UNDERSTANDING THE THREAT OF BIOLOGICAL WEAPONS IN A WORLD WITH COVID-19

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INTRODUCTION

Threats posed by biological weapons have been evolving for nearly a century. However, the pace of change has been accelerating in recent years due to several intersecting trends, including the accessibility of sophisticated biotechnology tools, plunging costs of sequencing and synthesis, and the convergence of new technology areas (e.g., synthetic biology, AI/machine learning, and robotics).

In 2020, a new set of dynamics around biological weapons emerged as a result of widespread failures of many nations around the world to effectively respond to the global spread of the novel coronavirus that causes COVID-19. After more than two years of global efforts to contain the spread of this highly transmissible disease, world leaders are still unable to discern the threat parameters of a COVID-19 era. However, one thing remains clear: the ongoing crisis could profoundly alter how countries perceive biological weapons and how these weapons may advance their security interests. For the hopefully-small number of nations that may consider biological weapons, the human, security, and economic toll of the COVID-19 pandemic is likely to shape their views regarding the deliberate use of disease to cause disruption and destruction.
Several nations are already behaving in ways that demonstrate significant cause for concern. For example, leaders in Iran have declared their nation’s need to increase defenses against biological weapons because of COVID-19—capabilities that would also enhance their ability to develop and test biological weapons if the nation pursues that path in the future. Meanwhile, China, Russia, and others have fueled an impactful disinformation campaign suggesting that COVID-19 originated as a biological weapon in the United States.¹

Policymakers around the world now confront a series of critical questions regarding the impact of COVID-19 on the future threat of biological weapons. These include:

- In a world with COVID-19, will countries already hedging toward biological weapons programs decide to pursue them more actively?

- If technologically-capable countries known to have developed biological weapons in the past (e.g., Russia) and those suspected of dual-use research that may cross into offensive capability development (e.g., China, North Korea, and Iran)² see value in having biological weapons arsenals, will they withdraw from relevant treaties and declare their clandestine programs as an integral part of their deterrence strategies? Or will such countries strengthen their clandestine capabilities while remaining members of relevant treaties—especially given the absence of a strong verification and enforcement regime?

- How will the economic and societal havoc caused by the global pandemic lead actors already interested in bioweapons to view the weaponization of engineered pathogens versus naturally occurring ones?

- How might budget pressures arising from the steep economic costs of the global pandemic influence calculations about biodefense and/or biological weapons programs?

These new questions come at a time when countries around the world have already adopted national security strategies and military postures that embrace a greater blurring of nuclear and non-nuclear deterrence and the advantages of hybrid tactics for undermining adversaries (e.g., Russia’s use of cyberattacks and disinformation campaigns alongside a build-up in traditional military capabilities).

Meanwhile, enthusiasm for international cooperation across a number of important and related areas has declined significantly, jeopardizing the long-term viability of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) and the Biological Weapons Convention (BWC) unless this trend is reversed. The repeated use of chemical weapons by Syria, Russia, North Korea, and non-state actors without significant retribution have further weakened the global norms against the possession and use of weapons of mass destruction (WMD).

Significant academic work explores the histories of former biological weapons programs and the potential threat of such weapons in the future.³ This literature has informed our study, though we must recognize a few key limits up front.

First, much of the hard evidence regarding current and recent biological weapons programs remains classified.⁴ In the absence of sufficient tangible information, the public literature diverges quite significantly regarding the likelihood and motivations of certain countries choosing to pursue biological weapons programs and the reasons behind their potential interest. In some cases, this divergence of opinion also holds true among experts who have examined terrorist threats and those who have focused solely on state-based threats.⁵

Some experts argue that cases of biological weapons development and their use will be extremely rare and manageable through deterrence and/or kinetic military action. Other experts express more wide-ranging and serious concerns...
about the threat (even before the COVID-19 pandemic) and believe that motivations for biological weapons and their technological potential will continue to expand and diversify in ways for which current policies by the United States and many other nations fail to adequately account. Additionally, the literature to date (in particular from the past ~20 years) shows significant disagreement among the scientific community regarding how advances in synthetic biology and gain-of-function research might play a role in both exacerbating and mitigating the threat of biological weapons in the future—a debate that has become more public in recent years.

Major disagreements among experts regarding the shape and scope of biological weapons threats and their highly technical nature have sowed much confusion and complacency among U.S. policymakers.

Further, the COVID-19 pandemic may be a game changer in shaping relevant threat parameters, at least for the next ten years. Biological weapons experts are still coming to grips with how the global pandemic will influence countries in the future. Given the newness of the questions raised, most analysis to date has taken the form of short commentaries. Some of this work has also gotten caught up on the narrow question of whether COVID-19 would make a good biological weapon itself—an important but small piece of the entire bioweapons threat spectrum. More in-depth work has been constrained by the caution exercised by analysts amid great uncertainty. Meanwhile, some biological weapons experts have also wanted to avoid contributing to the ongoing disinformation claiming that COVID-19 is a biological weapon.

A recent report published by the Center for Advanced Red Teaming, *Red Teaming the Post-COVID-19 Biological Weapons Threat Landscape*, represents a significant exception to the lack of in-depth work on the threat parameters of a post-COVID-19 world. The study entailed a red team exercise in which 300 participants engaged in simulated decision-making from the perspective of state leaders of 30 selected countries, which are not known to be currently developing biological weapons. The study aimed to investigate the effects of the COVID-19 pandemic on strategic decision-making and identify drivers that might lead to changes in their interest in biological weapons. Participants assessed 26 of the 30 countries to experience a small increase of interest in biological weapons in a world with COVID-19 due to perceived vulnerabilities to widespread societal disruption and economic harm. However, most countries were found to be primarily interested in pursuing biodefense activities rather than biological weapons programs. A handful of countries were assessed to have greater interest in biological weapons as a strategic deterrent or to shore up regime preservation in a world with COVID-19. Meanwhile, participants found that most countries would refrain from the development of biological weapons due to their fear of detection and reprisals, as well as reduced standing in the international community for violating nonproliferation norms and regimes.

Until these important issues, along with those arising from the ongoing COVID-19 pandemic, are explored in depth to provide greater understanding of the range of potential outcomes, U.S. policies for addressing biological weapons will remain inadequate—leaving gaping holes in our national security strategy.

In this paper, we present findings from our “futures research” in which we investigated 1) the incentives and disincentives for the development of biological weapons; 2) historical signals related to biological weapons; and 3) other trends, issues, and problems. To do this, we conducted an extensive survey of experts on biological weapons and other weapons of mass destruction. To ensure diverse perspectives, invited survey participants were cross-generational, cross-organizational, and multidisciplinary. The survey consisted of three analytical parts: an examination of past time horizons, current threat assessments, and forecasts for the future of biological weapons in a COVID-19 era.

We offer our findings in this report as follows. In Part I, we describe the different time horizons from the 1940s to the 2010s and present findings for each period based on our own research and assessments by survey participants. We evaluate how the trends, motivations, drivers, inhibitors, and wild cards related to biological weapons have evolved
over time: what has changed, and what has stayed the same. In Part II, we propose three alternate scenarios that represent divergent futures for biological weapons threats as influenced by the COVID-19 pandemic and illustrate the broad spectrum of possibilities for the future:

**Scenario 1:** The Rise of Biological Weapons as a Significant Component of Deterrence  
**Scenario 2:** Biological Threats Hasten a New Era of International Cooperation  
**Scenario 3:** A Hybrid World of Ambiguous Threats

These scenarios reflect detailed ideas and input that experts provided via CSR’s survey and private discussions. As such, they provide experts and policymakers with a significantly deeper understanding of the full range of futures for biological weapons threats. The world has already witnessed signs that indicate trending toward any one of these futures.

A better understanding of the spectrum of potential pathways for biological weapons will be crucial if the U.S. government is to read signals correctly, understand how the different motivations and drivers might push toward each of the three futures represented in the scenarios, and respond with appropriate policy solutions.

In Part III, we offer a preview of the policy responses that will be required to shape the desired parameters for a world that has experienced the devastation of COVID-19. Even before the COVID-19 pandemic, U.S. policy regarding biological weapons threats suffered from at least three serious issues.

First, the legacy of the 9/11 terrorist attacks, which shifted U.S. policy to focus heavily on bioterrorism, needs to be rebalanced with consideration of potential state-based biological weapons threats. The scale and resources countries could bring to such programs make this a truly catastrophic risk.

Second, U.S. strategy for addressing biological threats is oriented toward potential challenges stemming from advances in biotechnology without adequate plans for leveraging the advantages of technology—and ensuring such work is done in responsible, risk-reducing ways.

Third, funding to support defense against biological weapons threats has been declining in the United States for years. At the time of the publication of this report, these trends have not yet been seriously reversed. COVID-19 must be a wake-up call to the need for substantial increases in resources for addressing the full range of biological threats.

In the coming months, CSR will use the analysis in this paper to frame subsequent workshops focused on advancing policies to address these issues and others and better mitigate biological weapons threats. We hope the survey results and scenarios that follow will serve as a useful tool for improving policies and programs for addressing biological threats moving forward.
PART I:
SURVEY: HISTORICAL TRENDS SHAPING BIOLOGICAL WEAPONS PROGRAMS OVER TIME
In order to understand the future threat parameters for biological weapons, we must first take stock of the past and examine the sources of change over time and historical trends: **motivations, drivers, inhibitors, and the impact of wild cards.** This is much easier said than done for a world with COVID-19 since the world has not experienced a global pandemic on such a massive scale in more than a century. The 1918 influenza pandemic occurred many years before the start of formal biological weapons programs and nearly a century prior to some of today’s technological advances in synthetic biology. Hence, due to the wildcard of the global pandemic, future threats may defy the past trends, drivers, and inhibitors for biological weapons programs and produce some major surprises.

To help survey participants step back into decades of history, we assembled layered timelines for five different time horizons from the 1940s to the 2010s using an online multimedia tool. Each timeline contained a series of sequential developments that occurred over time in order to provide important context for biological weapons programs, including major world events, advancements in science and technology, changes in existing institutions, and key moments in daily life. We asked survey participants to answer the same series of questions for each time horizon to assess the motivations for countries to develop biological weapons and the features that made states perceive biological weapons as either attractive or unattractive. In this way, we aimed to be able to track the evolution of drivers and inhibitors over time and the impact of wildcards.

From the expert survey, we aimed to find patterns and identify the drivers of change that might also shape the future. Such analysis will help U.S. policymakers understand how things have evolved over time and consider what historical factors are still driving change today (e.g., advances in science and technology, geopolitical conflict or competition, new ideas and values, chance, or wild cards). The survey findings will help to identify what policymakers need to know about the past, present, and future in order to improve their decision-making and create new possibilities for the future.

In this section of the report, we describe the key events and trends we presented to experts on each of the timelines and describe findings from the survey.
The prospect of biological warfare emerged during the interwar period in the 20th century. Although World War II featured extensive use of chemical agents on both sides in the European theater, the Germans were in a more experimental phase regarding biological warfare in its targeting of livestock with disease. However, during the Second Sino-Japanese War from 1937 to 1945, the Imperial Japanese Army engaged in covert biological and chemical warfare research and development which, to date, still represents one of the most extensive known biological weapons programs. Unit 731 under the leadership of Surgeon Lieutenant General Shiro Ishii (a microbiologist and army medical officer) developed biological weapons, tested them extensively on human subjects, and used them on Chinese targets.

It was not until 1942, after the start of World War II, that the United States formally launched its biological weapons program. The few government officials involved kept the program secret from the general public. The U.S. biological weapons program took place alongside a far more expansive effort to build the atomic bomb. Although the war ended with minimal use of biological weapons by the Germans and the Japanese, revelations about the extent of the Japanese effort to develop biological weapons for use on the battlefield shocked the world. During the convening of the International Military Tribunal for the Far East, high-level members of Unit 731, including its commander, received immunity from the United States in exchange for the data Japanese scientists collected for their human experiments.

