Biological Weapons

This learning unit addresses the challenges to prevent acts of biowarfare and bioterrorism in an era of rapid advances and diffusion of sensitive biotechnologies.

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1. Introduction

What are Biological Weapons?

From the perspective of arms control, disarmament and non-proliferation, the situation in the area of biological weapons looks rather positive. The Biological Weapons Convention (BWC), which entered into force as early as 1975, 'prohibits the development, production, acquisition, transfer, stockpiling and use of biological and toxin weapons' [https://disarmament.unoda.org/biological-weapons/]. It can be credited with being the first multilateral disarmament treaty to ban an entire category of weapons of mass destruction (WMD) and there is now no legitimate military use for biological weapons whatsoever.

However, new developments in the life sciences pose significant problems and dangers due to their potential to create highly contagious and lethal pathogens without being noticed. Advances in genetic engineering make it easier to modify organisms, potentially leading to the creation of new, more dangerous biological agents.

While the development of biological weapons is prohibited, life science research can be understood to be dual use in the sense that some beneficial discoveries could be misused for harmful purposes. This dual-use character makes regulation and oversight complicated. In addition, the globalised nature of science and technology increases the risk of proliferation, provided there is malicious intent, as knowledge and materials can spread more easily across borders. To summarise: There are growing and serious problems despite the BWC's many years of existence.

This learning unit therefore aims to introduce students to the technical, historical, political and legal dimensions of biological weapons. On completion, you will have a basic understanding of:

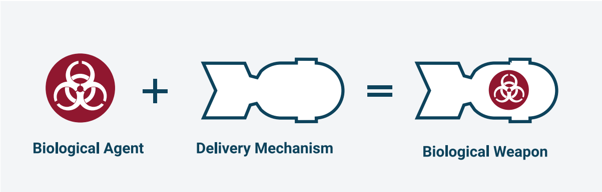
- the technical foundations of biological weapons;
- historical biological weapons programmes;
- the nature of bioterrorism;
- the political context;
- the international legal framework;
- current dangers and challenges.

2. Biological weapons basics

What are Biological Weapons?

The most important question at the beginning of any discussion on biological weapons is what exactly is meant by a biological weapon?

Biological weapons are complex systems that disseminate disease-causing organisms or toxins to harm or kill humans, animals or plants. They can take many different forms, but generally consist of two parts: a weaponised biological agent and a delivery mechanism.



Schematic representation of a biological weapon
Grübelfabrik, CC BY NC SA

While almost any pathogenic organism or toxin can be used as a biological weapon, to be useful to the military, biowarfare agents have traditionally been seen to require certain characteristics: They should be dispersible as an aerosol, be economically scalable, remain stable in the air, have a high virulence, and so on. The biological agent of choice will vary depending on the intended effect, be it to kill or incapacitate, contaminate terrain for long periods, trigger a major epidemic or psychological impact.

Past biological weapon programmes have researched and tested a large number of pathogens that eventually were not weaponised. Biological agents that were validated for biological weapons in past programmes include those that cause anthrax, brucellosis, Q fever, tularaemia, Venezuelan equine encephalitis, glanders, plague, Marburg virus disease and smallpox.

Porton Down laboratory staff carry out histological work in the Experimental Pathology Section of the Microbiological Research Establishment in the late 1960s
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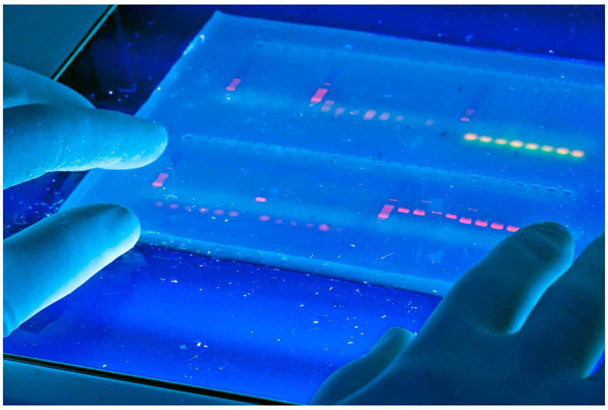
These are all biological agents found in nature. Biological agents may also be enhanced from their natural state to make them more suitable for use as weapons, as was the case in some of the historical programmes.

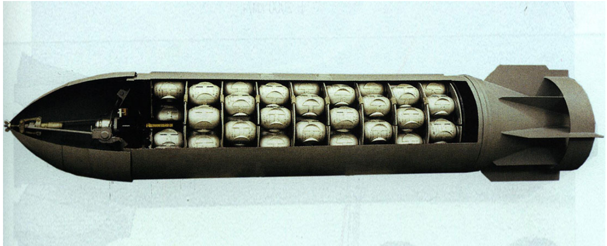
In future, biological agents might be completely unknown.



Working in a modern-day DNA lab (symbol picture)
University of Michigan/CC BY 2.0

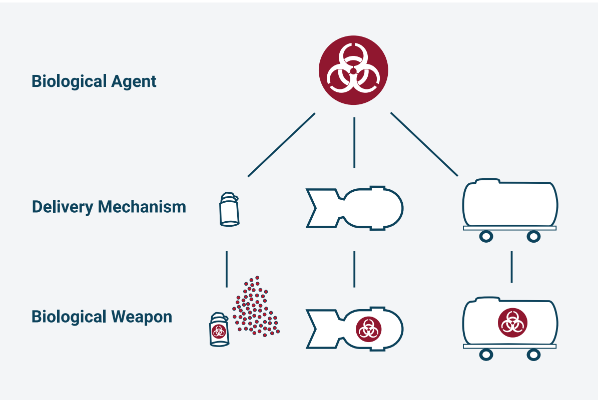
DNA synthesis techniques, which synthesize DNA strands from off-the-shelf chemicals and assemble them into genes and microbial genomes may enable the creation of bioengineered agents whose characteristics combine traits from a number of dangerous pathogens, or whose characteristics are entirely novel and possibly more deadly and communicable than those that exist in nature.

The delivery systems of biological weapons can also take a variety of forms. Past programmes have constructed missiles, cluster bombs and drones to deliver biological agents, as well as sprayers and spray tanks to be fitted to aircraft, cars, trucks and boats.



Soviet cluster bomb designed to disperse biological weapons
Raymond A. Zilinskas
https://www.woah.org/eng/BIOTHREAT2015/Presentations/5_ray_zilinskas_PP_15.pdf

There have also been documented efforts to develop delivery devices for assassinations or sabotage operations, including a variety of sprays, brushes and injection systems, as well as means for contaminating food and clothing.



The components of a biological weapon
Grübelfabrik (CC BY NC)

Biowarfare programmes can also come in all shapes and sizes, as they have done in the past, from the grandiose, resource-rich, high-tech ones to the small, almost primitive efforts funded on a limited budget.

The varied manifestations of biological weapons and BW programmes can make them especially hard to detect. This problem is compounded by the fact that there are few aspects of a BW programme that are unique to offensive applications and that are readily detectable by outsiders.

This is unlike nuclear and chemical weapons. Nuclear weapon programmes leave unique signatures during the development, production and testing process that can be detected at long range. Chemical weapon programmes require industrial-scale production facilities and large stockpiles of munitions to pose a significant military threat and these are visible to overhead reconnaissance systems. Of course biological weapons – such as munitions designed to disseminate biological agents – and biological defences – such as syringes filled with vaccine – can be readily distinguished when placed side by side, but the research, development, production and testing activities used to develop these capabilities are similar, if not identical, in many ways.

Key biological agents validated for biological weapons in past programmes
Bacillus anthracis
Anthrax is an acute infectious disease caused by *Bacillus anthracis*. It was the first disease for which a microbial origin was established — by Robert Koch in 1876.

Inhalation anthrax, the deadliest form, initially presents with flu-like symptoms such as a sore throat, fever, muscle aches, and malaise. A brief improvement is typically followed by respiratory failure and shock, often accompanied by meningitis.

Bacillus anthracis is one of the most feared biological warfare agents. It is easily disseminated, can cause high mortality rates, and poses a significant public health threat. Additionally, it may lead to widespread panic and social disruption, necessitating extensive preparedness measures.

Yersinia pestis
Plague, one of the oldest recorded diseases, is caused by the bacterium *Yersinia pestis*.

There are two primary forms: classic bubonic plague and pneumonic plague. The latter, which involves inhalation of the bacterium, has historically been a target in bioweapons programs.

Pneumonic plague presents with symptoms including malaise, high fever, chills, headache, and muscle pain. This progresses to septicaemic shock, respiratory failure, and often death.

Yersinia pestis is a strong candidate for biological weapons due to its ease of culture, mass production potential, and aerosolization capabilities.

Variola major
Smallpox, caused by the variola virus, is a highly contagious viral disease that was officially eradicated in 1980.

It manifests as fever, severe headaches, and a rash of small, solid, raised lesions. These lesions later fill with fluid, becoming inflamed and pus-filled, typically causing extreme pain.

Variola major is considered a potent biological weapon due to its hardy nature, high infectiousness via airborne transmission, ability to survive explosive delivery, and its capacity to cause a debilitating disease with high mortality.

Francisella tularensis
Tularemia, caused by the bacterium *Francisella tularensis*, primarily affects small mammals.

In humans, pneumonic tularemia presents with fever, headaches, chills, cough, chest pain, and difficulty breathing. Skin lesions and swollen lymph nodes may also develop, and the disease can be fatal.

Francisella tularensis is dangerous due to its ability to be aerosolized, causing large-scale tularemia outbreaks in both humans and animals. It is a resilient bacterium, highly infectious, and capable of surviving in various environments, including water, moist soil, hay, straw, and decaying carcasses.

