel testing methods to further enable simple-to-use diagnostics. Prioritize assessment, validation, and optimization of test performance. Use guidance for new variants and future pathogens.

Manufacturing and Infrastructure

- **Enable scaled and sustainable diagnostic manufacturing capabilities.** Support research and development projects, pathogen pivoting diagnostic use-cases, and investments in small businesses to enable innovation in scaled manufacturing automation at lower costs.
- **Support global diagnostics.** Establish the international infrastructure and financing needed for pandemic preparedness.

Regulatory Review

- **Facilitate regulatory review.** Expand existing programs supporting regulatory review of diagnostic tests to include the evaluation of sample collection, point-of-care, and laboratory-based tests. Develop infrastructure and expand regulatory pathway and guidance needed for next generation sequencing and agnostic diagnostics. Support independent evaluation, where possible.

Clinical Trials

- **Establish an Emergency Clinical Trials Steering Committee** to determine when coordinated, large-scale emergency research is needed, and to oversee the drafting of research protocols.
- **Conduct outreach to institutions and networks.** Begin supporting "warm base" research to facilitate rapid launch of future trials. This could include identifying a standing Outside the Continental United States (OCONUS) clinical trial network in geographic regions most likely to see emergence of pathogens of pandemic potential to facilitate expeditious safety and efficacy testing.
- **Develop an Emergency Master Trial Agreement** covering key terms such as data collection and use rights, to prepare institutions and clinical trial networks to carry out coordinated, large-scale clinical research in the event of an outbreak or other emerging public health issue.
- **Streamline Institutional Review Boards (IRB).** Rely on a central IRB in order to accelerate clinical trial standup and evaluation.

- **Build decentralized clinical study and healthcare delivery networks** that leverage existing retail clinics, pharmacies, and telemedicine providers to expand access to patients and real-world evidence (RWE) and allow clinical studies to be conducted in environments in which products were created, including evaluation in austere environments. Explore lessons learned from COVID-specific public-private partnerships (e.g., NIH ACTIV).

II. Ensuring Situational Awareness

Data for Decision Making

Create advancements in data infrastructure, analytics, and privacy technology in an organized platform to facilitate real-time decision making and policy development.

- **Improve data interoperability, security, privacy, and representation.** Develop, identify, and promote data standards and tools that improve data interoperability, security, privacy, and representation of diverse populations. Data should be from multiple sources along a patient's care continuum (longitudinally), before, during, and after hospitalization.
- **Improve digital (health) tools and data systems** to support planning, distribution of commodities and vaccines, tracking supplies, surveillance and case detection, monitoring coverage of services, the ability to track/monitor cases during a pandemic, and communicating to generate demand and reduce misinformation. Develop home diagnostics that include Quick Response (QR) readers that allow reporting of test results and automatic ordering of new tests.
- **Improve robustness of digital health networks and data systems** across countries and continents. Leverage and strengthen existing networks to provide real-time data for response.
- **Enhance multi-objective optimization decision framework.** Develop advanced processing and visualization tools to enable rapid decisions, especially during rapid response events.
- **Conduct fundamental research for understanding, monitoring, predicting, and responding to pathogen spread** to transform society's ability to forecast the likelihood of pandemic-scale events, detect outbreaks early, and respond quickly.

III. Strengthening Public Health Systems

Effectively Build Trust to Improve Innovation Uptake

- **Establish a national health knowledge research and response system.** A permanent public health capability is needed to enable effective pandemic response and quick action when concerns impacting health behavior arise. This system will focus on building and maintaining the public's trust in health agencies and government, promoting the uptake of behaviors that decrease disease transmission and severity, and improving health outcomes for vulnerable populations.
- **Establish a health information data collection system** that collects data on the public's understanding of health information—including health-related misinformation—using local community-based surveys, nationally representative surveys, and social and news media monitoring data to identify health-related rumors that can potentially decrease health behavior uptake and trust in government, science, and healthcare.
- **Establish interagency community of practices (COPs)** to assist agencies in building trust and rapidly identifying, responding to, and coordinating efforts when mistrust and poor user experience prevent MCM uptake. The COPs will create an updated Body of Knowledge on the state of public trust, impacts of varying degrees of public trust, and intervention best practices. This Body of Knowledge will be released publicly to increase transparency.