Despite the shadows of a looming conflict between the United States and the Soviet Union, the early postwar era produced many of the foundations for international cooperation in the 20th century, including the establishment of the United Nations in 1945 and the World Health Organization in 1948. However, international cooperation soon became stifled by the declaration of the Iron Curtain in 1946, the Berlin Blockade in 1948, and the Korean War from...
1950 to 1953. Against this backdrop, the emerging threat of bioweapons spurred several countries, including the United States and the Soviet Union, to conduct further research on both biodefense and offensive applications, work that continued to flourish throughout the first decades of the Cold War.

Notably during this period, several early building blocks for relevant future technological advancements were also established. Between 1943 and 1945, the electronic numerical integrator and computer (ENIAC), the world’s first programmable, electronic and general-purpose digital computer, was invented. In 1951, President Harry Truman made the first ever transcontinental television broadcast through 87 stations in 47 cities. In 1953, scientists discovered the double-helix structure of DNA and successfully tested a vaccine against the polio virus, opening the door to its eradication.

In the following, we provide findings on how experts view these and other trends during the time horizon of the 1940s and 1950s. In the illustrative graphs, we have color-coded the motivations and linked them to associated drivers and inhibitors as viewed through the lens of actions taken by decision-makers during that time: blue pertains to deterrence being the goal for countries seeking biological weapons, green for battlefield use, gray for what today is considered gray-zone or hybrid warfare, and orange for regime security. In cases where drivers and/or inhibitors are associated with more than one motivation, the primary motivation will be represented as a color-coded triangle in front of the secondary motivation.

In the text surrounding these graphs, we convey additional details of expert responses to the survey. For example, regarding the 1950s, 50% or more of surveyed experts ranked these five motivations as the most important factors in shaping interest in biological weapons:

- A deterrent against the WMD program of an adversary
- A force multiplier
- A deterrent against the conventional superiority of an adversary
- For use on the battlefield
- For retaliation

More than half of these experts ranked two drivers as being the most important factors for shaping biological weapons programs—in other words, the attributes states likely found most attractive—with many, but fewer than half, of respondents identifying three additional drivers as important:

- Magnitude of potential harm (e.g., deaths, casualties)
- Ability to incapacitate
- Economic damages
- Difficulty of developing and fielding new countermeasures
- Psychological impact

More than half of surveyed experts ranked four inhibitors as being the most important factors in countries showing restraint on biological weapons, followed by one more inhibitor selected by many, but fewer than half, of respondents:

- Difficulty of control after the release of a pathogen (which 72% of respondents believed was a top driver of countries showing restraint regarding biological weapons)
- Lack of or uncertain military utility on the battlefield
- Indiscriminate nature
- Fear of retaliation
- Uncertainty of impact (e.g., environmental factors)
The 1950s
Top Motivations for Biological Weapons Programs

- For retaliation: 5
- A deterrent against the conventional superiority of an adversary: 3
- A deterrent against the WMD program of an adversary: 1
- A force multiplier: 2
- For use on the battlefield: 4

The 1950s
Top Drivers for Biological Weapons Programs

- Psychological impact: 5
- Economic damages: 3
- Magnitude of potential harm (e.g., deaths, casualties): 1
- Ability to incapacitate: 2
- Difficulty of developing and fielding new countermeasures: 4
During this period, several countries began programs to develop biological weapons as a potential weapon for battlefield use. At this time, the leaders of those countries perceived them to offer not only a force multiplier on the battlefield, but also a powerful deterrent against nuclear weapons given their potential magnitude of harm. However, at the time, there was still much uncertainty surrounding their use as a military weapon due to their indiscriminate nature and uncertain impact. Many leaders were also concerned about the potential loss of control upon release of a dangerous pathogen. For this reason several countries, including the United States and the Soviet Union, began research and testing to ascertain answers to these questions.

Between the 1940s and 1950s, Japan's program provided a powerful wild card for shaping early trends, drivers and inhibitors, not only in terms of the scale of its efforts to develop and use biological weapons, but also its extensive testing on human subjects. Against the tense backdrop of the emerging Cold War, the sheer extent of Japan's program likely helped to shape the perceived military utility of biological weapons, as evidenced by the United States granting immunity to Japanese scientists to receive access to the results of their research.
At the start of the 1960s, any notion of banning biological weapons would have likely appeared to be wildly implausible. By this time, strategic competition between the United States and the Soviet Union had reached full throttle, and the longstanding ideological conflict between democracy and communism was brewing hot in Vietnam. The Soviets had launched the world's first satellite, Sputnik I, in 1957, creating the false perception of a capability gap with regards to intercontinental ballistic missiles and spurring an aggressive nuclear arms race. The United States and Soviet Union moved full steam ahead in their efforts to develop biological weapons. By 1965, both countries had become fully embroiled in the Vietnam War.

And yet, a unique combination of trends—the recognition of biological weapons as a powerful strategic weapon, early seeds of a detente between the United States and the Soviet Union, domestic anti-war protests in the United States, concern about the proliferation of biological weapons, and negative sentiments about its involvement in biological and chemical weapons programs—led President Nixon to renounce biological weapons in 1969.

Throughout the 1960s, U.S. scientists had investigated the potential of using biological weapons on the battlefield by conducting a series of secret open air tests under the Department of Defense’s Project Shipboard Hazard and Defense (Project SHAD). Amongst other outcomes, these tests confirmed the potential strategic impact of biological weapons on U.S. cities from the dispersal of pathogens with a low-flying plane; they offered a strong deterrent like a nuclear weapon, but were much easier to make and use.
Public controversy over then-classified U.S. biological and chemical weapons programs started in 1965 with revelations that the U.S. military used Agent Orange - various dangerous herbicides to destroy forest cover and crops - in Vietnam. The disclosure ignited years of public and Congressional debate about the use of biological and chemical weapons, including riot control agents. The anti-war movement also helped to build a strong public consensus against such weapons. Tensions came to a head in 1968 when more than 6,000 sheep died from exposure to nerve agents being tested at Dugway Proving Ground in Utah.

As other countries developed greater interest in both nuclear and biological weapons in the 1960s, the United States and Soviet Union discovered a common goal: the desire to prevent the further proliferation of such weapons and perhaps launch paths away from their own excesses. New interest in superpower cooperation first led to the negotiation and signature of the nuclear non-proliferation treaty (NPT) in 1968, which created a norm against the development of nuclear weapons by any new countries and committed what was then five existing nuclear weapon states to reducing and eventually eliminating their arsenals.

On the heels of this success, Soviet Foreign Minister Andrei Gromyko proposed to ban biological and chemical weapons at the United Nations General Assembly in 1969. In recognition of the strategic threat, President Nixon renounced the U.S. biological weapons program on November 25, 1969, pledging to destroy all stockpiles and calling upon other countries to join in banning the development and use of such weapons. This call was later codified in the Biological and Toxins Weapons Convention (BWC) in 1972. In the mid-1970s, the U.S.-Soviet detente continued to strengthen with the negotiation of the SALT I treaty the same year, placing limitations on strategic offensive arms and anti-ballistic missile defense, U.S. withdrawal from Vietnam in 1973, and the Helsinki Accords in 1975.
The 1960s and 1970s produced a variety of impressive technological advances. The U.S. landing on the moon in 1969 was followed up in 1975 by the Apollo-Soyuz, the first crewed international space mission, with millions watching a live television broadcast of the historic docking of the U.S. Apollo module with the Soviet space capsule. Intel debuted its first microprocessor, and IBM introduced its first floppy disk for external data storage and file transfer. The field of biotechnology also received a major boost in the 1970s with the invention of recombinant DNA. The new technology would allow scientists to merge DNA from different species, producing modified living organisms with new sets of characteristics. It would also allow scientists to enhance existing pathogens with greater lethality, infectivity, and other characteristics that would improve their use as biological weapons. Concerns about the potential implications led scientists to convene the Asilomar Conference in 1975 in order to set norms for advancing work in the field of genetic engineering.

Technological advances in the 1970s foreshadowed a darker turn in the threat of biological weapons for the future. Despite signing and ratifying the BWC, the Soviet Union decided to significantly expand its bioweapons program. In 1973, the Soviets created Biopreparat, an ostensibly civilian network of laboratories dedicated to the development, testing, and large-scale production of a wide selection of dangerous pathogens. Suspicions about Soviet intentions were exacerbated in 1979 by an unusual anthrax outbreak in the city of Sverdlovsk.

Meanwhile, other countries began to explore the utility of biological weapons. In 1975, the Rhodesian government (now Zimbabwe and Zambia) developed chemical and biological agents for use against insurgents within its borders. By 1981, South Africa had launched Project Coast, led by Dr. Wouter Basson, to develop chemical and biological weapons for internal use by its defense forces. In addition to state biological weapons programs, a growing number of incidents of international terrorism revealed a potential new threat dimension for the future.

In the following, we provide findings on how experts responded to the trends during this time horizon of the 1960s and 1970s. As described above, in the following illustrative graphs we have color-coded the motivations and linked them to associated drivers and inhibitors as viewed through the lens of the time horizon. In cases where drivers and/or inhibitors are associated with more than one motivation, the primary motivation will be represented as a color-coded triangle in front of the secondary motivation.

Regarding the 1960s and 1970s, 50% or more of surveyed experts believe that the first three motivations listed below were the most important factors in shaping interest in biological weapons, followed by two more motivations ranked as important by a smaller number of experts:

- **A deterrent against the WMD program of an adversary**
- **A force multiplier**
- **For use on the battlefield**
- For offensive use as an asymmetric and covert tool
- A deterrent against the conventional superiority of an adversary

Interestingly, the results of the survey indicate a general belief that the specific attributes that actors considered attractive in biological weapons were beginning to shift. While 50% of these experts believed that magnitude of potential harm was a key factor in this era, respondents showed a wider distributions of factors, likely reflecting their knowledge (that is now public) that different countries who had biological weapons activities in this era had more diverse interests in them, as described above:
• **Magnitude of potential harm (e.g., deaths, casualties)**
• Easy to hide
• Deniability
• Ability to incapacitate
• Psychological impact

In terms of what made biological weapons unattractive in this period, most experts ranked the top two inhibitors below as being the most important for showing restraint on biological weapons, followed by three additional inhibitors that many others regard as important:

• **Difficulty of control after the release of a pathogen**
• **Indiscriminate nature**
• Legal and moral constraints
• Uncertainty of impact (e.g., environmental factors)
• Fear of retaliation
The 1970s
Top Drivers for Biological Weapons Programs

- Psychological impact: 5
- Deniability: 3
- Magnitude of potential harm (e.g., deaths, casualties): 1
- Easy to hide: 2
- Ability to incapacitate: 4

The 1970s
Top Inhibitors for Biological Weapons Programs

- Fear of retaliation: 5
- Legal and moral constraints: 3
- Difficulty of control after the release of a pathogen: 1
- Indiscriminate nature: 2
- Uncertainty of impact (e.g., environmental factors): 4
By the 1960s and 1970s, several countries had developed expansive and active biological weapons programs and determined them to be a strategic weapon given their perceived significant magnitude of harm. Over several decades, these countries explored their utility for battlefield use and tested their effectiveness across a variety of circumstances. In our survey, experts judged the motivations of countries for pursuing biological weapons to have shifted slightly to include their perceived utility as an asymmetric or covert tool of aggression. Several features of biological weapons, their ease of concealment and deniability, lent themselves to a new form of gray zone warfare. Still, countries remained concerned about the many uncertainties—in particular, the difficulty of controlling a dangerous pathogen after release and fear of retaliation due to their indiscriminate nature.