Brucella

Brucella bacteria infect humans primarily through ingestion of contaminated milk or meat or through contact with broken skin.

Brucellosis, more common in animals like pigs, sheep, cattle, and dogs, causes flu-like symptoms in humans, including fever, headache, chills, and malaise. In some cases, nausea, vomiting, and diarrhea develop. Rarely, the infection may affect the heart and nervous system.

Brucella is regarded mainly as an incapacitant or as an anti-animal weapon intended to disrupt agricultural production.

Venezuelan equine encephalitis (VEE) virus

In natural settings, the Venezuelan equine encephalitis (VEE) virus exists in a rodent-mosquito cycle and only sporadically causes human infections. Mutations enabling replication in horses can lead to widespread equine outbreaks, killing thousands of horses and spreading across vast distances.

In humans, the severity of VEE infections varies significantly. Some strains cause high mortality and permanent neurological damage.

The virus is highly infectious and grows well in laboratory conditions, but advances in medicine have revealed that it is less controllable than previously believed when it served as a biological agent in the US.

Biological weapons are usually placed in the same category as chemical and nuclear weapons, in other words, weapons of mass destruction. There are, however, some overlaps and things get blurry.

Relationship between BTW and other non-conventional weapons
Grübelfabrik,CC BY-NC-ND 4.0

The overlap between biological and chemical weapons is most evident in the realm of toxins and bioactive molecules, as these substances can be derived from both biological organisms and synthetic chemical processes. Toxins such as botulinum and ricin are naturally occurring biological agents that can be weaponized, blurring the line between biological and chemical warfare. However, these agents are covered by the prohibitions contained in both the Biological Weapons Convention and the Chemical Weapons Convention. Additionally, advances in biotechnology may enable the synthesis and enhancement of bioactive molecules, which can be used to disrupt physiological functions in a manner similar to some traditional chemical weapons.

3. Biological Warfare and Bioterrorism

Technical Institute of Science and Microbiology Stepnogorsk, Kazakhstan
Raymond A. Zilinskas

Pre-20th century use of biowarfare

Biological weapons, bioterrorism and the fear of intentional disease have a long history and are not new thoughts. We knew how to spread disease long before we understood the science behind

'Poisoned water well' by J. Malczewski (1854–1929)
Digital collections of the National Museum in Warsaw/public domain

Among the older military techniques that can be considered biowarfare is the use of corpses of humans or animals to contaminate wells and other sources of drinking water. While the principal objective was thought to be the denial of clean water to the enemy, a secondary effect was to spread disease among people and animals that consumed the contaminated water.

The earliest recorded account of armies using infectious disease as a weapon is the 1346 siege of the heavily fortified Crimean city of Kaffa, an important trading hub on the Black Sea between Europe and the Far East controlled by the Maritime Republic of Genoa.

The sea route from Genoa to Kaffa
Data: Natural Earth, Image: PRIF, CC BY 4.0

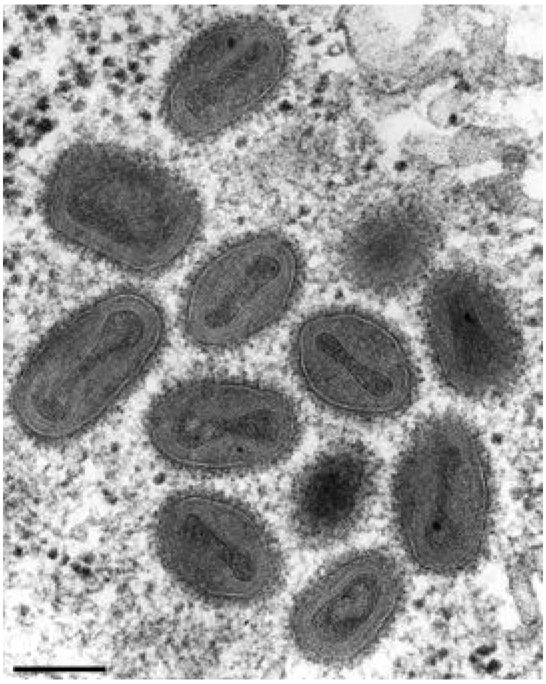
The Mongol forces besieging Kaffa suffered a severe natural outbreak of bubonic plague that was killing 'thousands upon thousands every day'. A contemporary Arabic source estimates 85,000 plague fatalities among the Mongol forces in the Kaffa region during this epidemic.

But the Mongols turned this to their advantage and catapulted the plague-infected corpses of their dead comrades over the city walls to spread the disease to the European traders taking refuge in Kaffa.

Mongol techniques of warfare in the 13th/14th century
Wikimedia Commons/public domain

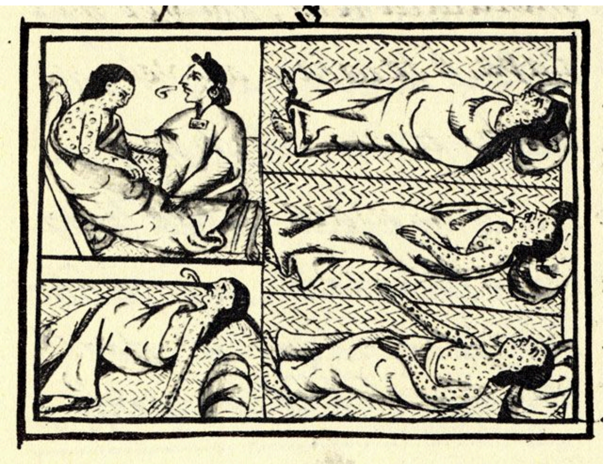
The Mongols were skilled siege warriors, and their artillery at Kaffa was likely numerous and sophisticated. The numbers of cadavers hurled into the city could well have been in the thousands. The Mongols' tactic finally broke the three-year stalemate; the Genoese were crippled by the plague and fled Kaffa by sea back to Europe.

A second well-documented account comes from North America and the wars against the Native Americans. Of the many new diseases that the Europeans brought with them to the New World in the 1700s and 1800s, smallpox was the most feared.



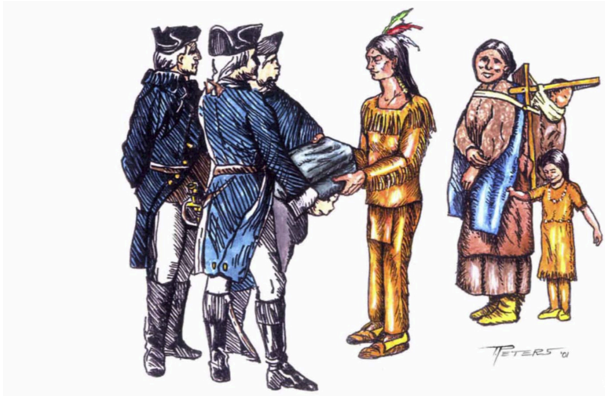
Smallpox virus under the electron microscope.
Hans R. Gelderblom/RK. Reproduced with the kind permission of the Robert Koch Institute

Among Europeans, smallpox epidemics typically had a case fatality rate of 20–40 percent; but among Native Americans, who had not previously been exposed to smallpox and who had not built up immunity towards the disease, fatality rates of 90 percent or higher were common.



16th century Florentine Codex shows Nahua infected with smallpox
Wikimedia Commons/public domain

In the late 1700s, at Fort Pitt on the Ohio River – in present day Pittsburgh – conditions were extremely crowded. Traders and settlers had been driven in by the hostilities, and smallpox had just broken out. Journal entries, ledgers and other documents from the time indicate that the ranking British officers at the fort met with a delegation from the native Delaware tribe, and handed over smallpox-contaminated sheets and linens from the fort's hospital under the false pretence of a gift.



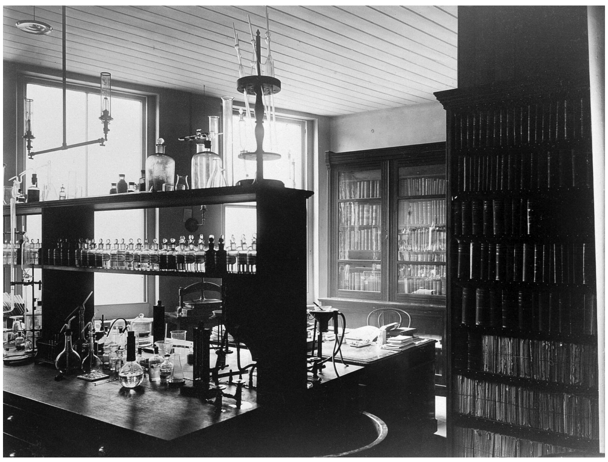
British officers deliberately spread smallpox to Native Americans
Nativeweb.org/Illustration: Terry R. Peters

A smallpox epidemic is reported to have broken out in the Delaware tribe at this time. Of course, the extent to which the spreading epidemic can be attributed to the blankets is impossible to determine, but the incident is indicative of what appears to be a history of sporadic British and American efforts to infect North American tribes with smallpox.

20th century biowarfare programmes

Historical examples of the use of bioweapons before the 20th century

For most of human history, attempts to transmit infections were rare and clumsy; they probably seldom worked out – and, when they did, they were in all likelihood redundant with natural routes of transmission. Lack of knowledge about infectious diseases and how they're transmitted prevented rational design of methods of biological attack. This changed in the 20th century.