- **Build, engage, and leverage trusted communication networks** in collaboration with local, State, jurisdictional, Tribal, and national partners, news outlets, fact-checking organizations, professional associations, and Federal agencies. Entities will leverage networks to disseminate priority health messages using findings from the National Health Knowledge Research and Response System.
- **Develop culturally appropriate guidance and training related to the trust and use of new, innovative products.** New guidance and training should consider how to best facilitate engagement and gather input from key partners and to ensure cultural and socioeconomic factors are considered when trying to improve behavior uptake around new products.
- **Disseminate appropriate guidance and training complementary to new innovations developed for the pandemic response.** Effective communication is achieved when repeated and consistent messages in the audience's preferred language are delivered through multiple channels by trusted individuals and organizations. Thus, support to disseminate and evaluate impact of new products is critical to maintain core capacities.

Workforce

- **Protect healthcare workers, first responders, and other frontline workers.** Develop plans to prioritize PPE supplies for frontline workers. Ensure their safety, needs, and perspectives are considered throughout the pandemic response, including protecting the mental health of healthcare workers and first responders. Ensure frontline workers have access to the latest diagnostic and screening tools to most effectively identify and isolate affected persons.
- **Develop mechanisms for surge staffing.** Due to the rapid increases of personnel needed during a pandemic response, mechanisms are needed to allow for surge staffing to effectively respond to emerging events. These mechanisms could include expanded hiring authorities and ongoing training programs to equip employees with the skills necessary for a pandemic response. Surge staffing capabilities should be expanded across the pandemic preparedness spectrum, including medical staff, manufacturing, public health responders, and others.
- **Prioritize retraining and uptraining of medical and public health staff, train frontline workers across sectors.** Due to the natural evolution of available MCMs and recommendations during a public health response, personnel may need to be trained, retrained, or uptrained on current standard of care, including infection prevention and control. Providing medical staff and frontline workers with the most up-to-date information and training should be prioritized before and during a pandemic to support preparedness, prevention, and response in vulnerable populations.

IV. Building Core Capabilities

Innovations in Health Care for a Pandemic Response

Some of the critical lessons learned during the COVID-19 pandemic involved the ability to provide life-saving health care for infected patients and prevent overwhelming the health care system during surges in infections. Breakthrough innovations in healthcare response will be prioritized, with special emphasis on distributed healthcare technologies for domestic and global applications.

- **Support technologies for providing health care in the home and in remote locations**. Telehealth, physiologic monitoring, home diagnostics testing, and sample collection and stabilization are all transformative technologies. Operational research can evaluate the integration of these technologies, demonstrating improved outcomes.

- **Accelerate predictive analytics for level-of-care decision making.** Allowing patients to receive care in home or remote locations, or in large emergency facilities, can be based on effective prognostic assessments.
- **Develop methodologies for rapid development of evidence-based practice guidelines.** Having steady-state networks that can rapidly accumulate best clinical practices via observational studies in the early stages of an outbreak can ensure clear guidelines are provided.
- **Improve integration of clinical practice and clinical research during an emergency**. Facilitating participation in clinical research (e.g., electronic informed consent) along with clinical care of patients will allow for near real-time accumulation of clinical best practices.

Innovative Manufacturing for Pandemic Response

Invest in and incentivize innovation for improved product quality, increased yield and scale, faster ramp-up time, improved supply chain reliability for precursors and critical items, and expanded domestic and geographically diverse manufacturing to enable faster and more equitable access.

Medical Product Production

- **Establish mAB manufacturing platforms.** Leverage state of the art antibody discovery, design, and manufacturing technologies to accelerated mAb development in an emergency response. Technologies such as continuous bioprocessing can significantly increase doses in an early response, and can significantly reduce cost per dose.
- **Begin the development of on-demand vaccine manufacturing capabilities** that could create and distribute vaccines rapidly at local hospitals and pharmacies.
- **Develop scaled manufacturing pilots.** Utilize scaling diagnostics manufacturing as an initial use case to prove capability and capacity for scaling during pandemic response.

Supply Chain and Resilience

- **Develop a continuous and long-range understanding of essential medical product manufacturing capacity and related global investments**, including analysis of LMIC essential medical product needs, to inform recommendations for essential medical product manufacturing investments and/or provision of technical assistance in LMICs.
- **Increase domestic diagnostic test manufacturing capacity and preserve increases achieved.** By domestically producing diagnostic tests and the supplies required to perform them, supply chain issues encountered during pandemics may be avoided.
- **Mature manufacturing technologies using advanced process controls**. Develop innovative approaches to process management (e.g., digital twin reactor control) that will result in decreased process development, increased process yields, reduced failure rates, increased product quality and consistency, and potentially reduced release assay requirements. Fundamental cyber-enabled manufacturing research will enable new biomanufacturing capabilities and network resilience.
- **Build good manufacturing practice systems and capacity.** Invest in growing a diverse skilled workforce including in biotechnology, support for the voluntary transfer of technology on mutually-agreed terms, joint ventures, and access to affordable financing.
- **Enhance domestic manufacturing capacity and capabilities.** Invest in infrastructure and a skilled workforce to increase U.S. competitiveness for commercially available vaccines and therapeutics.