During this period, the signing and entry into force of the BWC offered the most influential wild card, giving countries an alternative to developing biological weapons programs out of fear that their adversaries were also doing so. However, if the Soviet decision to expand its biological weapons programs during this period had been public at the time, this would have likely immediately dampened the potency of the new legal norm. South Africa’s biological weapons program, launched in 1981, represented another smaller but noteworthy wild card, in light of regime security as a rising motivation for developing such weapons.
With the dissolution of the Soviet Union, the multidimensional and complex threat environment of the post-Cold War decade of the 1990s brought the growing threat of and interest in WMD to the center stage of global politics. Blatant treaty violations by Iraq, North Korea, and Russia had overturned the Cold War assumption that treaty members would not violate their obligations in order to remain in good standing with the international community and gain access to the peaceful uses of related technologies. The clandestine WMD programs exposed significant gaps in the nonproliferation treaties and export control regimes and raised the specter of their use. In 1990, in response to Iraq’s invasion of Kuwait, the U.S.-led coalition began the Persian Gulf War under the threat of Iraq’s potential use of chemical and biological weapons on the battlefield.\footnote{With the dissolution of the Soviet Union, the multidimensional and complex threat environment of the post-Cold War decade of the 1990s brought the growing threat of and interest in WMD to the center stage of global politics. Blatant treaty violations by Iraq, North Korea, and Russia had overturned the Cold War assumption that treaty members would not violate their obligations in order to remain in good standing with the international community and gain access to the peaceful uses of related technologies. The clandestine WMD programs exposed significant gaps in the nonproliferation treaties and export control regimes and raised the specter of their use. In 1990, in response to Iraq’s invasion of Kuwait, the U.S.-led coalition began the Persian Gulf War under the threat of Iraq’s potential use of chemical and biological weapons on the battlefield.}

The rise of global terrorism, as evidenced by the terrorist bombing of the World Trade Center in 1993\footnote{The rise of global terrorism, as evidenced by the terrorist bombing of the World Trade Center in 1993, and the diffusion of dual-use technology and advanced science added a dangerous new dimension to the threat of biological weapons: the growing risk of non-state actor use. Two years later, Aum Shinrikyo’s sarin nerve attack on the Japanese subway confirmed the prospect of terrorist use of WMD. The attack killed more than a dozen people and sickened more than 5,000. Notably, it was later found that Aum Shinrikyo had tried to advance biological weapons as well, to the point of spraying anthrax from rooftops. The Tokyo subway attack was considered by many terrorism analysts to be a watershed event.} and the diffusion of dual-use technology and advanced science added a dangerous new dimension to the threat of biological weapons: the growing risk of non-state actor use.\footnote{Two years later, Aum Shinrikyo’s sarin nerve attack on the Japanese subway confirmed the prospect of terrorist use of WMD. The attack killed more than a dozen people and sickened more than 5,000. Notably, it was later found that Aum Shinrikyo had tried to advance biological weapons as well, to the point of spraying anthrax from rooftops. The Tokyo subway attack was considered by many terrorism analysts to be a watershed event.} Two years later, Aum Shinrikyo’s sarin nerve attack on the Japanese subway confirmed the prospect of terrorist use of WMD. The attack killed more than a dozen people and sickened more than 5,000. Notably, it was later found that Aum Shinrikyo had tried to advance biological weapons as well, to the point of spraying anthrax from rooftops.\footnote{The Tokyo subway attack was considered by many terrorism analysts to be a watershed event.} The Tokyo subway attack was considered by many terrorism analysts to be a watershed event.\footnote{Against this pessimistic backdrop, there were also signs of renewed energy to reduce the risks of WMD on all fronts. During the final days of the Soviet Union, the George H.W. Bush administration negotiated significant and irreversible reductions in strategic nuclear arms between the United States and Russia under the Strategic Arms Reduction Treaty (START). The agreement built upon the success of the Intermediate-Range Nuclear Forces Treaty and transitioned the superpowers away from an antagonistic bilateral relationship toward one defined by cooperative arms reduction. Progress did not stop here. In 1993, an impressive 130 countries including the United States, Britain,}
France, Russia, and China signed the Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction (CWC). In 1995, member countries agreed to an indefinite extension of the Nuclear Nonproliferation Treaty (NPT). In 1996, 71 countries including the United States signed the Comprehensive Nuclear Test Ban Treaty (CTBT), banning all nuclear weapons testing.

Starting in 1991, the United States, along with other countries, started working together under the Cooperative Threat Reduction (CTR) Program to dismantle WMD infrastructure or convert it to civilian uses, including state-level biological weapons programs from the Cold War era. One of this report’s co-authors (Andy Weber) worked closely with former Soviet states such as Kazakhstan to dismantle the industrial-scale biological weapons production facilities that were developed to deter and potentially attack the United States and its allies and held the potential to kill millions of people if fully mobilized. The CTR Program initially aimed to eliminate threats posed by biological, chemical, and nuclear weapons of the Soviet Union, but has evolved significantly into a nearly-global U.S. government program implemented by multiple federal agencies with threat reduction work underway in many countries around the world.

At the conclusion of the Persian Gulf War in 1991, the UN Security Council adopted resolution 687, which formed an inspection agency called the UN Special Commission (UNSCOM) with the aim of eliminating all remaining Iraqi biological, chemical, and nuclear weapons activities and ensuring its future compliance with international norms. Over several years of work, UNSCOM inspectors uncovered evidence of Iraq’s biological weapons program, despite years of denials by Iraqi officials, contributing to the program’s end.

Amidst these successes, the shocking truth about the Soviet biological weapons program began to leak out. In 1992, Russian President Boris Yeltsin admitted that the 1979 outbreak at Sverdlovsk came from military efforts to develop biological weapons in violation of the BWC. Following this disclosure, the United States, Britain, and Russia agreed...
to establish a trilateral process of information sharing and reciprocal site visits in order to increase the transparency of Russian bioweapons-related activities.\textsuperscript{44}

In 1995, a team of biological experts from the United States including CSR’s Andy Weber visited the Stepngorsk anthrax production plant in Kazakhstan, revealing the vastness of the Soviet bioweapons program for the first time. A year later, the United States and Kazakhstan agreed to dismantle the bioweapons infrastructure at the Stepngorsk production plant with funds and technical expertise from the CTR program. In 1998, the former deputy director of Biopreparat publicly confirmed details of Soviet plans to use anthrax, smallpox, and the plague delivered by strategic platforms in the event of a major war with the United States.

With biological weapons threats on the rise, the United States along with the international community sought throughout the 1990s to strengthen measures to prevent their development and use. In 1990, President George H.W. Bush signed the Biological Weapons Anti-Terrorism Act, making it illegal for the United States to develop or possess biological weapons. This legislation completed U.S. implementation of the BWC and enabled the prosecution of domestic violations. One year later, the U.S. Congress passed the Chemical and Biological Weapons Control and Warfare Elimination Act to strengthen international cooperation to control the proliferation of chemical and biological weapons and allow for economic sanctions in response to chemical and biological weapons activities.

In recognition of the gaps in the BWC, the Third Review Conference produced an Ad Hoc Group of Governmental Experts (VEREX) to “identify measures which would determine whether a State Party is developing, producing, stockpiling, acquiring, or retaining” biological weapons. As part of ongoing efforts, countries began to negotiate the parameters of a legally binding protocol to the BWC, which would include more effective measures to verify compliance. Meanwhile, the Australia Group, a voluntary export control regime established by like-minded countries, gradually expanded its export control activities to include materials and equipment related to biological weapons.

The 1990s concluded with two important trends related to biological weapons: the growing threat of non-state actors and a series of major technological developments that promised to expand their accessibility. In 1998, Osama bin Laden, the leader of al Qaeda, declared acquiring and using WMD to be a religious duty, a statement that seemed to mark the beginning of al Qaeda efforts to develop a biological weapons program.\textsuperscript{45}

With the emergence of the World Wide Web in 1989, the decade also laid the groundwork for the digital revolution in both information technology and genetic engineering. Developments in the mid to late 1990s included the start of Internet commerce, email communications, access to wireless networks, and search engines for the general public, creating many new possibilities. While the U.S. government launched the Human Genome Project with the aim of sequencing the human genome within 15 years, scientists achieved success in less than ten. The technologies developed along the way represented the building blocks for the field of synthetic biology in the future.

In the following, we provide findings on how experts responded to the trends during this time horizon of the 1990s. As above, in the illustrative graphs we have color-coded the motivations and linked them to associated drivers and inhibitors as viewed through the lens of the time horizon. In cases where drivers and/or inhibitors are associated with more than one motivation, the primary motivation will be represented as a color-coded triangle in front of the secondary motivation.

Regarding the 1990s, the majority of experts ranked the first three motivations listed below as the most important factors in motivating interest in biological weapons, followed by two more motivations for which many experts agreed on their importance:
• A deterrent against the WMD program of an adversary
• For offensive use as an asymmetric and covert tool
• A deterrent against the conventional superiority of an adversary
• An assassination tool
• Regime security

Additionally, most experts agreed that the top three attributes listed below were the most important factors for shaping biological weapons programs in this era, followed by two additional drivers which many experts found important:

• Easy to hide
• Deniability
• Psychological impact
• Accessibility
• Magnitude of potential harm (e.g., deaths, casualties)

For this time period, the surveyed experts also ranked the following three inhibitors as being the most important for showing restraint on biological weapons, followed by two additional inhibitors that many experts believe were important:

• Fear of retaliation
• Legal and moral constraints
• Difficulty of control after the release of a pathogen
• Uncertainty of impact (e.g., environmental factors)
• Indiscriminate nature

By the 1990s, the trends shaping biological weapons programs had shifted significantly. Several newer motivations for
The 1990s
Top Drivers for Biological Weapons Programs

- Deterrence
- Battlefield
- Hybrid Warfare
- Regime Security

- Magnitude of potential harm (e.g., deaths, casualties): 5
- Psychological impact: 3
- Easy to hide: 1
- Daniability: 2
- Accessibility: 4

The 1990s
Top Inhibitors for Biological Weapons Programs

- Deterrence
- Battlefield
- Hybrid Warfare
- Regime Security

- Lack of or uncertain military utility on the battlefield: 5
- Difficulty of control after the release of a pathogen: 3
- Fear of retaliation: 1
- Legal and moral constraints: 2
- Uncertainty of impact (e.g., environmental factors): 4
biological weapons programs emerged as the primary factors shaping the decisions of states, including their use as an asymmetric and covert tool, as an assassination tool, and for shoring up regime security. Meanwhile, their perceived military utility on the battlefield had nearly fallen out of consideration by this time except as it related to other characteristics of these weapons, such as the magnitude of potential harm.

During this period, the case of Iraq represented the most important wild card, with several surprises experienced in the 1990s and beyond. Despite fears that Iraq would use chemical and biological weapons during the Gulf War, it refrained from doing so. After repeated denials of possessing any biological weapons, UNSCOM eventually discovered evidence to the contrary. Once Saddam kicked out UN inspectors, he gave the impression that Iraq retained its WMD programs, a false perception that among other factors contributed to the second Gulf War in 2003. Iraq’s blatant treaty violations of the BWC, despite being outdone by the Soviet Union/Russia on that front, pointed to major gaps in the verification and enforcement mechanisms in the regime. U.S. determination to enforce legal norms against possession and use of WMD during the 1990s likely contributed to the perceived fear of retaliation becoming the number one inhibitor of biological weapons.
The September 11 terrorist attacks, carried out by al Qaeda operatives against U.S. targets including the World Trade Center in New York City and the Pentagon, served as a defining moment for the United States during the first decade of the 21st century, if not for much longer. The terrorist attacks led the United States to go to war against Afghanistan and Iraq, remaining in both countries for almost twenty years, and raised the specter of WMD terrorism to its highest level yet. Since the 9/11 attacks were planned by Osama bin Laden and other members of its leadership from a safe haven provided by the Taliban in Afghanistan, the United States, the United Kingdom, and Australia launched Operation Enduring Freedom with the objectives of defeating the Taliban and dismantling the al Qaeda network, later to be joined by multiple other partner nations.