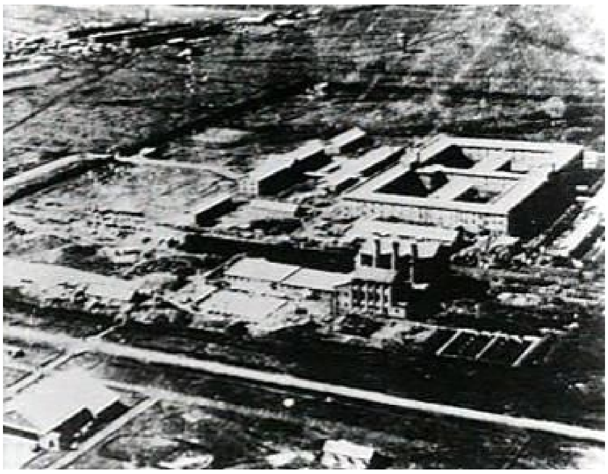


The interior of a pharmaceutical or chemical laboratory with a bench in the centre and books and papers on shelves around the walls
Wellcome Collection/CC-BY-4.0

The revolution in microbiology transformed ignorance about infection into sophisticated understanding. Over the period 1880 to 1900, the microbial basis of infectious disease was proven, the pathogens causing virtually every common bacterial disease of importance were identified and studied, and their mechanisms of transmission worked out. Coupled with new organisational links between the military and sciences, this paved the way for manipulating infection and the systematic design and improvement of biological weapons.

Advances in science were applied to unconventional weapons at an industrial scale for the first time in World War I, and the horrors of gas warfare led to several arms limitation treaties. A key treaty was the League of Nations' 1925 Geneva Protocol prohibiting the use of chemical weapons in international armed conflicts.

A prohibition on the use of 'bacteriological methods of warfare' was added to the treaty late in the negotiations, almost as an afterthought, because unlike chemistry, there were no indications at the time that biology was being militarised. Yet, shortly after the treaty was signed, the Japanese did exactly that.

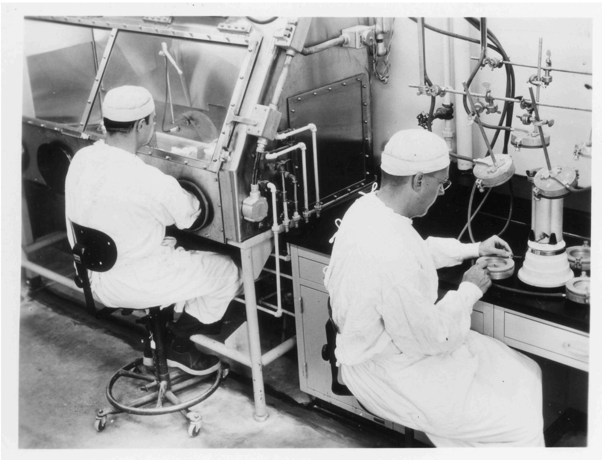


Secret Unit 731, Japanese research and development facility for biological and chemical warfare
Wikimedia Commons/public domain

They developed a bioweapons programme on a significant scale that included the most atrocious human subject experiments on thousands of Chinese prisoners of war and attacks on civilians with biological agents – actions unique in military history. Most major World War II combatants conducted research on biological weapons, but none of these programmes were on the scale of the Japanese programme.

The post-war nuclear age set a high standard for the next 20 years of biological weapons development; they made it imperative for bioweaponeers to show how pathogens could devastate populations at the same enormous scale as the bombs dropped on Hiroshima and Nagasaki.

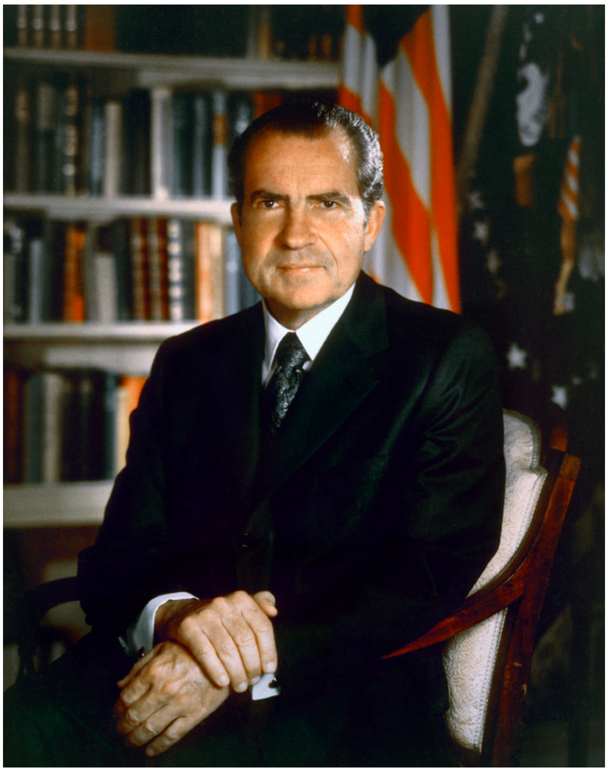
Post-war American efforts to show that biological warfare could rival nuclear warfare were extensive, and involved laboratory and human subject research into potential pathogens, the industrial production and stockpiling of agents, the manufacture of bombs and spray generators, fitting of airplanes and ships for dispersal, the indoctrination of troops, and large-scale field trials.



US scientists research germs and bacteria in 1957
National Archives and Records Service/public domain

Yet, despite the intensive development and testing, and simulations of disease attacks on civilians that grew larger and more elaborate until they verged on reality, biological weapons were neither assimilated into the thinking and planning of the regular military, nor used by the United States or its partners – the United Kingdom and Canada, and, later, Australia.

In a political move that caught the bioweaponeers off guard, the newly elected President Richard Nixon unilaterally renounced biological weapons in 1969, paving the way for the multilateral Biological Weapons Convention, introduced three years later.



US President Richard Nixon
National Archives and Records Service/public domain

The US bioweapon programme was dismantled in the early 1970s, the considerable stockpiles destroyed and the facilities converted. Ironically, it was only after signing the Biological Weapons Convention – the multilateral treaty banning biological weapons – that the Soviet programme began its incredible expansion.

The expansion and redirection of the programme was proposed by a small but very influential group of scientists arguing for exploiting the new field of genetic engineering that was just beginning to emerge in the West. New pathogen properties, such as antibiotic resistance and enhanced stability, were to be engineered directly into pathogens, including agents not on classical bioweapons agent lists. These altered pathogens formed a novel arsenal of weapons that could not be predicted by Western intelligence.

The tightly controlled programme was even more secret than the USSR's efforts in the realm of nuclear weapons. Rather than expanding the Soviet military biological institutions, the new offensive programme was established in the civilian sphere. Western intelligence services most likely knew about the military biological institutions and kept them under observation, so the better option was to 'hide' the new institutions in plain sight.

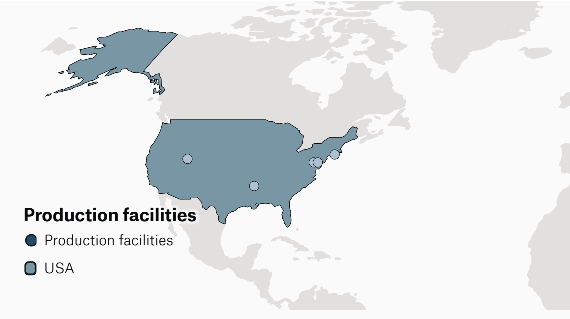
An entirely new, ostensibly commercial network of institutes, production plants and storage facilities was constructed. Collectively known as 'Biopreparat', it worked both sides of the street: it cured diseases and invented new ones.

In the years following the USSR's collapse, the Cooperative Threat Reduction Programme decommissioned the main production plant and testing site, and transformed the majority of the known Biopreparat facilities into more open research facilities – some of which began international collaborations on peaceful microbial research, including international scientist exchanges.

The three key military institutes involved in the BW programme remain closed to outsiders, and it is not possible to ascertain whether the biological weapons programme has been terminated in its entirety. Russia's current official position is that no offensive BW programme ever existed in the Soviet Union.

You can find additional information on the US and Soviet bioweapons programmes in the discussions below or simply skip to the next section.

In the US programme, research, development and pilot-scale production were located at Fort Detrick and at the Edgewood Arsenal in Maryland, with additional facilities at the animal research station at Plum Island, New York. Biological agent and munitions production took place in a large purpose-built ten-floor facility at Pine Bluff, Arkansas. Early trials were carried out at Dugway Proving Ground in Utah.



Map showing locations of US research production facilities
Data: Natual Earth. Graphic: PRIF
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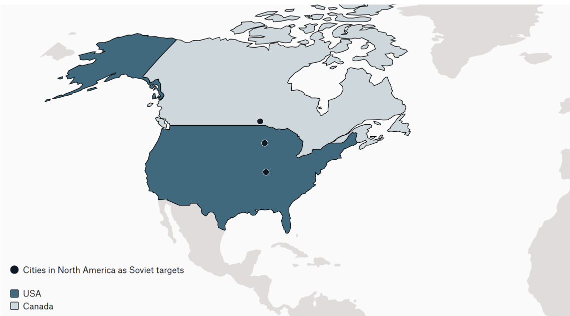
Open-air field trials to test aerosol dispersion patterns were conducted at a large number of locations throughout the US. A series of trials initiated in 1953 under the 'St Jo' programme simulated anthrax attacks on urban targets to estimate munitions requirements for the strategic use of biological agents against typical target cities. Three North American cities were chosen to approximate Soviet cities: St. Louis, Minneapolis and Winnipeg, Canada.



North American cities chosen to approximate Soviet cities for bioweapon attacks: St. Louis, Minneapolis and Winnipeg, Canada
PRIF (CC-BY-SA)

For months, the scientists involved in the experiments used generators mounted on top of cars parked in various urban locations to disperse clouds of simulants. Many of the open-air field trials were held at sea for fear of soil contamination, public disclosure and possible danger to local populations. 'Project 112' was a land and sea project for expanded offensive testing of chemical and biological weapons.