Personal Protective Equipment

Maintain and drive a culture shift toward ubiquitous use of high-quality respiratory protection across different settings, including the general public.

Research and Development

- **Support innovation to develop next-generation masks and respirators**. Designs should maximize fit, ease of wear (e.g., comfort, breathability, thermal burden), effectiveness, and affordability. New products should include reusable masks and new renewable, sustainable, and environmentally safe bio-derived materials, and user-centered designs for all sectors and diverse populations. Develop compatible methods and guidance for disinfection of PPE supporting reuse.
- **Improve standards, guidance, and foundational science for the development of high-performing children's masks.**
- **Encourage the development and commercialization of sensor technologies** to provide real-time, field-based respirator fit and/or filter penetration data for N95 filtering facepiece respirators.

Capacity Building and Infrastructure

- **Launch a whole-of-U.S. Government Public Health Supplies Innovation Center (IC)** focused on PPE innovation, test and evaluation, regulation, production, and manufacturing, among other priorities, as outlined in the National Strategy for a Resilient Public Health Supply Chain.
- **Establish Personal Protective Technology (PPT) Centers of Excellence** to conduct and coordinate pre-competitive PPE technologies research, design, and psychosocial aspects of use.
- **Establish a sustainable and scalable "digital stockpile"** of tested, transferable, turn-key public health supply fabrication plans that can be accessed during surge events and for future pandemics.
- **Develop specific hospital surveillance for PPE-sensitive organisms (MRSA, VRE)** that can be a benchmark for appropriate PPE use.

Reducing Disease Transmission in the Built Environment

Spur innovation, communications, and implementation of built environment technologies (e.g., ventilation, air filtration and cleaning, and surface materials) to reduce indoor transmission of COVID-19 and future threats.

Research and Development

- **Conduct fundamental research for understanding, monitoring, predicting, and responding** to pathogen spread to transform society's ability to forecast the likelihood of pandemic-scale events, track disease transmission, detect outbreaks early, and respond quickly.
- **Conduct research to determine the social, behavioral, and economic drivers of disease transmission,** and educate the general public on best practices for transmission mitigation. Invest in research to improve the communication of science to diverse audiences.
- **Develop standard efficacy testing methods for air treatment technologies** that promote appropriate labeling and informed use and enable high-quality, standardized, innovative products to come to market in a trusted manner. The scope of the air treatment technologies covered include both physical (e.g., germicidal UV (GUV), filtration) and chemical antimicrobial methods.
- **Expand the use of GUV** in priority congregate settings through research, test and evaluation, real-world demonstration projects, clear standards and guidance, and LED technology innovation.
- **Conduct real-world implementation research for reducing disease spread.** Conduct multidisciplinary epidemiological studies on effectiveness of building-level mitigation approaches in diverse settings (e.g., hospitals, schools, transportation hubs, other congregate settings).
- **Develop methods and practical guidance to reduce transmission from common, high-touch surfaces**, including antimicrobial surfaces, residual or long-lasting antimicrobial coatings and products, *in situ* disinfection methods, and disinfectant application methods.

- **Support innovation in building and infrastructure design**, indoor air quality monitors, pathogen sensors, advanced materials, and air disinfection technologies to foster healthy, safe and secure working, learning, and living environments for all.
- **Utilize existing test bed capabilities** to test and evaluate built environment interventions in both laboratory and real-world settings.

Guidance and Implementation

- **Develop health-based guidance and standards to improve ventilation and indoor air quality.**
- **Establish indoor air quality and built environment interventions** as routine and significant parts of public health and epidemiological strategy including the use of contact tracing and investigation teams for building-related transmission events.
- **Establish the federal buildings portfolio as an exemplar** of innovation, implementation, and standards for ventilation and indoor air quality to reduce disease transmission.

Enabling Innovation

Leverage and expand U.S. Government authorities to promote innovative practices via creative and streamlined finance mechanisms, support for small businesses, extension of emergency contracting processes, open innovation calls, and promotion and scaling of best practice programs.