During the early years of the operation, the United States uncovered tangible evidence of a biological weapons program developed by the terrorist organization in Afghanistan. In 1999, Hambali (aka Riduan Isamuddin), the head of Jemaah Islamiyah, a group of Islamist radicals based in southwest Asia and associated with al Qaeda, introduced an ex-Malaysian Army Captain, Yazid Sufaat, to al Qaeda leader Ayman Zawahiri. Sufaat had earned a degree in biochemistry and served as a medical technician in the Malaysian Army. Under Zawahiri’s direction, he moved to Afghanistan and began work to help al Qaeda develop anthrax as a biological weapon. During the same timeframe, Zawahiri also recruited a Pakistani government biologist to build a laboratory in Kandahar, Afghanistan. In June 2001, a few months before the 9/11 attacks, U.S. border officials detained two individuals, Abderraouf Yousef Jdey and Zacharias Moussaoui, for suspected ties to al Qaeda and possible plans to carry out a biological attack.

Concerns about the threat of biological terrorism were further heightened due to five anthrax letters sent by U.S. mail to media and political figures just over a month after the 9/11 attacks. The letters spread anthrax spores throughout the local mail systems, sickened 22 people, and killed five. The Amerithrax case went unresolved until 2009 with the identification of Dr. Bruce Ivins, a U.S. scientist working on top secret biodefense efforts, as the lead suspect. By 2003, U.S. government officials were warning of an imminent WMD terrorist attack. Fueled by ongoing suspicions of WMD in Iraq and growing concerns of their use, the United States went to war against Iraq to rid the country of its WMD for once and for all. In the aftermath of the invasion, however, no such weapons were ever found. Nonetheless, for some officials, the preemptive war had the desired effect, causing Libya to worry it might be the next country targeted for invasion. Muammar Gaddafi agreed to eliminate his country’s WMD programs in December of 2003, but the reasons were likely more complex.

Despite the rising threats posed by biological weapons, as perceived by many countries, international collaborative efforts to reduce their risks stalled when the Fifth Biological Weapons Convention Review Conference failed to agree to verification measures in 2001. The BWC states parties have made little progress toward these goals ever since. Meanwhile, access to sophisticated technologies to develop biological weapons increased tremendously during the 2000s. New developments followed on the heels of the successful mapping of the human genome under the Human Genome Project and were viewed as a harbinger of things to come. For example, in 2002, scientists synthesized the polio virus from its genome sequence using DNA and chemicals, creating it from scratch for the first time. By 2007, the cost of next generation sequencing had dropped by 70 times, accelerating the field of biotechnology and enabling broader access to the tools of genetic engineering.

During the 2000s, another looming biological threat came into view—the increasing risk of zoonotic crossover of a dangerous pathogen from animals to humans leading to a global pandemic. In 2002 and 2003, a new coronavirus started spreading across China and around the world, causing the disease now known as Severe Acute Respiratory Syndrome (SARS). The coronavirus is believed to have possibly started with bats, spread to cats, and then to
humans. After its initial emergence in China, it spread to 26 other countries, infecting 8,096 people and causing 774 deaths. The SARS outbreak was one of several to emerge in the 2000s including H1N1 (swine flu) and H5N1 (avian flu), serving as precursors for the emergence of the COVID-19 pandemic starting in 2020.

The United States responded to the perceived new suite of biological threats in a number of ways. The U.S. Congress enshrined the U.S. strategic national stockpile into law in 2002 as part of the Public Health Security and Bioterrorism Preparedness and Response Act. In addition to strengthening biopreparedness, the act expanded existing Select Agent Rules to require all entities that possess, use, or transport select agents to register with the Centers for Disease Control and Prevention or the U.S. Department of Agriculture. The legislation also imposed enhanced security requirements and personnel reliability assessments for individuals with access to select agents. In 2004, the Project BioShield Act was signed into law with the objective to accelerate research, development, purchase, and availability of effective medical countermeasures against biological, chemical, radiological, and nuclear agents.

Beyond advancements in biotechnology, the 2000s also offered several important signals in the field of information technology for the future of threats and solutions. The invention of the smartphone in 2007 and the rise of social media (Wikipedia in 2001, Facebook in 2004, YouTube in 2005, and Twitter in 2006) transformed modes of influence and communication and offered many new avenues for countering biological threats.

Multilateral cooperation to address WMD risks also began taking new forms in this time period. In one important example, in 2002 then-G8 members announced the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction in which they enhanced coordination and committed to increasing resources. The Global Partnership also led to changes in policies and legal authorities in countries such as the United States to reduce bureaucratic impediments to cooperation across nations.
In the following, we provide findings on how experts responded to the trends during this time horizon of the 2000s. Once again, in the illustrative graphs, we have color-coded the motivations and linked them to associated drivers and inhibitors as viewed through the lens of the time horizon. In cases where drivers and/or inhibitors are associated with more than one motivation, the primary motivation will be represented as a color-coded triangle in front of the secondary motivation.

Interestingly, regarding the 2000s, there were no single motivations for biological weapons that the majority of experts ranked as important. During this period of great flux, conflict, and increasing knowledge of certain states’ histories regarding biological weapons, the following list cites the motivations for biological weapons for which the largest number of experts agreed were important:

- For offensive use as an asymmetric and covert tool
- An assassination tool
- A deterrent against the WMD program of an adversary
- Regime security
- A deterrent against the conventional superiority of an adversary

The majority of experts believe that the top two attributes in the following list were the most important factors for shaping biological weapons programs, followed by three additional drivers that many experts found important:

- **Deniability**
- **Psychological impact**
  - Magnitude of potential harm (e.g., deaths, casualties)
  - Easy to hide
  - Accessibility

Finally for this era, most experts listed two inhibitors as being the most important for showing restraint on biological weapons, followed by three additional inhibitors that many experts agreed were important:

- **Fear of retaliation**
- **Legal and moral constraints**
  - Difficulty of control after the release of a pathogen
  - Risk of detection
  - Technical difficulty
The 2000s
Top Motivations for Biological Weapons Programs

- Deterrence
- Battlefield
- Hybrid Warfare
- Regime Security

### The 2000s
Top Motivations for Biological Weapons Programs

- A deterrent against the conventional superiority of an adversary: 5
- A deterrent against the WMD program of an adversary: 3
- For offensive use as an asymmetric and covert tool: 1
- An assassination tool: 2
- Regime security: 4

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The 2000s
Top Drivers for Biological Weapons Programs

- Deterrence
- Battlefield
- Hybrid Warfare
- Regime Security

### The 2000s
Top Drivers for Biological Weapons Programs

- Accessibility: 5
- Magnitude of potential harm (e.g., deaths, casualties): 3
- Deniability: 1
- Psychological impact: 2
- Easy to hide: 4
By the 2000s, experts perceived deterrence-related motivations to have moved down from the top spots. During this period, states were assessed to place more value on biological weapons for their gray zone warfare potential—i.e., their use as asymmetric, covert, and assassination tools. Corresponding with this important shift, the deniability of biological weapons and their psychological impact emerged as the top drivers for biological weapons. Fear of retaliation and legal and moral constraints remained the most important inhibitors for biological weapons.

During this period, the 9/11 terrorist attacks accounted for the most significant wild card. For at least one decade afterward, policymakers and analysts alike considered non-state actor development and use of biological weapons to be the greatest threat, fueled by rapid advances in both information technology and biotechnology.
The decade of the 2010s, which set the context for the current global pandemic, was fast-paced in terms of technological advancements in biotechnology, the evolution of the threat space, and the weakening of legal norms for biological weapons. Whereas biological terrorism continued to be of greatest concern to U.S. national security, especially with the rise of ISIS in Iraq in 2011, an increasing number of states demonstrated a stronger interest in biological weapons. Several of them even used chemical weapons as tools of psychological terror, weakening the norms against the use of WMD.

In July 2012, the Syrian government confirmed that it possessed chemical and biological weapons, but did not offer specific details. One month later, U.S. President Barack Obama warned Syrian president Bashar al-Assad against using chemical weapons in its ongoing conflict, suggesting that such an action would warrant a military intervention. Less than one year after that, the U.S. government determined with high confidence that the Syrian government had repeatedly used sarin nerve agent against its own population, confirmed later by investigations by the UN and the Organisation for the Prohibition of Chemical Weapons. In October 2013, the Syrian government agreed to hand over its chemical weapons and materials for destruction and render production capabilities within the nation unusable. As part of its declarations in 2014, Syria revealed the existence of production facilities for and stockpile of purified ricin.

A number of other countries have indicated potential interest in biological weapons in recent years. In 2015, North Korea’s state media showed Kim Jong Un touring the Pyongyang Biotechnical Institute that was ostensibly established for the production of biopesticides. The facility contains many dual-use capabilities that could be used to produce large quantities of biological warfare agents. In 2019, the U.S. State Department indicated concerns surrounding dual-use biological research activities taking place in China in its Compliance Report. Such activities tread the blurry
line between legitimate biodefense research and a biological weapons program. In the same report, the United States alleged that Iran is engaging in offensive biological weapons research, and that the government had already constructed a plant for producing pharmaceutical botulinum toxin that is intended for non-peaceful purposes.66

Several instances of states using chemical weapons as assassination tools have exacerbated concerns about the perceived utility of biological and chemical weapons programs. Such incidents have also contributed to the weakening of norms against the use of WMD. In 2017, Kim Jong-Nam, half-brother of North Korean leader Kim Jong-Un, was assassinated at the Kuala Lumpur International Airport in Malaysia with VX, a chemical nerve agent believed to have come from North Korea.67 In 2018, a former Russian agent and his daughter were poisoned with a Novichok chemical agent of Russian origin on their visit to the United Kingdom. Both of them survived, but one other came into contact with the poison and died.68

The decade of the 2010s juxtaposed a worsening threat environment and weakening norms with a decline in international cooperation and U.S. leadership to reduce the risks associated with WMD. In 2012, Russia announced its intention not to renew collaboration with the United States under its Cooperative Threat Reduction programs. The members of the BWC continued to struggle with efforts to strengthen verification and restore the relevance of the treaty in light of advancing technologies. Meanwhile, the United States withdrew from a number of international agreements including the 1987 Intermediate-Range Nuclear Forces Treaty (INF Treaty) in 2019.69

The decade leading up to the global pandemic also saw further signs of the growing threats posed by emerging infectious diseases and zoonotic spillover. From 2014 to 2016, West Africa struggled to contain an Ebola outbreak that started in rural Guinea, and the virus quickly spread to urban areas and across borders within weeks. Only a few months later, the outbreak had turned into a global epidemic, resulting in more than 28,000 cases and 11,325 deaths.70 Between 2015 to 2016, there was a large outbreak of the Zika virus, including some local transmission across southern regions of the United States, leading to a total of 36,512 symptomatic cases across all states and territories.71

In the following, we provide findings on how experts responded to the trends during this time horizon of the 2010s. In the illustrative graphs, we have color-coded the motivations and linked them to associated drivers and inhibitors as viewed through the lens of the time horizon. In cases where drivers and/or inhibitors are associated with more than one motivation, the primary motivation will be represented as a color-coded triangle in front of the secondary motivation.