At least 50 Project 112 trials took place, involving warships, bombers and airplanes fitted with spray generators. In the late summer of 1968, the final and probably most elaborate open-air biological tests took place over the Pacific Ocean downwind of Johnston Atoll, 1,000 miles southwest of Hawaii.

Bill Patrick, Fort Detrick's chief of product development and one of the top US bioweaponeers, recalls the trial.

> At sunset, just as the sun touched the horizon, a Marine Phantom jet flew in low [...] a single pod under its wings releasing a weaponised powder. The powder trailed into the air like a whiff of smoke and disappeared completely. [...] The jet was disseminating a small amount of biopowder for every mile of flight [in a single-source laydown]. [...] At Johnston Atoll, the line of particles moved with the wind over the sea, somewhat like a windshield wiper sweeping over glass. Stationed in the path of the particles, at intervals extending many miles away, were barges full of monkeys, manned by nervous Navy crews wearing biohazard spacesuits. The line of bioparticles passed over the barges one by one. Then the monkeys were taken back to Johnston Atoll, and over the next few days half of them died. Half of the monkeys survived, and were fine.
>
> Source: Congressional Record Volume 144, Number 26 (Thursday, 12 March 1998), U.S. Senate, Page S1880)

> It was clear that a jet that did a laydown of a modest amount of military bioweapon over a city like Los Angeles could kill half the city's population. The open-air biological trials decisively removed any doubts as to whether bioweapons worked. Bill Patrick recalls:
>
> 'When we saw those test results, we knew beyond a doubt that biological weapons are strategic weapons. We were surprised. Even we didn't think they would work that well.'
>
> Source: Congressional Record Volume 144, Number 26 (Thursday, 12 March 1998), U.S. Senate, Page S1880

The extensive, multi-agency Soviet bioweapons programme encompassed both military and civilian research facilities. This posed challenges to keeping the programme secret, and a new classification level higher than 'Top Secret' called 'Series F' clearance was established to cover up the programme.

By the end of the 1980s, Biopreparat controlled three dozen institutes, mobilisation plants and other types of facilities that were either involved in biological weapons R&D or supported it in some way. These were spread throughout the Soviet Union. They could be found in Moscow and Leningrad (now St. Petersburg); in Kirov, 500 miles east of Moscow; and, still further away, in Kazakhstan, Uzbekistan and Siberia.

LU02 MAP – Soviet research facilities

Map showing locations of Soviet research facilities
Data: Natural Earth. Graphic: PRIF
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Biopreparat created new biological weapons enclaves, at Obolensk and Koltsovo, and built factories dedicated to biological agent production, the most impressive of which was an enormous plant at Stepnogorsk. It is estimated that at least 30,000 people worked for the Biopreparat system, though many argue that the figure could be substantially higher.

Soviet factory interior with 20,000 fermenters for bioweapon production
Courtesy of Andy Weber

The first defector to emerge from Biopreparat was Vladimir Pasechnik, a microbiologist and director of one of the major bioweapon facilities, who arrived in Great Britain in late 1989, just as the Soviet Union was beginning to crumble. Pasechnik's revelations shocked his Anglo-American debriefers. When President Yeltsin took office in January 1992, the US forced him to admit publicly that there had been an offensive Soviet bioweapons programme and that it had continued into his presidency.

In the years following the USSR's collapse, the US developed a Cooperative Threat Reduction Programme (see below) to offer Soviet bioweaponeers with collaborative research grants that could provide them with gainful employment. Recipients of these 'brain drain prevention' grants were told that they must not share their advanced knowledge of how to develop, produce, test and disperse biowarfare agents or peddle weapons materials, particularly genetically engineered pathogens.

This condition seems to have been an effective deterrent, as there is little evidence of proliferation and black marketeering from the Soviet bioweapons programme.

Bioterrorism

Bioterrorism is a relatively new concept that emerged during the early 1990s in the United States to describe terrorists' use of biological weapons.

In the last years of the Cold War, a new set of threats posed by rising third-world states and terrorists supported by these states began to be projected by some US security analysts and national security commissions – particularly on the right of the political spectrum and with ties to the Pentagon – and among these threats were terrorists armed with biological weapons and other weapons of mass destruction.

As the Cold War faded, the threat of biological weapons from third-world states and terrorists hostile to the United States began to replace the Soviet threat. Although little credible evidence existed at the time that such states or terrorists would, or even could, resort to biological weapons, the newly perceived threat became the driving force behind US preparedness and biodefence programmes of considerable institutional proportions.

Different assessments of the importance, urgency and scale of the threat were present in the early political debates on bioterrorism. 'Alarmists', who included prominent scientific and technical advisers, tended to emphasise the vulnerability of the civilian population, and they would apply their impressive scientific and technical skills to the possibility of "apocalyptic" attacks with natural pathogens and genetically engineered hybrids.

They were less focused on the identities of bioterrorists, and in their interests in pursuing such attacks or their capacities to do so. In contrast, 'sceptics' tended to have backgrounds and training in the history, politics and culture of terrorism, and for them, questions of the identity, interests and details of past attackers were the primary questions to ask.

Ultimately, alarmism trumped scepticism and federal funds poured into major new US civilian biodefence programmes.

The 'Amerithrax' attacks, as the FBI code-named the anthrax mailings immediately following 9/11, revealed serious shortcomings in US biosecurity, and also raised fears about the growing potential for bioterrorism on American soil.

Envelopes containing anthrax sent by an unknown sender to various addressees after 11 September 2001
Federal Bureau of Investigation (FBI)

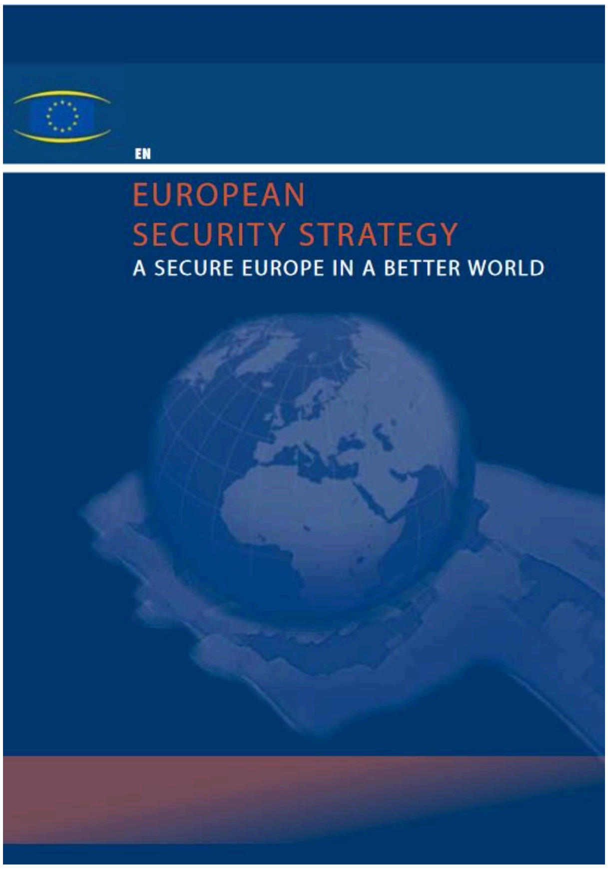
The threat of bioterrorism became one of the Bush administration's key security concerns during its two terms in office, and it initiated a series of new regulations, policies and programmes in the early to mid-2000s to strengthen US preparedness against a bioweapon attack.

Concern about the threat of international terrorism coupled with WMD proliferation was also exported from the United States to international security forums and back to capitals around the world following 9/11 and the Amerithrax attacks. Bioterrorism became an international problem requiring a policy response, and counter-offensives materialised in international risk and security strategies.

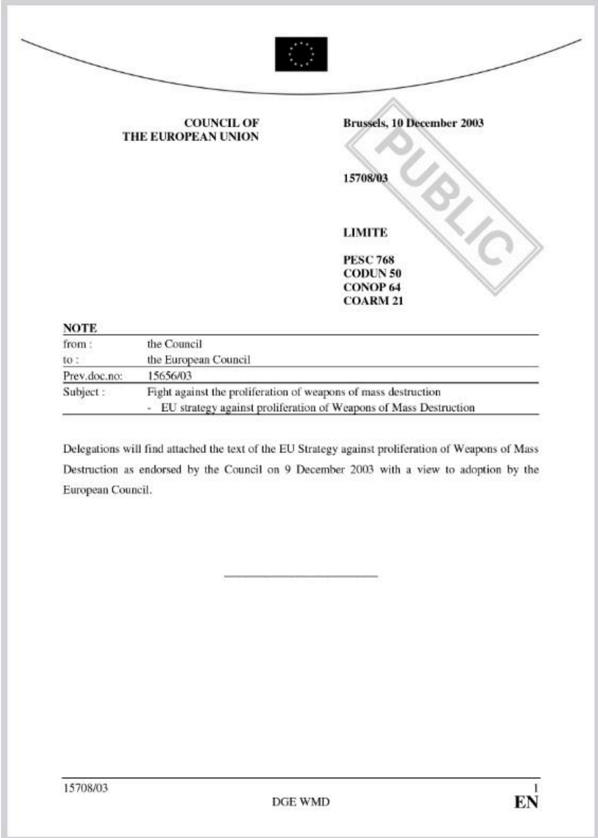
Envelopes containing anthrax sent by an unknown sender to various addressees after 11 September 2001
Federal Bureau of Investigation (FBI)

In Europe, the European Commission launched a programme to respond to the consequences of WMD attacks, and particularly bioterrorism attacks, already within a few weeks of 9/11 and Amerithrax. The European security strategy

7809568enc.pdf], drawn up for the first time in 2003, focused heavily on the new threat from WMD and terrorists committed to maximum violence. In parallel, the European Union also adopted a strategy against proliferation of weapons of mass destruction.