- **Conduct portfolio view of U.S. Government investment.** Identify gaps and opportunities in the development lifecycle by understanding existing programs and investments at each stage.
- **Form biodefense/pandemic preparedness biotechnology coordination.** Provide guidance – including robust IP protection – to ensure transition from initial funds to larger investments. Approach investments in biotech as a portfolio. Develop SBIR funding guidance to meet dynamic biotechnology ecosystem. Enable R&D collaboration, especially with regulatory partners.
- **Allow cross-agency engagement for companies working to achieve AP3 objectives.** Use business support programs, regardless of funding source. Establish interagency agreements to reimburse this support, or expand funding to lead agency to account for engagement.

V. Managing the Mission

- **Organize rapid response capability cell.** Systematize and centrally integrate a rapid research response process and associated protocols and team members. This capability should be associated with frequent live-fire exercises to identify gaps and exercise the capabilities.

Conclusion

Though substantial progress has been made towards developing and implementing the transformational capabilities outlined in AP3, numerous gaps exist in the Nation's ability to respond and prepare for emerging health threats. This document highlights a number of key achievements made throughout the COVID-19 pandemic while also outlining priority science and technology research areas and programs that must be advanced to improve U.S. and global pandemic preparedness. Continuing to accelerate innovations across all pillars of AP3 to mitigate the toll of future pandemics and other biological threats is a national imperative.

Relevant Publications

Reducing Disease Transmission in the Built Environment

Blachere et al. (2022). Face mask fit modifications that improve source control performance. Am J Infect Control 50(2): 133-140. https://doi.org/10.1016/j.ajic.2021.10.041

Derk et al. (In preparation) Efficacy of Do-It-Yourself Air Filtration Units in Reducing Exposure to Simulated Respiratory Aerosols.

Dowell et al. (2022). Reducing SARS-CoV-2 in Shared Indoor Air. JAMA. https://doi.org/10.1001/jama.2022.9970

Calfee et al. (2021). Virucidal Efficacy of Antimicrobial Surface Coatings against the Enveloped Bacteriophage Φ6. Journal of Applied Microbiology.

Coyle et al. (2022). Reduction of exposure to simulated respiratory aerosols using ventilation, physical distancing, and universal masking. Indoor Air 32(2): e12987. https://doi.org/10.1111/ina.12987

Coyle et al. (2021). Efficacy of Ventilation, HEPA Air Cleaners, Universal Masking, and Physical Distancing for Reducing Exposure to Simulated Exhaled Aerosols in a Meeting Room. Viruses 13(12): 2536. https://doi.org/10.3390/v13122536

Hardison et al. (2022). Evaluation of Surface Disinfection Methods to Inactivate the Beta Coronavirus Murine Hepatitis Virus. Accepted to Journal of Occupational and Environmental Hygiene. https://doi.org/10.1080/15459624.2022.2088768

Hardison et al. (2021). Efficacy of Detergent-Based Cleaning Methods Against Coronavirus Surrogate MHV-A59 on Porous and Nonporous Surfaces. Journal of Occupational and Environmental Hygiene. https://doi.org/10.1080/15459624.2021.2015075

Lindsley et al. (2021). Efficacy of Portable Air Cleaners and Masking for Reducing Indoor Exposure to Simulated Exhaled SARS-CoV-2 Aerosols - United States, 2021. MMWR Morb Mortal Wkly Rep 70(27): 972-976. https://doi.org/10.15585/mmwr.mm7027e1

Brooks et al. (2021). Maximizing Fit for Cloth and Medical Procedure Masks to Improve Performance and Reduce SARS-CoV-2 Transmission and Exposure, 2021. MMWR Morb Mortal Wkly Rep 70(7): 254-257. https://doi.org/10.15585/mmwr.mm7007e1

Lindsley et al. (2021). Virus decay rates should not be used to reduce recommended room air clearance times. Infect Control Hosp Epidemiol: 1-2. https://doi.org/10.1017/ice.2021.494

Lindsley et al. (2021). Efficacy of universal masking for source control and personal protection from simulated cough and exhaled aerosols in a room. J Occup Environ Hyg 18(8): 409-422. https://doi.org/10.1080/15459624.2021.1939879

Lindsley et al. (2021). A comparison of performance metrics for cloth masks as source control devices for simulated cough and exhalation aerosols. Aerosol Sci Technol 55(10): 1125-1142. https://doi.org/10.1080/02786826.2021.1933377

Lindsley et al. (2021). Efficacy of face masks, neck gaiters and face shields for reducing the expulsion of simulated cough-generated aerosols. Aerosol Sci Technol 55(4): 449-457. https://doi.org/10.1080/02786826.2020.1862409