Regarding the 2010s, most experts ranked the three motivations listed in bold below as the most important factors in shaping interest in biological weapons, followed by many experts who believed the subsequent two motivations were important:

- An assassination tool
- For offensive use as an asymmetric and covert tool
- Regime security
  - A deterrent against the conventional superiority of an adversary
  - A deterrent against the WMD program of an adversary

Notably, most experts ranked one driver, deniability, as being the most important factor for shaping biological weapons programs in this era. Additionally, just under half of respondents believed the subsequent four additional drivers were important:
• Deniability
• Psychological impact
• Accessibility
• Easy to hide
• Magnitude of potential harm (e.g., deaths, casualties)

Finally, experts ranked the first three inhibitors listed below as being the most important for showing restraint on biological weapons, followed by many experts believing that the two additional inhibitors listed were important:

• Fear of retaliation
• Legal and moral constraints
• Difficulty of control after the release of a pathogen
• Indiscriminate nature
• Risk of detection

The 2010s
Top Motivations for Biological Weapons Programs

![Bar chart showing the top motivations for biological weapons programs during the 2010s. The chart displays the percentages of each motivation, with the highest being A deterrent against the WMD program of an adversary at 5%, followed by Regime security at 3%, An assassination tool at 1%, and For offensive use as an asymmetric and covert tool at 2%. The lowest motivation is A deterrent against the conventional superiority of an adversary at 4%.]
The 2010s
Top Drivers for Biological Weapons Programs

- Magnitude of potential harm (e.g., deaths, casualties)
- Accessibility
- Deniability
- Psychological impact
- Easy to hide

The 2010s
Top Inhibitors for Biological Weapons Programs

- Risk of detection
- Difficulty of control after the release of a pathogen
- Fear of retaliation
- Legal and moral constraints
- Indiscriminate nature
In the 2010s, the dramatic shift in trends for biological weapons programs from their early beginnings between the 1940s and the 1970s to today is particularly evident. Whereas world leaders originally considered biological weapons for their potential utility on the battlefield and their value primarily as a strategic deterrent against nuclear weapons, experts assess that today, for those who may consider biological weapons, their added value is highest from the standpoint of gray zone or hybrid warfare and their potential as asymmetric, covert, assassination tools and for providing regime security. They continue to be perceived as providing an effective deterrent against nuclear weapons and conventional superiority of adversaries, though as the world has changed, factors shaping how biological weapons decisions may manifest have also evolved to match these motivations. Experts emphasized the features of biological weapons that enable plausible deniability and heighten psychological impact over their potential as a strategic weapon.

Interestingly, experts judged the inhibitors for biological weapons to have remained fairly stable over time with fear of retaliation and difficulty of control upon release in the top five for all time horizons. Following the BWC entry into force, legal and moral constraints appeared in the top five for all subsequent time horizons.

During this period, Syria’s repeated use of chemical weapons on its own population as a tool of terror represents the most critical wild card. In defying the redline set down by President Obama and the international community, Assad’s regime openly and repeatedly defied the longstanding norms against use of WMD and challenged the effectiveness of the verification and enforcement mechanisms. The process of destroying Syria’s chemical weapons produced both stunning successes and several failures. With oversight by the Organization for the Prohibition for Chemical Weapons (OPCW), the international community came together in 2014 to successfully destroy Syria’s declared chemical weapons using U.S. technologies on a large ship in the Mediterranean Sea. However, the Assad regime resumed the use of chlorine on its population shortly afterward, and the international community soon discovered undeclared chemical materials in Syria. Moreover, the Assad regime remaining in place after using WMD, and emerging discussions of potential normalization and cooperation with such a regime, are bound to shape perceptions about biological weapons programs in the future.

Of course, this environment set the stage on which another wild card emerged in the first year of the following decade that could reinforce some of the drivers and trends that we have described, or drive even more dramatic changes: the extreme human, security, and economic toll of the COVID-19 pandemic.
FORECASTING THE THREAT PARAMETERS AFTER THE DESTRUCTION OF COVID-19

A world with COVID-19 could take many forms with regards to the pursuit and/or rejection of biological weapons. At one extreme, countries could decide to eschew international cooperation, cross the normative line, withdraw from relevant treaties, and then restart, accelerate, and/or launch biological weapons programs. At the other end of the spectrum, countries could respond to the global pandemic by ending clandestine efforts to move toward biological weapons, coming together as an international community, doubling down on international cooperation to prevent the proliferation of biological weapons programs, and finding new and creative solutions to bolster the norm against these weapons and provide for verification and enforcement. A COVID-19 reality could also end up somewhere in between these two scenarios. In a hybrid world of ambiguous threats, countries could remain parties to relevant treaties while seeking to bolster their biodefense programs, and straddle the blurry line between defensive and offensive work.

Today, suspicions remain high that certain countries are developing biological weapons programs. This stems from several factors, including the ubiquity of dual-use biotechnologies, the small-to-indetectable physical footprint of sites for developing biological weapons, and ongoing WMD programs by several countries.
Such suspicions tend to be exacerbated whenever countries increase their investments to counter biological threats, given that those same capabilities may facilitate the development and testing of offensive biological weapons. For example, detection technologies for knowing a biological attack is underway and personal protective equipment for protecting against it can also be used by a country testing biological agents for weapons purposes. In one prominent example of these suspicions rising and being politically leveraged, the Russians have for years spread disinformation that U.S.-supported labs in countries like Georgia and Kazakhstan are a means of the United States encircling Russia with biological weapons (notably, one of this project’s principal investigators has been a target of this disinformation).

In fact, the United States and Russia also have a public, long-running dispute accusing one another of biological weapons programs. In April 2019, for example, U.S. Assistant Secretary of State in the Bureau Of International Security And Nonproliferation Chris Ford stated in a speech:

“Unfortunately, the Russians show no sign of ever having gotten rid of their biological weapons program. Indeed, far from demonstrating its elimination of this program as required by the Biological and Toxin Weapons Convention (BWC), Russia has refused to properly declare the termination of the program under the BWC – and Yeltsin’s successor, Vladimir Putin, has gone back to denying that Moscow’s biological weapons program ever existed in the first place.”

Some countries have expressed concerns that the biological defense programs of countries such as the United States, Russia, China, and Iran could be used for making biological weapons should their leaders decide to move in that direction. Such concerns are worsened by long-term disagreement among these countries and others about whether to strengthen the Biological and Toxin Weapons Convention—the central treaty banning biological weapons but which has no verification mechanism and suffers from weak enforcement similar to its counterpart treaties on nuclear and chemical weapons.

Distrust among certain countries has been driven to new heights by the ongoing global pandemic. Leaders from Iran, Russia, China, the United States, and other countries have to varying degrees pushed rumors that COVID-19 is the result of a deliberate biological weapons program despite the preponderance of evidence that it resulted from a natural or accidental transmission (albeit with often-passionate disagreement about the likelihood of each potential root cause). The death and illness, political tensions, and economic devastation caused by the COVID-19 pandemic will continue to be one of the most profound factors shaping how nations view the threat of biological weapons in the years ahead.

To forecast this range of potential futures, we first asked experts to predict the top motivations, drivers, and inhibitors for biological weapons programs in a world with COVID-19. Similar to the process used above to describe past eras of biological weapons threats, in the illustrative graphs that follow, we have color-coded the motivations and linked them to associated drivers and inhibitors as viewed through the lens of the time horizon. In cases where drivers and/or inhibitors are associated with more than one motivation, the primary motivation will be represented as a color-coded triangle in front of the secondary motivation.

In our survey, experts ranked five motivations as the most important factors in shaping interest in biological weapons over the next five years:

- **For offensive use as an asymmetric and covert tool**
- **An assassination tool**
- **A deterrent against the WMD program of an adversary**
- **A deterrent against the conventional superiority of an adversary**
- **A tool for targeting specific populations or ethnic groups**
The majority of experts who participated agreed that these are the top motivations expected within this timeframe. Almost ¾ of these experts (72%) ranked “for offensive use as an asymmetric and covert tool” as the top motivation. Many participants cited specific details related to these judgements, which CSR has reflected in the scenarios presented in the next section of this report.

Next, experts ranked two factors the highest in terms of what characteristics might make biological weapons attractive to interested actors, followed by several others for which many experts agreed are important factors:

- Deniability
- Psychological impact
- Accessibility
- Economic damages
- Easy to hide

Finally, regarding the next five years, experts ranked four inhibitors as being the most important for making biological weapons unattractive, followed by one additional inhibitor which 40% of respondents agreed is important:

- Difficulty of control after the release of a pathogen
- Uncertainty of impact (e.g., environmental factors)
- Indiscriminate nature
- Fear of retaliation
- Technical difficulty
The COVID-19 Era
Top Drivers for Biological Weapons Programs

The COVID-19 Era
Top Inhibitors for Biological Weapons Programs
PART II:
BIOTHREAT FUTURE
SCENARIOS
Keeping the motivations, drivers, and inhibitors of the previous section of this report in mind, we developed three different scenarios that could occur over the next five-year period (roughly to 2026-27). Each scenario represents divergent outcomes for biological weapons threats following the end of the COVID-19 pandemic based on the motivations, drivers, and inhibitors assessed by experts:

**Scenario 1:** The Rise of Biological Weapons as a Significant Component of Deterrence  
**Scenario 2:** Biological Threats Hasten a New Era of International Cooperation  
**Scenario 3:** A Hybrid World of Ambiguous Threats

For the remainder of this report, we build out these scenarios in great detail, to help provide experts and policymakers with a significantly deeper understanding of the full range of potential futures for biological weapons threats. The world has already witnessed signs that indicate trends toward any one of these futures. A better understanding of the spectrum of potential pathways for biological weapons will be crucial if the U.S. government is to read the signals correctly, understand how the different motivations and drivers might push toward each of the three scenarios, and to respond with appropriate policy solutions.

**NOTE:** The following scenarios are fictitious. They are derived from potential trends, motivations, drivers and inhibitors that surveyed experts believe will shape future decisions about biological weapons programs in a COVID-19 era. Many of these trends are already visible today, and others follow historical patterns, yet all are shapeable. As the intention of this research is greater understanding to help mitigate risks—not to accuse any nation or inflame tensions—the authors have developed fictional profiles for different types of countries for each scenario.
SCENARIO 1: THE RISE OF BIOLOGICAL WEAPONS AS A SIGNIFICANT COMPONENT OF DETERRENCE

In the first scenario, we imagine a world in which the profound human and economic devastation from the COVID-19 pandemic has convinced many technologically-capable countries of a rather grim notion: biological weapons offer one of the most powerful deterrents against adversaries in an uncertain security environment. The disruptive potential of contagious pathogens, even a novel pathogen with relatively low virulence, has enhanced the perceived value of biological weapons as a strategic deterrent. This shift unleashes a new round of biological weapons proliferation over the past five years.

Many countries now find biological weapons attractive for their low cost and small footprint relative to nuclear weapons, combined with their potential for economic damage and psychological impact. Given the lack of health preparedness of even the most developed countries, the perceived asymmetric utility has grown considerably since the global COVID-19 pandemic. Moreover, a number of countries see biological weapons as the ultimate tool for hybrid warfare and targeted attacks such as assassinations—especially given the ongoing difficulty of identifying the origin of COVID-19.

By 2026, the rhetoric around biological weapons has become eerily similar to that for nuclear weapons, with the exception of their utility for assassination-level use. A few countries are currently suspected of pursuing biological weapons for small-scale use, such as in targeted attacks and assassinations, beyond the countries believed to have biological weapons programs before the pandemic. A majority of countries view the BWC and relevant fora for international cooperation to be broken, weak, or useless. Both developed and developing countries have engaged in finger-pointing when assigning blame for the complete breakdown in diplomatic channels and failure of international cooperation.

The following trends contributed to such a world in a COVID-19 era:

- **Slow distribution of vaccine supplies**: The sluggish rollout of vaccines around the world, especially to developing countries, allowed more time for the novel coronavirus to undergo several notable mutations in 2021-2022, causing further surges in cases of COVID-19 and many more deaths in unprotected regions. Additional waves of COVID-19 in certain regions continued to impede international travel with mobility restrictions and border controls into 2023, preventing the global economic recovery from taking hold until much later than necessary. Inequalities in early vaccine distribution and the lack of international assistance to bolster public health responses
at various peaks of the pandemic left many countries feeling embittered against developed nations. In many nations, this issue coupled with many other drivers of nationalism that influenced their political landscapes and altered relevant policies that shaped how nations interact.