2003 EU Security Strategy
EU https://www.consilium.europa.eu/media/30823/qc7809568enc.pdf



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CONOP 64
COARM 21

NOTE

from :	the Council
to :	the European Council
Prev.doc.no:	15656/03
Subject :	Fight against the proliferation of weapons of mass destruction - EU strategy against proliferation of Weapons of Mass Destruction

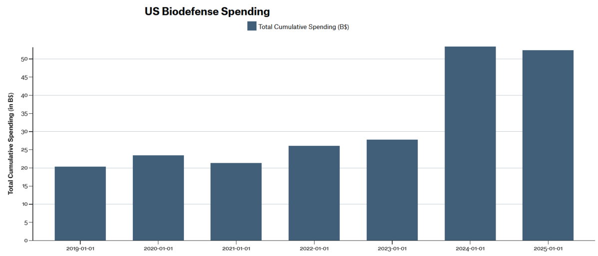
Delegations will find attached the text of the EU Strategy against proliferation of Weapons of Mass Destruction as endorsed by the Council on 9 December 2003 with a view to adoption by the European Council.

15708/03 DGE WMD 1 EN

2003 EU Strategy against Proliferation of Weapons of Mass Destruction
EU https://data.consilium.europa.eu/doc/document/ST-15708-2003-INIT/en/pdf

The change in government in the US saw an evolution in US thinking about its response to bioterrorism. The Obama administration announced its first major policy initiative on biosecurity in 2009. While the Bush administration's efforts had been focused on biodefence, Obama's National Strategy for Countering Biological Threats was focused on prevention. It emphasised linking deliberate disease outbreaks from bioterrorism attacks with naturally occurring disease outbreaks, to create a more seamless and integrated link across all types of biological threats – echoing what the WHO had been pushing multilaterally for years.

The Obama administration's strategy also worked to create more linkages between health and security, by enhancing disease surveillance and fostering cooperation between the public health, life science and security communities. The strategy emphasised the need for international cooperation and partnerships to deal with the global nature of the threat, and called for expansion of bioengagement activities into Africa and South Asia.



US cumulative budget for biosecurity across all relevant government agencies. Amount requested in 2024, amounts approved prior to that
Council on Strategic Risk – Biodefense Budget Breakdown
https://councilonstrategicrisks.org/nolan/biodefense-budget-breakdown/

Reality check: Threat assessment

Threat assessments during the 2010s suggest that there had been concerns about al Qaeda's efforts to obtain bioweapon capabilities, and it had been leaked that Israel had secretly detained a suspected Al Qaeda bioweapons expert for a number of years. There had also been some reports indicating that ISIS might have an interest in bioterrorism. Yet, despite these concerns, the suggestive features of past bioterrorism incidents indicate that while the risk of a crude, small-scale bioterrorism attack is possible and likely, the risk of a sophisticated large-scale bioterrorism attack with mass fatalities and severe consequences is low. Despite the widespread attention given to the risks of bioterrorism, few terrorists have contemplated using biological agents, fewer still have made any serious effort to develop the capability to employ biological agents – and the number who have ever tried to use them is even smaller. There are six commonly identified past bioterrorism incidents which are cases in point. Three of these attacks took place in the US, one in Japan and two in Europe.

Bioterrorism incidents and lessons learned: Case studies over time

1972 · USA, R.I.S.E.

In 1972, a group of teenagers with fantasies of apocalyptic regeneration for humankind created a group called R.I.S.E. The acronym is not fully understood but it is believed that the R was for Reconstruction, S for Society and the E for Extermination. However, the meaning of I remains unclear[1]. The group obtained several biological agents and learned how to grow them, but failed to mount planned attacks before being arrested.

1981 · England, Dark Harvest

In 1981, activists, calling themselves 'Dark Harvest' protested against the British chemical defence establishment by dropping two packages with soil collected from a British World War II anthrax test site, placing one near a railway station and sending another package to the Conservative Party Conference. In the first case, the anthrax concentration was below the critical value, but still detectable. In the second case, no anthrax could be detected in the soil[2]

1984 · USA The Rajneeshees cult

In 1984, a cult known as the Rajneeshees actually spread a biological agent. They deliberately contaminated salad bars with salmonella to cause voters to fall ill, keeping them away from the polls during local elections in Oregon. Salmonella rarely kills, and no one died in this attack, but more than 750 people were infected, some of them severely.

1990–1995 · Japan, The Aum Shinrikyo cult

In the early 1990s, the Japanese Aum Shinrikyo cult tried to develop and disseminate anthrax. It launched two unsuccessful attacks in 1990 and 1993 respectively, when it released botulin toxin near the Japanese parliament and other government buildings in Tokyo but to no known effect. Another attempt was prevented in 1995. The cult had more success with chemicals, however. In 1995, they went on to carry out the sarin attack on the Tokyo underground, poisoning almost 6,000 people.[3]

2001 · USA, The anthrax letters

The most lethal biological attacks were the 2001 anthrax letters, which killed five people and caused another 17 to become ill. The series of five anonymous letters containing a deadly strain of anthrax were sent to media outlets and the U.S. Senate within weeks of the unprecedented terrorist attacks on New York and Washington on 11 September 2001. The letters overtly linked the two attacks, with its messages of '09-11-01 You can not stop us' and 'this is next'. The perpetrators are yet to be found.

2018 · Germany, Ricin found in Cologne

In 2018, German police arrested a Tunisian man in Cologne after they discovered toxic ricin in his flat. The suspect is said to have successfully produced ricin using an IS manual from June 2018 onwards. He had come to the authorities' attention through his online purchases as well as information received via the 'Islamist Terrorism Hotline' that made it clear he could be planning an attack. The operation against the suspect was part of a broader counterterrorism effort, and his arrest was seen as a significant success in preventing a potential terrorist attack in Germany.[4]

Lessons to be drawn

So, what can be learned from these incidents? While future cases may differ significantly from past ones, there are suggestive features of previous bioterrorism incidents that can improve assessments of current and future threats.

First, bioterrorism can take many forms. It might be motivated by a desire to cause mass casualties, as was the case for R.I.S.E. and Aum Shinrikyo. But it is equally true that the perpetrators may not be focused on killing people at all. The Rajneeshees wanted to disrupt an election, so hoped that their attack would seem like a natural outbreak. Similarly, if microbiologist and vaccinologist Bruce Ivins was the Amerithrax perpetrator, as the FBI claims, his motives clearly did not fit the typical characterisation of a terrorist. Bioterrorism incidents may therefore be motivated by very different political and personal considerations.

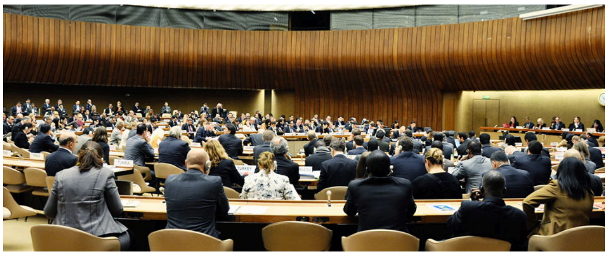
Second, the skills required to undertake even rudimentary bioterrorism attacks are greater than often assumed. Certain technical and scientific expertise is required to culture and disseminate microorganisms, even in crude ways. More sophisticated attacks, involving larger quantities of agent and more complex dissemination methods, as attempted by Aum Shinrikyo, may be beyond the capabilities of even well-organised and funded terrorist groups. While the challenges may not be technically insurmountable, terrorist groups rarely engage in the types of complex research and development required for such attacks, and some of the necessary expertise may demand access to tacit knowledge, which is difficult to obtain.

Third, organisational factors may be critical. While simpler forms of bioterrorism are within the reach of lone actors or malicious activists like Dark Harvest, a group effort would be necessary to mount larger, more sophisticated attacks. As Aum Shinrikyo's experience suggests, this may create serious obstacles to the many technical challenges facing a would-be bioterrorist. The complexities of undertaking such activities in a covert manner should not be underestimated.

Finally, the scarcity of bioterrorism incidents is telling. The Rajneeshees demonstrated that it is possible to carry out crude bioterrorism attacks with little difficulty, and the Amerithrax case showed how disruptive such attacks could be. Yet, despite this, few terrorists have shown a serious interest in developing biological weapons.

1. [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7305902/]
2. [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7305902/]
3. [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7305902/]
4. [https://www.faz.net/aktuell/politik/inland/bio-bomber-wichtige-hinweise-aus-der-bevoelkerung-15649882.html]

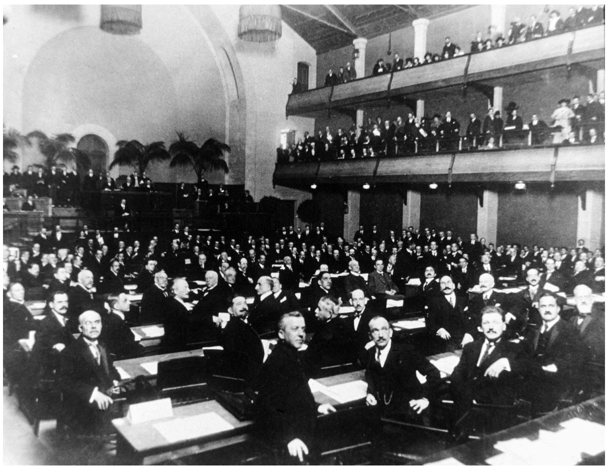
4. The Norm against Biological Weapons



Meeting of the Biological Weapons Convention, 2014
Filippa Lentzos

The international community has drawn clear red lines about the misuse of biology. The two biological cornerstones of the rules of war are the genevaprotocol and the Biological Weapons Convention (BWC). Together, they prohibit the development, production, stockpiling and use of biological weapons.