Mikelonis, A., Archer, J., Wyrzykowska-Ceradini, B., Morris, E., Sawyer, J., Chamberlain, T., Abdel-Hady, A., Monge, M. and Touati, A. (2022) Determining Viral Disinfection Efficacy of Hot Water Laundering. J Vis Exp. doi: 10.3791/64164

Monge et al. (2021). Inactivation of MS2 bacteriophage on copper film deployed in high touch areas of a public transport system. Letters in Applied Microbiology 74(3): 405-410. https://pubmed.ncbi.nlm.nih.gov/34695284/

Ratliff et al. (2021). Evaluating Impact of Ultraviolet-C Exposure Conditions on Efficacy against MS2. Accepted to Letters in Applied Microbiology. http://doi.org/10.1111/lam.13770

Shah, S.R., Kane, S.R., Elsheikh, M. and Alfaro, T.M. (2021) Development of a rapid viability RT-PCR (RV-RT-PCR) method to detect infectious SARS-CoV-2 from swabs. Journal of Virological Methods 297, 114251. https://doi.org/10.1016/j.jviromet.2021.114251

Wood, J.P., Magnuson, M., Touati, A., Gilberry, J., Sawyer, J., Chamberlain, T., McDonald, S. and Hook, D. (2021) Evaluation of electrostatic sprayers and foggers for the application of disinfectants in the era of SARS-CoV-2. Plos One 16, e0257434. doi: 10.1371/journal.pone.0257434

Personal Protective Equipment (PPE)

Andrews et al. (2022). “Understanding filtering facepiece respirators.” American Journal of Nursing. 122(2):21-23. doi: 10.1097/01.NAJ.0000820540.36250.bf.

Andrews et al. (2021). “Respiratory Protection in a Time of Crisis: NIOSH Testing of International Respiratory Protective Devices for Emergency Use.” Health Secur. 19(4):379-385. doi: 10.1089/hs.2020.0173. Epub 2021 Jan 11. PMID: 33434096; PMCID: PMC8906491.

Haas et al. (2022). "Using public feedback about the use of elastomeric half mask respirators to inform a national deployment study within health settings." Journal of the International Society for Respiratory Protection, 38(2), 92–106. NIOSHTIC-2 Search Results - Full View (cdc.gov)

Haas et al. (2021). "Lessons learned from the development and demonstration of a PPE inventory monitoring system for U.S. hospitals." Health Security, 19(6), 10 p. doi:10.1089/hs.2021.0098

Greenawald et al. (2022). "Elastomeric half mask respirators: An alternative to disposable respirators and a solution to shortages during public health emergencies." Journal of the International Society for Respiratory Protection, 38(2), 74–91. NIOSHTIC-2 Search Results - Full View (cdc.gov)

NIOSH (2022). "Evaluation of exhalation resistance and inspired carbon dioxide concentration in elastomeric half-mask respirators with modified or covered exhalation valves." Strickland KT, Fernando R, Schall J, Walbert G, Brannen J. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2022-109. https://doi.org/10.26616/NIOSHPUB2022109.

NIOSH (2021) PPE CASE: Assessment of Filter Penetration Performance and Fit for Decontaminated N95 Respirators by Quinn, T., Bergman M., Strickland, K., Streeter, R., Vollmer, B., Meyers, J., Wilson, A., Pollard, J.P. Pittsburgh, PA U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NPPTL Report Number P2021-0101.

NIOSH (2021) PPE CASE: Evaluation of Fit and Strap Extension Performance of Stockpiled Filtering Facepiece Respirators from One U.S. Facility. By Greenawald LA, Moore SM, and Yorio PL. Pittsburgh, PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NPPTL Report Number P2021-0102.

NIOSH (2020). Filtering facepiece respirators with an exhalation valve: measurements of filtration efficiency to evaluate their potential for source control. By Portnoff L, Schall J, Brannen J, Suhon N, Strickland K, Meyers J. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2021-107. DOI: https://doi.org/10.26616/NIOSHPUB2021107.

NIOSH (2020) PPE CASE: Filtration efficiency performance of non-NIOSH-approved international respiratory protective devices: phase two. Andrews A, Powers J, Cichowicz J, Coffey C, Fries ML, Yorio PL, D'Alessandro M. Pittsburgh, PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NPPTL Report Number P2020-0113.

NIOSH (2020). PPE CASE: Inhalation and Exhalation Resistance and Filtration Performance of Stockpiled Air-Purifying Respirators: Overall Performance of Nearly 4,000 Respirators Sampled from Ten Stockpile Facilities. By Greenawald, L., Moore, S., and Yorio, P.L. Pittsburgh, PA U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NPPTL Report Number P2020-0111.