- **Weak global recovery from the pandemic**: The COVID-19 pandemic demonstrated what public health and biodefense experts have warned of for decades: infectious diseases—even those with relatively low mortality rates—can cause extreme human suffering, cripple the most powerful economies, and exacerbate geopolitical tensions. Soon after the last major wave of the pandemic finally subsided in 2023, the global economy remained locked in a stubborn recession for the next two years, shrinking by 5% annually. Until recently, economic growth had stalled in many countries due to labor shortages in certain industries, high inflation, a contraction in per-capita income, and persistent supply chain disruptions. Although supply chain issues early on in the pandemic were mostly local, due to hoarding practices and a limited supply of certain manufactured items such as computer chips, by late 2021 a serious shortage of raw materials such as plastic, aluminum, and construction materials set in around the world. This also coupled with other factors to cause a ripple of disruptive effects that eventually trickled down into essential food supply chains, already affected by natural disasters and other events. In some countries, the lack of adequate food supplies led to mass migration, producing internal instability and exacerbating regional tensions. The economic decline of many low- and middle-income nations, formerly strong participants in international cooperative mechanisms and treaty systems, has frayed international cohesion against the risks posed by biological weapons.

- **Continuing lack of investment in global health and biodefense**: The COVID-19 global pandemic highlighted specific vulnerabilities in defenses and countermeasures, which countries did not adequately address even after the start of the pandemic—and for which international cooperation has continued to lag ever since. Though many technologies needed to quickly and effectively detect and respond to emerging infectious diseases already existed at the onset of the pandemic in 2020, they were not yet widely deployed or integrated into highly-functional public health systems capable of supporting policy decisions to help curb the spread (e.g., production of new diagnostics and scaling them). In the post-pandemic years, many countries have lacked either the resources and/or political will in the to remedy the situation, leaving them vulnerable to future outbreaks.

- **Major growth in the global bioeconomy fails to prioritize risk mitigation for future pandemics**: Although pharmaceutical companies emerged as major winners during the COVID-19 pandemic, investment in vaccines had contracted severely by 2024 in response to the lack of sustained investments by national governments. As a result, despite major growth in the use of biological resources for the creation of products and services around the world, in 2026 many countries still do not have bioeconomies capable of supporting effective responses to global pandemics in the future. Given the residual supply chain issues, some major suppliers remain protective regarding exporting critical supplies needed to respond to a public health crisis.

- **The unraveling of the BWC and the WHO**: In the immediate years after the pandemic, several countries attempted to strengthen the BWC and the WHO and to develop new multilateral cooperative mechanisms. They emphasized the need to act collectively to prevent future pandemics and to guard against rising interests in biological weapons by some actors. Yet there was clear and increasing division among nations in the post-pandemic years—enough to prevent the cohesion needed to advance any new ideas to strengthen norms and institutions. Even work to augment BWC confidence-building measures, viewed as a relatively low bar for progress, fell apart with states accusing one another of expanding their dual-use defensive capabilities to mask offensive programs. Due to the humanitarian and economic damage caused by the COVID-19 pandemic, some states even descended into conditions of such intense fragility and internal conflict that they lost the capacity and political will to participate in multilateralism. Moreover, leadership in a few countries shifted from pro-democratic parties to hyper-nationalistic and deeply authoritarian rule. Despite various attempts to strengthen the BWC and introduce new treaties and agreements for pandemic prevention, many nations have voted no or abstained.
In this scenario, more nations are considering biological weapons programs than prior to the COVID-19 pandemic—in particular those with adversaries who have thus far failed to bolster their public health systems, which were stretched to the limit during the pandemic. Political leaders and experts within these countries perceived biological weapons to have increased in their strategic value as a deterrent and asymmetric military capability. Those states pursuing biological weapons have shifted most resources to exploring contagious pathogens and preparing vaccines to protect their own population against them.

For example, Country A decided to pursue a biological weapons program for the first time in its history after a contentious election brought far more nationalistic leaders to power. Even before the pandemic, its political leaders worried greatly about border integrity due to incursions by an aggressive adversary thought to be in possession of WMD and increasing biodefense activities of neighboring countries. Country A’s concerns have grown due to an expansion of BSL-4 laboratories in the region. Despite declarations that such labs were intended solely for peaceful, defensive work, Country A believes they house high-risk gain of function research and other dual-use experiments that serve as a ruse for offensive research.

Though countries have long eschewed the battlefield utility of biological weapons, the global pandemic demonstrated their powerful asymmetric value against highly developed countries such as the United States. In the early months of the pandemic, several U.S. naval vessels were sidelined due to COVID outbreaks amongst their crews, reportedly affecting up to 65 percent of the entire U.S. naval fleet. This situation has led many countries to rethink the value of a biological weapons program. By using biological agents, a developing country or even non-state actors could challenge the conventional forces of major power by causing significant damage to their force readiness.

Given its limited economic resources, Country A was particularly drawn to the asymmetric capabilities of biological weapons at a low development cost. Since Country A was already accustomed to leveraging the deniability and difficulties of attribution associated with cyber weapons, biological weapons seemed to be a good fit to bolster their security. When the leaders of Country A decided to expand its capabilities to conduct hybrid warfare tactics, they also launched a small-scale but impactful biological weapons program as a part of that strategy.

Other nations are attracted to the potential for mass effect and societal disruption, their potential for deniability and continuing challenges in attribution, and the potential for strong psychological impacts. A few nations have expanded their biological weapons programs, launched new lines of effort to exploit advances in biotechnology, and chosen to make their programs overt to support deterrence objectives.

Country B had already conducted biological weapons activities before the global pandemic, with the primary purpose of serving as a deterrent against the nuclear programs and conventional superiority of adversaries. The COVID-19 pandemic reinforced its past decisions to experiment with biological weapons, inspiring a new expansion in both scale and diversity. Country B has since shifted away from its past focus on smallpox, which becomes contagious only after the appearance of scabs and can be countered with existing vaccines, to an emphasis on dangerous pathogens capable of rapid transmission prior to infected individuals showing symptoms and for which there are currently no effective treatments. Though its population and military forces also remain vulnerable to the use of certain pathogens, its political leaders have long viewed such a risk as analogous to the effects of nuclear weapons, though perhaps somewhat more controllable depending on which disease agents are used.

Unfortunately, international cooperative measures have proved insufficient to stop these trends. Widespread disappointment about the level of international cooperation during the pandemic and rising distrust among nations led a majority of key decision-makers to dismiss the value of relying on cooperative mechanisms. Several have formally withdrawn from the BWC and declared their intent to develop biological weapons to provide a strategic deterrent.
since they can be produced at a relatively low cost compared to other alternatives—and because the treaty no longer seemed to provide a strong guarantee that their adversaries will restrain from doing the same.

For example, in 2024 Country C made the shocking decision to formally withdraw from the BWC, though it stopped short of affirming its biological weapons program on the public stage. Even before the COVID-19 pandemic, the international community had long suspected Country C of having an advanced biological weapons program in addition to nuclear and chemical weapons. In the decade prior to COVID-19, its political leaders viewed its biological weapons program as a hedge against all-out war. However, political and military leaders now see biological weapons as being useful for a wider range of scenarios, including smaller-scale use in hybrid conflicts and for assassination purposes. Country C is suspected to have weaponized pathogens to carry out several assassinations in 2025; it is also believed to be behind several incidents of suspected agroterrorism.

Though Country B is not a member of the BWC, its political leaders have also delivered public remarks, blaming the weakness of the treaty regime and other like treaties for the political, economic, and social upheaval around the world and advocating for new norms and institutions. To distract from its activities, Country C has ramped up powerful disinformation campaigns regarding the biodefense and public health facilities of other nations. This decision was tied to its broader strategy of altering international institutions to better favor its interests and creating mistrust among nations it views as adversaries. The international community now believes Country C has begun cooperating with Country B by providing samples for deadly infectious disease agents and conducting scientific exchanges.

In a terrible feedback loop, suspicions regarding countries pursuing biological weapons have further weakened the BWC and norms against WMD. These tensions are compounded by lack of bilateral and regional discussions, which have come to halt with the exception of a few dialogues by nongovernmental experts and scientists. Without strong multilateral cooperation, there is further concern of cascading effects of these trends incentivizing yet additional countries to consider biological weapons.

**Conclusion**

In the 2026-27 timeframe, these three countries are not alone in their endeavors to explore the potential of biological weapons. Based on estimates from the intelligence agencies of various nations, as many as fifteen new countries may have active biological weapons activities. Activities range from small-scale experimentation to large-scale programs with broad scopes. Many other nations are actively conducting dual-use research that raises significant concerns regarding their applicability beyond peaceful intentions.

While it is difficult to quantify, these trends are contributing to an increasingly tense global security environment. The taboo against the use of weapons of mass destruction continues to deteriorate, international cooperation and dialogue continue to decline, and the risks of conflict—including from miscommunication and miscalculations—appear to be on the rise. The instability of the global environment has fed anti-democratic movements in many regions, in some cases fueled by disinformation.
SCENARIO 2: BIOLOGICAL THREATS HASTEN A NEW ERA OF INTERNATIONAL COOPERATION

In the second scenario, the world has pivoted back toward greater international cooperation on major threats to international security following the historic, global destruction from the COVID-19 pandemic—including but not limited to doubling down on commitments to laws and norms against biological weapons. As the pandemic’s primary lesson, nations now regard biological weapons as unpredictable, uncontrollable, and indiscriminate in their devastation, and thus highly undesirable as a weapon for any reason.

The end of the COVID-19 global pandemic, its acceleration brought about by many countries working closely together, helped to build the public trust and political will needed for investing in strong improvements in public health systems at the national level and a significant expansion of international cooperation. Both the trend toward strengthening the global order and the enormous damage wrought by COVID-19 are believed to have steered most countries away from any residual interest in biological weapons—and in at least one case, led to a nation putting an end to its biological weapons activities altogether.

By 2026, countries no longer assign any significant strategic value in developing biological weapons programs. Thanks to improved regulation of social media, any disinformation campaigns to the contrary have been quickly squashed. The global pandemic demonstrated the ability of a pathogen to cause massive loss of life, and states acknowledge that the effects of biological weapons use could be extremely hard to contain. Uncertainty of impact, difficulty of control, and the indiscriminate nature of infectious diseases have made them particularly unattractive for use under any circumstance.

The notion of military utility of biological weapons and their value as a strategic deterrent appear to have become irrelevant once and for all. Not only can no country fully escape the effects of a bioweapon, a country would need to be willing to start a pandemic in order for biological weapons to have a deterrent effect—something that would diminish credibility. A majority of countries appear to be taking the “deterrence by denial” approach to creating robust capacity to halt malicious biological threats before they become widespread, with global early warning for outbreaks from any source as a cornerstone. With improved capabilities to rapidly develop countermeasures and protect populations, most states have high confidence that any outlier states will be deterred from seriously considering their development or use.
The following trends helped to produce such a world in the COVID-19 era:

- **Strong recovery from COVID-19:** Many world leaders took steps to ramp-up COVID-19 vaccine production and global distribution beginning in late 2021. The countries that housed significant vaccine production capacity were finally able to work through supply chain and logistical hurdles to reach ever-higher manufacturing levels. Many nations also increased their funding for getting COVID-19 vaccines to the arms of underserved populations around the world. In time, deaths, severe illness, and strains on public health systems related to COVID-19 waned, and the emergence of new variants slowed considerably, bringing the global pandemic to a swift end in late 2022.