The 1925 Geneva Protocol



The League of Nations at its opening session in Geneva
UN Photo /Jullien https://dam.media.un.org/asset-management/2AM9LO3APKNT?WS=SearchResults

TREATY

Geneva Protocol

Effective 17 June 1925 Legally binding 163 Member States

The Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, commonly known as the Geneva Protocol, is a treaty prohibiting the use of chemical and biological weapons in war.

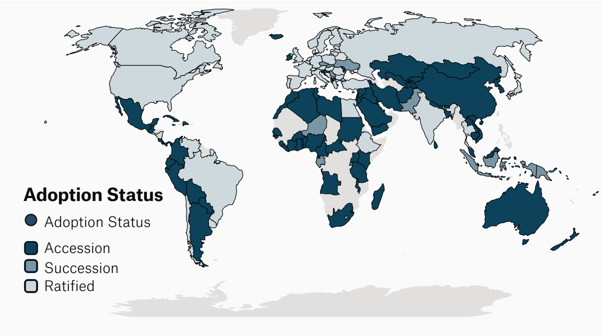
Current Adoption

AUT	BEL	BRA	BGR	CAN	CHL	DNK	EGY	SLV	EST	ETH	FIN
FRA	DEU	GRC	HUN	IND	IRL	ISR	ITA	JAM	JPN	JOR	KAZ
KEN	KWT	KGZ	LAO	LVA	LBN	LSO	LBR	LBY	LIE	LTU	LUX
MDG	MWI	MYS	MDV	MLT	MUS	MEX	MCO	MNG	NLD	NIC	NOR
POL	PRT	NLD	NIC	NOR	POL	PRT	ROU	RUS	ESP	AFG	ALB
DZA	AGO	ARG	ARM	AUS	BHR	BGD	BEN	BTN	BOL	BFA	CPV
KHM	CMR	CAF	CHN	COL	CRI	CIV	HRV	CUB	PRK	DOM	ECU
GNQ	SWZ	GHA	GTM	GNB	VAT	ISL	IRN	IRQ	MAR	MDG	MWI
MYS	MDV	MEX	MCO	MNG	MAR	MOZ	MMR	NAM	NRU	NPL	NZL
NGA	OMN	PAN	PRY	PER	PHL	QAT	KOR	MNG	MAR	MOZ	MMR
NAM	NRU	NPL	NZL	NGA	OMN	PAN	PRY	PER	PHL	QAT	KOR
SAU	SYC	SGP	ZAF	SDN	YEM	ATG	BRB	CYP	CZE	FJI	GAB
GRD	IDN	MLT	MUS	MNE	NER	PAK	PNG	MDA	MNE	NER	PAK
PNG	RWA	SEN	SRB	SVK	SVN	TZA	AND	ARE	AZE	BDI	BHS
BIH	BLR	BLZ	BRN	BWA	CHE	COD	COG	COK	COM	DJI	DMA
ERI	FSM	GBR	GEO	GIN	GMB	GUY	HND	HTI	KIR	KNA	LCA
LKA	MHL	MKD	MLI	MRT	NIU	PLW	PSE	SLB	SLE	SMR	SOM
SSD	STP	SUR	SWE	SYR	TCD	TGO	THA	TJK	TKM	TLS	TON
TTO	TUN	TUR	TUV	UGA	UKR	URY	USA	UZB	VCT	VEN	VNM
VUT	WSM	ZMB	ZWE								

☐ Adopted by ratification
▒ Adopted by accession, acceptance, or succession
■ Not adopted

Data: United Nations Treaty Collection

Prompted by the horrific experiences of chemical warfare during World War I, the 1925 Geneva Protocol (official name: Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare) was negotiated under the auspices of the League of Nations from 4 May to 17 June 1925. The aim was to prevent similar atrocities in future conflicts. It entered into force on 8 February 1928 and has the status of an international treaty that prohibits the use of biological and chemical weapons in war. Over time, many countries have joined the Protocol, reinforcing the global norm against the use of such weapons.



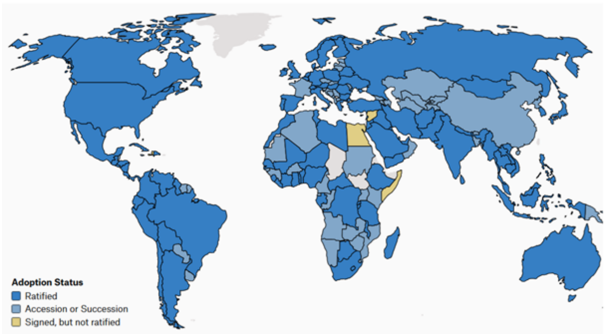
Map showing member states of the Geneva Protocol
Data: Natual Earth. Graphic: PRIF

However, it does not explicitly prohibit their development, production or stockpiling. As a result, the Protocol contained considerable loopholes enabling states to legally possess and manufacture biological weapons 'just in case'. Over time, an increasing number of states felt that the Geneva Protocol was inadequate and that the loopholes had to be closed, eventually leading to the Biological Weapons Convention.

Biological arms control and disarmament: The Biological Weapons Convention (BWC)

Conference of the Committee on Disarmament at work 1971
UN photo (cropped) https://dam.media.un.org/asset-management/2AM9LOWM3RQE?WS=SearchResults

Today, the cornerstone of the biological arms control and disarmament regime is the Biological Weapons Convention (BWC), or the 'Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction', as it is officially known.



Global participation in the Biological Weapons Convention (BWC)
Data: UNODA Disarmament Treaties Database, Natural Earth, Image: PRIF/CC BY SA

The BWC is an extraordinary treaty. Negotiated in a relatively short period of time, it was the first treaty to outlaw an entire class of weapons. The political atmosphere in the late 1960s/early 1970s when the BWC was negotiated was dramatically different from the international political situation today. The Cold War severely limited progress in arms control and disarmament. Occasionally, however, there were windows of opportunity to advance arms control. BWC negotiators took advantage of one of these windows to successfully draft and approve the final text of the Convention.

The BWC opened for signature in 1972 and entered into force in 1975. The UK, US and USSR acted as depository powers. Unusually for an arms control treaty, the BWC was agreed without routine on-site verification mechanisms to enhance assurance of compliance. Some states argued that the nature of biological weapons is such that they are inherently impossible to verify: not only can significant quantities of biological agents be produced in small and readily concealable facilities, but most of the equipment required – the fermenters, centrifuges and freeze-dryers – is ubiquitous in public, private and commercial laboratories. Other states argued that, while the same level of accuracy and reliability as the verification of, for example, nuclear arms control treaties is unattainable, it is possible to build a satisfactory level of confidence that biology is only used for peaceful purposes.

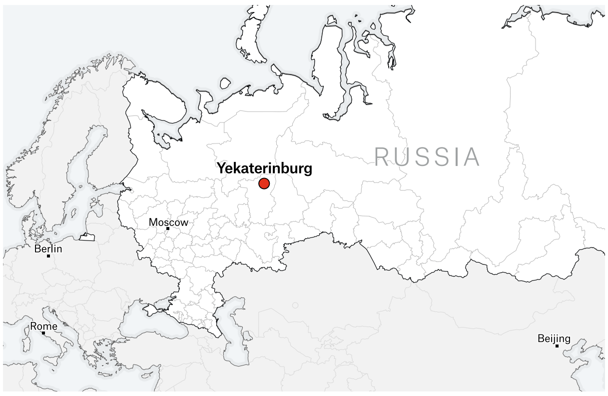
The lack of a verification mechanism had immediate impacts on the BWC. Shortly after the USSR signed the treaty in 1972, analysis of CIA spy plane photographs raised suspicions that the Soviet Union was defying its obligations to dismantle its BW programme.

Lockheed U-2 high-altitude reconnaissance aircraft operated from the 1950s over Soviet territory and provided visual intelligence from an altitude of more than 20,000 metres in the era before satellites were widely available
USAF (public domain)

These photographs and US suspicions continued after the Convention entered into force in 1975. What the spy plane photos appeared to show was that the Soviets were constructing new structures at their BW installations rather than getting rid of BW agents and munitions.

The first conference to review the operations of the BWC was held in March 1980, in the period often referred to as the 'second Cold War'. At that conference, Sweden proposed establishing a Consultative Committee to investigate issues of non-compliance with the treaty. The Committee would have the ability to conduct fact-finding missions with on-site inspections. The USSR objected, arguing that a review conference was not the appropriate forum to introduce amendments to the Convention.

The Soviets may well have had other reasons to object to the Swedish proposal. In the spring of 1979, there was an outbreak of anthrax in the Soviet city of Yekaterinburg, then known as Sverdlovsk.



Yekaterinburg
Data: Natural Earth , Image: PRIF/CC BY 4.0.

Because the city was home to a facility the US long suspected was a BW lab, intelligence analysts in the West suspected that a leak or explosion at the facility caused the outbreak.

The US made its suspicions public at the first BWC review conference and raised allegations that the outbreak was due to a biological weapon accident, charging the Soviets with treaty violation. The Soviets responded to the allegation by acknowledging the existence of the anthrax epidemic and blaming it on the ingestion of tainted meat.

Ultimately, the controversy was resolved by abandoning the efforts to establish a Consultative Committee to investigate non-compliance. The anthrax outbreak controversy lingered until independent scientific investigations conducted after the collapse of the Soviet Union revealed that the U.S. suspicions of a leak at a biological weapons facility was indeed correct.

A much larger second attempt to address the lack of verification provisions in the treaty, by adding a legally binding compliance protocol, took place between 1994 and 2001. This attempt failed too. The US rejected the draft protocol on the grounds that it did not offer rigorous enough verification measures to detect clandestine bioweapons activities, but that it was invasive enough to compromise classified and proprietary information from the US biodefence programme and pharmaceutical industry. Several other states who also had concerns with the draft protocol were happy to hide behind the formal rejection by the U.S.

A legally binding mechanism with measures to verify compliance with the BWC is a long-term goal for the European Union. In the meantime, the BWC remains an arms control treaty whose provisions are notoriously difficult to verify, and one that provides very few traditional tools to carry out the process of verification and to make an informed and accurate verification judgment.

1968 · Negotiations begin

1969 · Nixon's elections opens a window of opportunity

1972 · Opened for signature

1975 · Entry into force

1980 · First review conference; Swedish proposal for Consultative Committee fails

1994–2001 · Negotiations on compliance protocol also fail

TREATY

Biological Weapons Convention

Effective 10 April 1972 Legally binding 0 Member States

The Biological Weapons Convention (BWC) is a treaty that prohibits the development, production, and stockpiling of biological and toxin weapons.

Current Adoption

AFG	AGO	ALB	AND	ARE	ARG	ARM	ATG	AUS	AUT	AZE	BDI
BEL	BEN	BFA	BGD	BGR	BHR	BHS	BIH	BLR	BLZ	BOL	BRA
BRB	BRN	BTN	BWA	CAF	CAN	CHE	CHL	CHN	CIV	CMR	COD
COG	COK	COL	COM	CPV	CRI	CUB	CYP	CZE	DEU	DJI	DMA
DNK	DOM	DZA	ECU	EGY	ERI	ESP	EST	ETH	FIN	FJI	FRA
FSM	GAB	GBR	GEO	GHA	GIN	GMB	GNB	GNQ	GRC	GRD	GTM
GUY	HND	HRV	HTI	HUN	IDN	IND	IRL	IRN	IRQ	ISL	ISR
ITA	JAM	JOR	JPN	KAZ	KEN	KGZ	KHM	KIR	KNA	KOR	KWT
LAO	LBN	LBR	LBY	LCA	LIE	LKA	LSO	LTU	LUX	LVA	MAR
MCO	MDA	MDG	MDV	MEX	MHL	MKD	MLI	MLT	MMR	MNE	MNG
MOZ	MRT	MUS	MWI	MYS	NAM	NER	NGA	NIC	NIU	NLD	NOR
NPL	NRU	NZL	OMN	PAK	PAN	PER	PHL	PLW	PNG	POL	PRK
PRT	PRY	PSE	QAT	ROU	RUS	RWA	SAU	SDN	SEN	SGP	SLB
SLE	SLV	SMR	SOM	SRB	SSD	STP	SUR	SVK	SVN	SWE	SWZ
SYC	SYR	TCD	TGO	THA	TJK	TKM	TLS	TON	TTO	TUN	TUR
TUV	TZA	UGA	UKR	URY	USA	UZB	VAT	VCT	VEN	VNM	VUT
WSM	YEM	ZAF	ZMB	ZWE							

■ Not adopted

Data: United Nations Treaty Collection

Cooperative Threat Reduction

The Cooperative Threat Reduction (CTR) Programme was established by the United States to provide former states of the USSR with assistance to destroy their unconventional weapons. The creation of the CTR Programme in 1991 was a historically rare innovation in international problem-solving

The initiators of the CTR Programme, Senators Sam Nunn and Richard Lugar, leaving the White House in November 1991 after briefing President George H. W. Bush on the Nunn-Lugar legislation
Wikimedia/US government

Prior to the early 1990s, states accomplished the reduction of arms through laboriously negotiated treaties such as the 1991 Strategic Arms Reduction Treaty or the 1990 Conventional Forces in Europe Treaty. Or they withdrew weapons unilaterally – usually in tandem with the introduction of improved versions of the weapons being retired.

The disintegration of the Soviet Union left several of the 15 successor states with major nuclear, chemical and biological weapons capabilities.However, they had limited resources to deal with these capabilities. The Cooperative Threat Reduction Programme was established by the US to provide these states with the necessary assistance to destroy their unconventional weapons [`https://globalbiodefense.com/2021/10/17/looking-back-at-the-biological-threat-reduction-program-through-the-decades/`], to ensure the security and safety of the weapons in storage, and to put verifiable safeguards in place against the proliferation of such weapons.

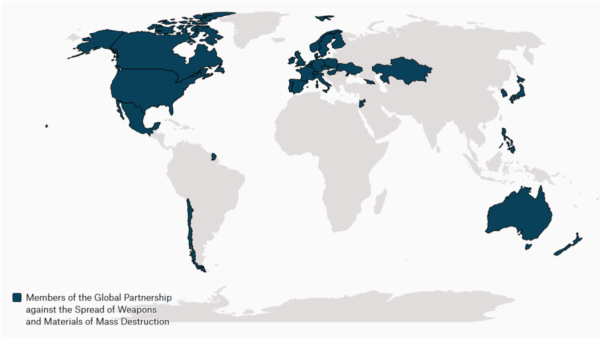
However, they had limited resources to deal with these capabilities. The Cooperative Threat Reduction Programme was established by the US to provide these states with the necessary assistance to destroy their unconventional weapons, to ensure the security and safety of the weapons in storage, and to put verifiable safeguards in place against the proliferation of such weapons.

The original focus of the CTR Programme was primarily to help Russia and the other former Soviet Union states meet their obligations under various arms control treaties. The Biological Weapons Convention prohibits biological weapons, but permits research to develop vaccines and therapeutics such as antibiotics.

Yet, the treaty offers little specific guidance about when such research, testing and other biological activities crosses over into the military realm. Since the BWC lacked the kind of concrete destroy-this/reduce-that/definitely-do-'x' definitions that you find in the nuclear accords, the biological mission for the CTR Programme was not as easily defined or executed in the early 1990s.

A big impetus for the biological CTR work was to enhance transparency and to get Moscow to open up about its bioweapons programme. The Russians did not see a downside to having CTR assistance at the Biopreparat facilities, but Ministry of Defence officials drew a red line and refused Western requests to visit the military biological facilities. The Ministry of Defence also blocked collaborative research grants to military scientists.

Despite this, biological CTR programming in the former Soviet Union was very successful. It upgraded the physical security of a number of facilities and trained staff in more rigorous safety and security practices. It enabled the destruction of Steponogorsk, the main BW production facility in the Soviet Union, and cleaned up much of the BW test site in the Aral Sea so that it posed less of a health threat to local populations, both human and animal – and, of course, the clean-up also limited access to potential BW agents. 'Brain drain prevention' grants, provided as part of CTR programming through the International Science and Technology Center, kept a lot of bioweaponeers in Russia in gainful employment so they did not have to look for other employers who might have exploited their expertise or access to various genetically engineered pathogens. The European Union and other Western states began adding funds and projects to the US CTR initiative. This was formalised in 2002 through the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction [https://www.gpwmd.com/].



Partners of the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction
https://www.gpwmd.com/partners

When the CTR Programme started, the funds available to tackle nuclear and chemical weapons threats far outstripped those to address the biological threat. Now, biological programmes are the largest part of the overall CTR budget, and the focus is on providing states with the capabilities to manage a disease outbreak, regardless of whether it is naturally occurring or deliberately introduced.

5. Scientific advances and the misuse of biology

Trends in bioscience

Petri dishes

Research in biology and biomedicine is essential to global health. It provides insights into disease agents, their transmission and how we can treat them. But these same insights can also be repurposed to intentionally cause harm. The biological risk landscape is becoming more complicated and more challenging. Some of the trends underpinning this development were underway before COVID-19, but the pandemic has significantly accelerated them.

There are five key trends that are relevant here:

- Increased numbers of maximum microbiological containment laboratories
- Growth in high-risk research, such as manipulations of potential pandemic pathogens
- Exacerbation of the risks posed by technological convergence
- Increased use of legal and illegal tools, such as industrial espionage, cybertheft, academic infiltration and early-stage investment to tap into bioinnovation ecosystems
- The rise of biological disinformation

These trends mean that in the near to medium term, it is technically possible for biological weapons to emerge that are capable of causing greater harm than before, that are more accessible to more people, that can be used for more precisely targeted attacks and that can be harder to attribute.

Emerging research areas with high misuse potential

Not all research is of concern. Various efforts have been made, particularly in the United States, to characterise biological research with particularly high misuse potential.

Examples of such 'dual-use research of concern' that have been identified include experiments that:

- manipulate the pathogenicity, virulence, host specificity, transmissibility, resistance to drugs or ability to overcome host immunity to pathogens;
- synthesise pathogens and toxins without cultivation of microorganisms or using other natural sources;
- identify new mechanisms to disrupt the healthy functioning of humans, animals and plants;
- develop novel means of delivering biological agents and toxins.

Starting in the early 2000s, several high-profile experiments raised concern amongst observers by:

- making mousepox more deadly (2001);
- synthesising poliovirus from scratch (2002);
- reconstructing the extinct 1918 flu virus (2005).

More recent examples highlight the risks of technological convergence. In 2022, for example, a drug development company which uses AI to search for new, non-toxic molecular structures that can be used as drugs, demonstrated how easy it was to reprogramme its algorithm to actively search for toxic molecules [`https://www.nature.com/articles/s42256-022-00465-9`]. The result was an AI-trained algorithm that identified hundreds of new compounds even more toxic than known chemical warfare agents.