- **Stronger investments in public health and pandemic prevention:** The COVID-19 pandemic highlighted the simple but grave reality, which experts had warned about for decades, that the entire world is vulnerable to biological threats. After the pandemic demonstrated the potentially catastrophic impact of infectious diseases, states became more persuaded than ever to embrace strategies of prevention, aimed at catching and stopping emerging pathogens with pandemic potential before a major outbreak occurs and increasing vigilance against potential accidental or deliberate releases. By 2026, most states around the world have significantly bolstered their public health systems. This is especially the case among lower- and middle-income countries, which have prioritized public health capacity building, prevention, and preparedness capabilities. This trend helped prompt higher-income nations to place a much greater priority on countering infectious diseases as well.

- **New countermeasures, expansion of biodefense activities, and improved global safety standards:** The COVID-19 pandemic led to a widespread increase in biodefense activities around the world and the development of new, effective countermeasures. The advancement in mRNA and other platform vaccine technologies—including the corresponding rapid development period—serves as a powerful deterrent to any states that might still consider developing and using biological weapons. However, remaining uncertainty about how COVID-19 originally passed to humans and triggered the pandemic created a heightened awareness that biodefense activities can easily be misconstrued (or deliberately miscast). Immediately after the pandemic, states acknowledged the potential risks posed by dual-use research and gain-of-function work and called for greater attention to improving biosecurity and global standards. As a result, many nations have recently come together to increase transparency, information-sharing, and technology exchanges in biodefense, strengthen protocols for handling infectious agents, and agreed to limit the expansion of BSL-4 laboratories.

- **Strengthened verification of the BWC:** In the aftermath of COVID-19, though not caused by a biological weapon, most nations embraced the need to strengthen the BWC given its contribution to pandemic prevention in addition to its role in countering biological weapons. In addition to expanding discussions on public health, early warning, biosafety standards, vaccine production, medical countermeasures, and supply chains, a majority of BWC members have signed onto a voluntary verification protocol (similar to the IAEA’s Additional Safeguards Protocol) in 2024. By signing the protocol, these states agreed to preliminary on-site verification, which has become less costly due to advances in DNA sequencing and more effective with real-time results. The BWC staff at the UN feeds this data into a global database along with information on hazardous biological agents from public and private sources. The new on-site verification protocol has been bolstered by a network of commercial sequencing and synthesis companies, which serve as BWC-accredited labs (akin to those used for chemical weapons threats). These companies have adapted their screening methods to focus on detecting sequences of concern while supporting multilateral cooperation.
• **Improved global health cooperation at WHO:** Even as countries and international organizations worked together to end the COVID-19 pandemic, many countries started empowering formal and ad hoc organizations—including the WHO—with additional trust and financial resources. A majority of states agreed early on that improving global health-related cooperation would contribute to reducing future biological weapons threats. Nations came together to work toward accelerating the detection of emerging diseases and improving the capacity of countries around the world to quickly attribute the origins of outbreaks, thereby helping to deter countries from bioweapons use.

• **Greater transparency of dual-use biological activities:** In recent years, countries have far greater access to information about the dual-use biological activities around the world due to advances in AI-enabled technologies and institutional reforms within the BWC and WHO. In particular, the international community has seen a strong increase in transparency exchanges among members of the BWC. These include: an annual detailed exchange of data on research centers and laboratories including a list of microorganisms and toxins used for biodefense research; declarations of national vaccine production facilities; and the prompt exchange of information on outbreaks of infectious diseases and similar occurrences caused by toxins among members of the WHO.

In this scenario, most if not all nations have zero interest in biological weapons programs and are committed to working together to prevent the full spectrum of biological threats. The confidence built among countries and cooperation emerging in this COVID-19 world has opened doors to other avenues of significant threat reduction and re-established lines of communication between countries for which scientific and technical exchanges had all but ended.

As one of the most notable achievements, the global pandemic spurred the establishment of a global early warning system—based on early characterization, enhanced diagnostics, lab capacity, and biosurveillance. The effort required years of extensive diplomatic negotiations and significant public-private collaboration. In order to establish this complex endeavor, national policies and international law have been updated to reflect the interconnected nature of biosurveillance. The new system is based on national capabilities that are integrated into regional reporting hubs and connected to a newly-established institution with strong bureaucratic ties to the WHO and BWC. In addition to helping to prevent outbreaks from developing into pandemics, the global early warning system also acts as a strong deterrent against biological weapons. Given significant enhancements in the detection and characterization of pathogens (including novel, potentially-engineered ones), any country that uses a biological weapon can no longer count on concealing their biological weapons program, or on deniability.

The positive collaborative environment following the pandemic has produced new cooperative mechanisms. The shortages of medical countermeasures and personal protective equipment (PPE) spurred the creation of a public-private collaboration to organize a stockpile of essential items to avoid global shortages and hoarding in the event of the next pandemic. Every country will have the opportunity to make investments in the stockpile and draw upon supplies when needed.

Although the concept predated COVID-19, Country J’s strong push to establish an international agency devoted to biological safety and biosecurity quickly gained traction. The pandemic made many nations around the world particularly interested in prompt investigations and response to disease outbreaks with pandemic potential, and these became central aspects of the work to establish the agency. Today, it acts as a central hub for data exchange between states and supporting nations in their compliance with the BWC and confidence-building with other nations. The agency invests heavily in training biosecurity experts and ensuring their engagement across security and health organizations, facilitated by healthy budgets provided by nation-states and philanthropies.
The international agency also hosts rapid-response teams that most nations respect as independent technical experts. These teams conduct fact-finding missions into disease outbreaks in collaboration with the WHO and exercise responses in times when there are no active responses. The rapid response teams are made up of international, unbiased scientists that can be deployed in less than 24 hours and are considered technology experts. Metagenomic sequencing forms the backbone of this work as it can rapidly analyze material, including any novel, natural, or synthesized pathogens.

Against the backdrop of stronger international cooperation and norms against biological weapons, Country K decided to change its course and abandon its covert biological weapons program. After COVID-19, Country K suffered a severe economic downturn due to relatively high casualties per capita and political turmoil. Its political leaders grew worried that the country might face debilitating sanctions if they were caught. Meanwhile, the military leaders of Country K convinced its leadership that the attributes of biological weapons were less useful in military contexts than they once believed.

In spite of these positive trends, the biological weapons activities of Country L continue to cast a shadow. In the past, Country L deployed targeted, offensive chemical weapons in attacks against its own citizens and remained outside the major treaties that outlaw weapons of mass destruction. The lack of a severe international reaction persuaded its leaders to keep its biological weapons program active even after the global pandemic. Country L appears to be primarily interested in biological agents that are optimal for carrying out assassinations and covert small-scale use against its own population.

**Conclusion**

In this scenario, the COVID-19 pandemic led most nations to gravitate toward greater international cooperation and seek out mechanisms that could prevent another seismic biological event. Although the BWC and other treaties cannot constrain all states from developing or supporting a biological weapons program, global interconnectedness, the deployment of advanced technologies, and the stand-up of tailored mechanisms to augment those institutions are widely recognized as having reduced the threat that states will develop and use biological weapons to mass effect.
SCENARIO 3: A HYBRID WORLD OF AMBIGUOUS THREATS

In the third scenario, we envision a world in which biological weapons threats are on the rise following the COVID-19 pandemic: a perception driven by deliberate disinformation campaigns. The false notion that biological weapons programs were already widespread and quite advanced toward the end of the pandemic triggered the launch and expansion of many “defensive” biological programs starting in 2022, the specific activities of which have further blurred the line between biodefense activities and offensive programs.

Given the ongoing obscurity surrounding the origins of the COVID-19 pandemic, several nations appear to have concluded, as the primary lesson from the pandemic, that biological weapons provide an effective covert tool that can be wielded as part of hybrid warfare strategies or as a relatively cheap strategic deterrent. Several key features of biological weapons, including their accessibility, significant potential for causing severe economic damage, and uncertain impact, lend themselves to providing a cheap and effective deterrent against adversaries. For other countries, their deniability, easy concealment, and psychological impact make biological weapons an ideal tool for hybrid warfare or shoring up regime security.

By the 2026-27 timeframe, international norms and collaboration on biological threats have weakened but not yet collapsed, leaving country leaders with much confusion and a profound lack of clarity regarding their defensive needs. While countries have maintained the political appearances of remaining committed to norms against biological weapons, many also appear to be hedging their bets and are developing at minimum a latent biological weapons capability.

In this world, many countries have launched robust biodefense programs that far exceed their past efforts. These programs are heavily characterized by dual-use research and BSL-4 infrastructure that blur the boundaries between defense and offense. In some cases, these peaceful programs have been enhanced by top secret contingency plans to prepare to quickly cross the line over to offensive military programs should a political decision be made to do so. In others, military and scientific leaders have leveraged resources under their discretion to move toward the weaponization of biological capabilities. Specific details regarding multiple countries’ activities and intentions remain elusive, triggering other states to adopt similar postures.
We predict the following trends would help to produce such a world in a COVID-19 era:

- **Adequate global distribution of vaccine supplies:** The initial slow rollout of vaccines around the world in 2020 and 2021, especially to developing countries, allowed more time for the novel coronavirus to undergo notable mutations, causing further surges in cases of COVID-19 and many more deaths in unprotected regions. Thankfully, by the end of 2022, developed countries managed to accelerate vaccine distribution and expand financial assistance for public health, aided in part by the production of protein-based vaccines without cold storage requirements and new treatments for COVID-19. Additional waves of COVID-19 continued to impede international travel with mobility restrictions and border controls for much of 2022 and into 2023. Increased global vaccinations, however, started to relieve these pressures by early 2023, allowing a moderate global economic recovery to occur before a more permanent recession could take hold. Inequalities in early vaccine distribution and the lack of international assistance to bolster public health responses, however, have left many countries feeling lackluster about the prospects of international collaboration.

- **Moderate global recovery from the pandemic:** The COVID-19 pandemic demonstrated what public health and biodefense experts have warned of for decades: infectious diseases—even those with relatively low mortality rates—can cause extreme human suffering, cripple the most powerful economies, and exacerbate geopolitical tensions. Soon after the last major wave of the pandemic subsided in 2022, the global economy remained locked in a stubborn recession, showing few signs of growth. It wasn’t until late 2023, with the end of labor shortages and supply chain disruptions, that the global economy began bouncing back again. The global pandemic reminded many low- and middle-income nations of the imperatives of international cooperation and highlighted the risks posed by biological weapons. However, many such nations have remained uncertain if they should depend on developed countries to contribute their fair share when push comes to shove.

- **Modest investments in public health infrastructure:** The COVID-19 global pandemic highlighted specific vulnerabilities in defenses and countermeasures, which countries did not adequately address during the pandemic. Though many technologies needed to quickly and effectively detect and respond to emerging infectious diseases already existed at the onset of the pandemic in 2020, they were not yet widely deployed or integrated into highly-functional public health systems capable of supporting policy decisions to help curb the spread (e.g., production of new diagnostics and the scaling of them). In the post-pandemic years, many countries have made modest investments to improve their public health infrastructures, but resisted calls for greater investments and international cooperation. This lack of enthusiasm has stymied several public-private partnerships attempting to launch a global early warning system.

- **Major growth in the global bioeconomy lowers barriers:** Over the past five years, manufacturers have increasingly turned to biology to produce sustainable products. Major advances in synthetic biology around the world led to a $4 trillion gold rush in new investments by 2026. In many countries, both developed and developing, the global bioeconomy has been viewed as a strategic means for reinvigorating the COVID economy. Political and private sector leaders concerned about the rising effects of climate change and ecological degradation have touted a global shift to renewable, bio-based products. Major growth in the global bioeconomy, however, has lowered barriers to entry for biodefense and dual-use research related to biological weapons. In the absence of effective international cooperation and norms, political leaders are concerned about increased proliferation of biological weapons.

- **Global surge in biodefense activities and expansion of BSL-4 laboratories:** The COVID-19 pandemic has led to a widespread increase in biodefense activities around the world and to the development of new countermeasures against biological threats. The advancement in mRNA and other platform vaccine technologies during the pandemic has served as a powerful deterrent to any states that might still consider developing and
using biological weapons. This notion has made robust biodefense programs attractive to many more states than before. With little regard for potential risks, many countries have accelerated work on dual-use research and gain-of-function experimentation. In 2026, there are now 75 BSL-4 labs in operation, under construction, or planned in 30 different countries around the world--many of them are located near urban centers, adding to the risk of accidental release. The increase in these maximum-security biological laboratories has contributed to the perception of a rise in offensive programs. Many of these laboratories do not adhere to the highest global standards for safety and security, which has been a source of growing concern among neighboring countries.

- **Disinformation campaigns trigger greater interest in biological weapons**: After the end of the global pandemic, several countries continued to engage in effective disinformation campaigns, in part to distract the international community from their own activities, but also to disrupt and remake the global order to suit their own interests. The steady flow of false information about biodefense activities has produced the idea that biological weapons programs were already widespread and quite advanced before the end of the pandemic. As the idea has gained traction over the years, it has triggered the launch of many “defensive” biological programs, which have further blurred the line between biodefense activities and offensive programs.

- **Business as usual for the BWC and the WHO**: Despite the massive devastation caused by the global pandemic, the state of affairs at the BWC and WHO has remained business as usual for the past five years. In 2026, a majority of countries continue to express their support for international cooperation on public health and nonproliferation. However, few nations have increased their financial contributions or supported moves to strengthen either institution over the years. By 2026, the BWC states parties have reached a stalemate on efforts to improve verification of treaty obligations. Meanwhile, investments in global health security at the WHO appear to have stagnated.

In this scenario, biological threats are perceived to be growing rapidly. However, their true nature remains ambiguous and distorted by disinformation campaigns. More nations than ever before have demonstrated interest in biodefense activities, which has led to a worldwide explosion in dual-use research and a broad expansion of high-security laboratory infrastructure. Lower barriers to entry have been a key factor in driving this level of activity. For many states, biological weapons are attractive for their deniability, psychological impact, and ease of concealment.

In the absence of greater international cooperation, biodefense programs remain concealed behind closed doors of ostensibly peaceful programs, causing other countries to become increasingly suspicious. Even major advances in biotechnology, which could lead to major breakthroughs in medicine, are perceived through a negative lens.

For example, in 2026 Country X announced that its top scientists are on the cusp of revolutionary advancements in precision medicine and genetic engineering. Buoyed by its dedication to collecting vast stores of genomic, epigenetic, and other health data, Country X claims that it will soon be able to design custom cures to a long list of genetic diseases. Due to disinformation campaigns attributed to Country Y, however, the international community has expressed concerns that recent advances in understanding disease pathways by Country X could be used to develop designer pathogens capable of targeting individuals for assassination or as a means of psychological warfare against specific ethnic groups within its borders. Country X has refused to provide any transparency into its cutting-edge precision medicine programs for fear of economic espionage and further damage to its reputation from disinformation campaigns.

In a rush to detect the subtle signatures of offensive biological weapons programs, the intelligence agencies of Country Z collaborated to develop an AI-enabled tool said to be capable of predicting the intent and actions of countries given an analysis of their capabilities and relevant open source data. Though many countries remain skeptical of the tool’s effectiveness, Country Z has recently been able to rally a coalition of other countries to impose pre-emptive sanctions on Country X. If Country X refuses to allow voluntary inspections of its research facilities, the coalition has implied its willingness to engage in military strikes.
To add to this dismal outlook, only two months ago, an accidental release of a dangerous pathogen with characteristics similar to anthrax occurred at a BSL-4 laboratory in Country Y. Luckily, the ensuing outbreak was detected quickly and the outbreak contained to several scientists working at the laboratory. However, Country Y has denied engaging in gain-of-function research related to anthrax and has refused to admit WHO officials into the country for a follow-up investigation. Suspected work on anthrax by Country Y tracks with a growing consensus that studying highly transmissible agents for any purpose, save for protecting a population against their scourge, is too high-risk.

Conclusion

In this scenario, biological threats, though quite ambiguous in their character, are perceived to be rising. Meanwhile, states remain resistant to make investments in public health infrastructure and global early warning systems needed in order to prevent the next pandemic from spinning out of control. Such a system would also convince states that any use of biological weapons will ultimately fail; in its absence, these weapons continue to remain attractive. With international cooperation for addressing such threats on the decline, most countries seem to have learned few if any useful lessons from the COVID-19 pandemic. Should another dangerous pathogen cross over from its host to infect humans, the world is likely to confront yet another global public health catastrophe.
PART III:
TRANSLATING LESSONS
LEARNED FROM COVID-19
INTO STRENGTHENED U.S.
POLICY FOR COUNTERING
BIOLOGICAL THREATS
An in-depth overview of past motivations, drivers, and inhibitors for biological weapons programs, along with the three fictional scenarios described above, offer a valuable tool for helping policymakers better understand how trends in biological weapons threats may be affected by COVID-19 and reimagine potential pathways to mitigate these threats.

As discussed in the introduction to this paper, U.S. policymakers now confront a series of critical questions regarding the impact of COVID-19 on the future of biological weapons. These include:

- In a world with COVID-19, will countries already hedging toward biological weapons programs decide to pursue them more actively?
- Might technologically-capable countries known to have developed biological weapons in the past, or currently suspected of relevant activities (e.g., Russia, China, and Iran), withdraw from relevant treaties and declare their clandestine programs as an integral part of their deterrence strategies? Or will such countries strengthen their clandestine capabilities while remaining members of relevant treaties—especially given the absence of a strong verification and enforcement regime?
- How will the economic and societal havoc caused by the global pandemic lead actors already interested in bioweapons to view the weaponization of engineered pathogens versus naturally occurring ones?
- How might budget pressures arising from the steep economic costs of the global pandemic influence calculations about biodefense and/or biological weapons programs?

Even before the COVID-19 pandemic, U.S. policy regarding biological weapons threats suffered from at least three serious problems.
First, the legacy of the 9/11 terrorist attacks, which shifted U.S. policy to focus heavily on bioterrorism, needs to be rebalanced with consideration of potential state-based biological weapons threats. Recognizing that bioterrorism remains a serious concern that may also be influenced by COVID-19, U.S. policy must include adequate attention and resources focused on the threat of nation-states maintaining, starting, or bringing back past biological weapons programs. The United States was correct to put significant attention to terrorist threats after 9/11, though at times, this has distracted attention from state-level biological threats. The scale and resources countries could bring to such programs make this a truly catastrophic risk.

Second, U.S. strategy for addressing biological threats is oriented toward potential challenges stemming from advances in biotechnology without adequate plans for leveraging the advantages of technology—and ensuring such work is done in responsible, risk-reducing ways. While both terrorist and state-based bioweapons concerns are real, today’s U.S. biosecurity strategy focuses too heavily on the ways in which biotech advances may exacerbate these threats. Recognizing how profoundly the technological and economic changes described in brief above have expanded biological threats, attempts to slow or over-regulate advances driven almost entirely in the private sector---and that occur around the world---will not be an effective policy approach.

Though these threats are real and highly concerning, changes in a range of technologies and market conditions are bringing to reality many tools not previously available for countering biological weapons threats---with faster speeds and lower costs than were previously imaginable. The world is witnessing important advances in synthetic biology and gene editing, significantly reduced costs in synthesis and sequencing, the continuing spread of widely accessible materials and techniques, robotics and machine learning enabling more rapid and cheaper bioproduction, and the explosion in data these advances are driving, among other trends. These areas of progress offer significantly more hope for game-changing progress against biological weapons threat than U.S. policy currently recognizes. Shifting U.S. strategy to better embrace these changes is an important and realistic goal—but it requires a strong understanding of how COVID-19 could be a game changer regarding biological weapons threats. Such a shift is also a necessary starting point for reducing some of the known biological weapons-relevant risks highlighted in this report (e.g., the proliferation of high-security labs and high-risk research) and advancing the multilateral cooperation it cites as necessary for strengthening norms and institutions against biological weapons.

Third, funding to support defense against biological weapons threats has been declining in the United States in recent years. Some key programs have held a mostly steady level of funding over the past decade, which masks a declining purchasing power and hides relevant adjustments within programs (e.g., moving more funding from countering biological weapons to chemical weapons threats within defense programs). In recent years the Executive Branch and Congress often diverged on policies and funding levels to address biological threats, and in ways that were not predictable or partisan—a trend that may get much worse depending on how the COVID-19 pandemic reshapes threats of deliberate biological weapons. Notably, in summer 2020 bipartisan leaders in Congress pushed back on the Trump administration for reducing funding for Department of Defense programs that are critical to countering biological weapons threats.85

In other words, U.S. policies for addressing biological weapons were already in dire need of updates even before COVID-19 hit. Now the pandemic has created new gaps in our understanding of the potential threat and urgency in rectifying this problem, in particular the overarching question animating this project: will the devastation caused by the COVID-19 pandemic make countries more or less likely to develop biological weapons?

In the coming months, CSR will use the analysis in this paper to frame subsequent workshops focused on advancing policies to address biological weapons threats in the world with COVID-19 and to inform ongoing dialogue with U.S. government officials and those of select other governments. Together with these experts and stakeholders, CSR hopes to put the United States in a better position to deal with biological threats in the future.
APPENDIX A:
EVOLUTION OF MOTIVATIONS, DRIVERS & INHIBITORS FROM THE 1950s UNTIL THE COVID-19 GLOBAL PANDEMIC

In the following, we have lined up the graphic illustrations for motivations, drivers, and inhibitors over the different time horizons assessed in our expert survey. For each graph, we have color-coded the motivations and linked them to associated drivers and inhibitors as viewed through the lens of that time horizon:

- Blue - Deterrence
- Green - Battlefield
- Gray - Hybrid warfare
- Orange - Regime security

This high-level overview helps to show how trends related to biological weapons have evolved over time.

The first series of graphic illustrations show the top five motivations for developing biological weapons. Over time, states appear to have lost interest in their battlefield utility, but gained new interest in their utility for hybrid warfare and regime security.
The second series of graphic illustrations shows the top five attributes that made biological weapons attractive for each time horizon. Each is color-coded based on the associated motivation(s) for that time period.

The third series of graphic illustrations shows the top five inhibitors for each time horizon. Each is color-coded based on the associated motivation(s) for that time period.
APPENDIX B:
SURVEY DEMOGRAPHICS

In the following, we provide data on the demographics for the expert survey.

Q1 What is your gender?

Q2 What is your age?

Q3 What is your highest level of education?

Q4 How many years of experience do you have reading about, studying, or working on issues related to biological weapons?
The timeline for the 1940s and 1950s that this project used is available here.

The timeline for the 1960s and 1970s that this project used is available here.

We created multimedia timelines using the Knight Lab timeline application. This application, developed at Northwestern University's Knight Lab, is "an open-source tool that enables anyone to build visually rich, interactive timelines. Beginners can create a timeline using nothing more than a Google spreadsheet."

The timeline for the 1940s and 1950s that this project used is available here.


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The timeline for the 1940s and 1950s that this project used is available here.


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The timeline for the 1960s and 1970s that this project used is available here.


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For information on the Strategic National Stockpile, see the U.S. Department of Health and Human Services website: https://www.phe.gov/about/sns/Pages/default.aspx.

For information on Project BioShield, see the U.S. Department of Health and Human Services website: https://www.phe.gov/about/barda/Pages/Project-BioShield.aspx.

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