As a consequence, entire fields of biological research are now raising concerns. These include:

- **'gain-of-function'** studies, where potentially pandemic pathogens are artificially mutated and 'enhanced to create even more potent strains of some of the world's deadliest diseases;
- **synthetic biology,** which aims to engineer biology and which is likely to make it possible to create dangerous viruses from scratch in the near future;
- **neurobiology,** which may improve the operational performance of troops through neuropharmacological agents that enhance functions such as perception, attention, learning, memory, language, thinking, planning and decision-making; or which may degrade enemy performance through incapacitating biochemical agents or so-called 'non-lethal' weapons.

Security risks

There are three principal scenarios the security community has concerns about:

1. Under the guise of legitimate research, highly skilled and trained biologists use their knowledge to create biological agents or genetic constructs for illegitimate ends.
2. Militaries or state-sponsored groups of states exploit legitimate scientific advances for hostile purposes.
3. Increases in legitimate and sophisticated life sciences and life science infrastructures increase national capacities to threaten or carry out a biological attack.

Today, responsible science and bioinnovation is as important as ever and it is widely recognised that scientists, and especially scientists doing high-risk life sciences research where outcomes could – accidentally, inadvertently or intentionally – potentially significantly impact society, have a professional obligation to engage.

In a Bulletin of Atomic Scientists article titled 'Scientific blinders: learning from the moral failings of Nazi physicists' [https://thebulletin.org/2019/07/scientific-blinders/], Talia Weiss writes:

> Scientists and engineers […] today […] may feel they have little in common with physicists working in the service of the German government during WWII. […] Yet researchers working on military and cutting-edge technologies are confronting the same questions that faced nuclear physicists under the Third Reich: As scientists, how can we avoid making (or stumbling into) decisions that do more harm than good? And when is it our responsibility to question, object to, or withdraw from a research project?
>
> Talia Weiss in a Bulletin of Atomic Scientists article titled 'Scientific blinders: learning from the moral failings of Nazi physicists'

These are questions every responsible scientist must ask him or herself.

The role of data and AI

Biological data is becoming increasingly digitised and collated in large datasets. Statistical methods, algorithms, machine learning and computational power are significantly changing how that genomic data is analysed, both in terms of how it is classified and in terms of how it is used to make predictions. What are some of the security risks of these developments?

The integration of AI and machine learning into biology opens up new possibilities for understanding how genetic differences shape the development of living organisms, including ourselves. It also opens up new possibilities for understanding how these differences make us, and the rest of the living world, susceptible to disease, and this comes with risks.

For example, we can use AI and the advanced pattern recognition it offers to predict effective enhancement of pathogens that make them even more dangerous. Artificial intelligence could make it easier to design bacteria and viruses with enhanced pathogenicity, or with expanded host ranges. It could also make it easier to design pathogens with altered transmission routes, ones that are resistant to available counter-measures or that have the ability to evade an immune system response. Artificial intelligence can also be used to predict and design novel pathogens that never existed before, pathogens tailored to target mechanisms critical in the immune system or the microbiome, for example. And AI could be used as a means to predict and design new toxic compounds or new toxic proteins such as ricin.

Another way in which AI could increase risks in the life sciences is by identifying key genetic components of a disease manifestation and enabling manipulation. Or it could provide insight into the susceptibility of a population, or subpopulations, to particular diseases – potentially allowing more targeted biological weapons focused on genetic groups.

Large language models, or chatbots, pose yet another type of risk. The first bio-focused chatbot, or biomedical chatbot, BioGPT, was released by Microsoft in January 2023. Trained on millions of biomedical research articles, it aims to support biologists, life scientists and clinicians in various advanced research scenarios, and could, for example, help to develop new drugs more quickly. By comparing millions of clinical cases, it could also, for instance, help to identify the best medical treatment for each patient.

But these opportunities are also accompanied by biosecurity risks. Chatbots increase accessibility to existing knowledge and capabilities, and as such may lower the barriers to biological misuse. They can also identify specific avenues to biological misuse. They can generate ideas and help plan how to attain and modify pathogens, and they can help plan how to disseminate biological agents.

There are plenty of risks, but at the same time, there are also significant limitations to AI and machine learning in the life sciences. So, while AI and deep learning will significantly impact biology and life sciences, we are still at an early stage and need to better understand potential uses, and limitations, of AI in these fields.

Biological disinformation

Disinformation is a set of carefully constructed false messages leaked to an adversary's communication system in order to deceive the decision-making elite, specific communities or publics. There are significant geostrategic motives for disinformation campaigns, and these have been around for a long time.

Disinformation is most influential when spread through traditional media or endorsed by groups and individuals with high levels of community respect. Depending on the country, this could be political or religious leaders, judges, members of the military or other trusted members of the target community. The digital age has meant that other routes to reach audiences have become increasingly accessible. Social media, amplified by bots and trolls, has enabled disinformation campaigns to spread throughout global audiences cheaply, remotely and in real time.

Some of the consequences of deliberately fanning false narratives are that it:

1. foments and exacerbates divisive political fissures;
2. erodes trust between citizens and elected officials and their institutions;
3. popularises foreign government policy agendas and narratives;
4. creates general distrust or confusion over information sources;
5. undermines citizen confidence in democratic governance.

6. Summary and Further Reading

Summary

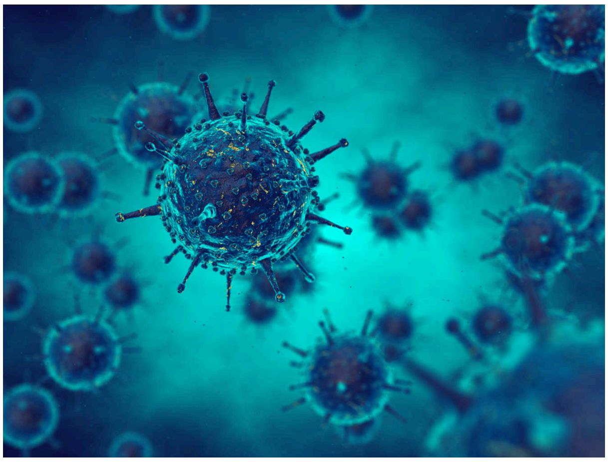


Illustration of a virus
nobeastsofierce/Adobe Stock https://stock.adobe.com/de/search?creator_id=201734807&filters%5Bcontent_type%3Aphoto

This learning unit has provided an overview of several critical aspects of biological weapons. It covered the key biological agents and delivery systems used in these weapons, detailing their mechanisms and potential impacts. The unit examined the biological weapons programmes of Japan, the United States and the Soviet Union over the 20th century, offering historical context and insights into their development and deployment. Additionally, it assessed the bioterrorism threat and various government responses, highlighting the measures taken to counter these dangers. The international legal framework banning biological weapons and the main challenges of biological disarmament and non-proliferation were also explored, emphasising the ongoing efforts to regulate and eliminate these threats. Lastly, the unit addressed scientific research areas with high misuse potential and the impact of emerging technologies on the threat of biological weapons, as well as efforts to promote responsible science to mitigate these risks.

Reading

Further reflections from the authors: [https://www.nature.com/articles/s42256-022-00511-6]

A podcast with some of the authors: [https://www.lawfaremedia.org/article/lawfare-podcast-sean-ekins-and-filippa-lentzos-teachable-moment-dual-use]

www.BioWeaponsDisinformationMonitor.com [https://www.bioweaponsdisinformationmonitor.com]

Further reading and relevant external links

Lentzos, Filippa/Bowsher, Gemma. 2023. “Climate or conflict? Legionnaire’s outbreak in Poland raises questions” [https://thebulletin.org/2023/10/climate-or-conflict-legionnaires-outbreak-in-poland-raises-questions/], in: *The Bulletin of Atomic Scientists*, 5 October.

Lentzos, Filippa/Francese, Tancredi. 2023. “Biological Weapons Convention: In the crosshairs of geopolitical tensions”, in: *Georgetown Journal of International Affairs*, Part 1 [https://gjia.georgetown.edu/2023/05/17/biological-weapons-convention-in-the-crosshairs-of-geopolitical-tensions-part-1/]; Part 2 [https://gjia.georgetown.edu/2023/05/17/biological-weapons-convention-in-the-crosshairs-of-geopolitical-tensions-part-2/]

King’s College London Global BioLabs Report 2023 [https://www.kcl.ac.uk/warstudies/assets/global-biolabs-report-2023.pdf], March 2023

Lentzos, Filippa. 2022. “Biological weapons are a thing of the past…or are they?” [https://www.liebertpub.com/doi/10.1089/genbio.2022.29048.fle], in: *GEN Biotechnology* 1 (4): 355–9.

Lentzos, Filippa. 2022. “AI and biological weapons” [https://link.springer.com/chapter/10.1007/978-3-031-11043-6_7], in: Schöring Niklas/ Reinhold, Thomas (eds.): *Armament, Arms Control and Artificial Intelligence: The Janus-faced nature of machine learning in the military realm.* Springer.

Lentzos, Filippa. 2020. “How to protect the world from ultra-targeted biological weapons” [https://thebulletin.org/premium/2020-12/how-to-protect-the-world-from-ultra-targeted-biological-weapons/], in: *The Bulletin of Atomic Scientists* 76 (6): 302–8.

Lentzos, Filippa. 2016. *Biological Threats in the 21st Century: The Politics, People, Science and Historical Roots.* Imperial College Press.

Terms

Geneva Protocol
The Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, commonly known as the Geneva Protocol, is a treaty prohibiting the use of chemical and biological weapons in war.