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Bioterrorism and Global Politics: Strengthening International Law for Emerging Biological Threats

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Abstract
Bioterrorism has re-emerged as a critical global security challenge amid rapid advances in biotechnology, artificial intelligence, and synthetic biology, compounded by geopolitical fragmentation and lessons learned from the COVID-19 pandemic. This paper examines the historical evolution of biological warfare, tracing its progression from ancient and medieval practices to highly industrialized state-sponsored programs of the twentieth century. It further analyzes how contemporary dual-use technologies, particularly CRISPR-Cas systems and AI-enabled biological design, have lowered barriers to misuse by both state and non-state actors. The study critically evaluates existing international legal instruments, with particular emphasis on the Biological Weapons Convention (BWC), highlighting persistent deficiencies such as the absence of verification mechanisms, limited institutional capacity, and uneven implementation. Recent legal and policy developments, including amendments to the International Health Regulations, regional initiatives by African States Parties, and proposals for an International Agency for Biological Safety, are assessed for their potential to modernize global biosecurity governance. The paper argues that effective prevention of emerging biological threats requires an integrated, data-driven, and multilateral approach that balances security, scientific innovation, and equitable access to biotechnology. Strengthening international law through institutional reform, responsible innovation, and enhanced cooperation is essential to address the evolving nature of bioterrorism in the twenty-first century.

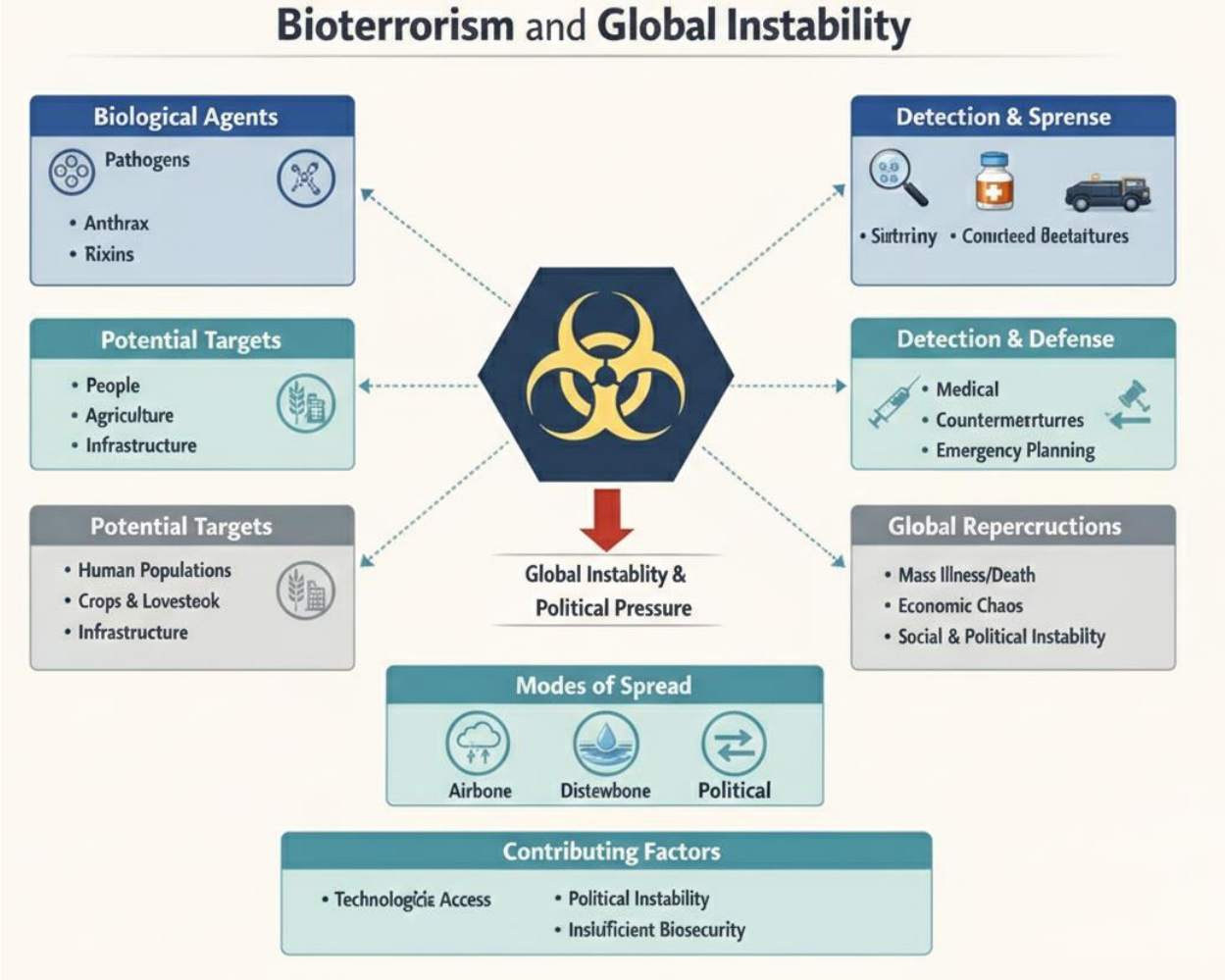
Keywords Bioterrorism; Biological Weapons Convention; Biosecurity; Synthetic Biology; Artificial Intelligence; International Law; Dual-Use Research; Global Health Security

1. Introduction

The convergence of rapid biotechnological innovation, shifting geopolitical alliances, and the systemic vulnerabilities exposed by the COVID-19 pandemic has elevated the threat of bioterrorism to the forefront of the global security agenda. As the international community observes the fiftieth anniversary of the Biological Weapons Convention (BWC) in 2025 and the centenary of the 1925 Geneva Protocol, the landscape of biological risk is undergoing a fundamental transformation (Arms Control Association, 2024). Bioterrorism, defined as the intentional release of biological agents or toxins to harm or kill humans, animals, or plants to further political or social objectives, represents a unique challenge to the traditional state-centric model of international law (INTERPOL, 2017). This report

provides an exhaustive analysis of the historical evolution of biological warfare, the dual-use challenges posed by emerging technologies such as artificial intelligence and synthetic biology, and the critical need to strengthen the international legal framework to mitigate these unconventional threats in a fragmented geopolitical environment (African States Parties, 2025)

Figure 1: The Ecosystem of Bioterrorism: Drivers, Dynamics, and Pathways to Global Instability



2. The Historical Trajectory of Biological Exploitation

The use of disease as a weapon is an ancient phenomenon that predates modern scientific understanding of pathogens. Historically, biological warfare has been utilized for over 2,000 years, evolving from crude methods of contamination to sophisticated state-sponsored programs (Umar, 2024). The earliest documented instances involved the Hittites, who weakened their enemies by sending rams possibly infected with tularemia into opposing territories. In the 4th century BC, Scythian archers dipped their arrows in mixtures of decomposed human blood and animal manure, creating a primitive but lethal form of biological attack (Carus, 2017).

2.1 Medieval and Early Modern Precedents

The medieval period witnessed a more strategic application of biological contagion. During the 1346 siege of Caffa, Tartar forces catapulted the cadavers of plague victims into the city, an event that

contemporary notary Gabriel de Mussis linked to the subsequent spread of the Black Death across Europe (Hatami, 2025). While the epidemiology of the 14th-century plague pandemic was likely more complex than a single event, the siege of Caffa remains a potent historical reminder of the catastrophic potential when diseases are harnessed as instruments of war (Koulesser, 2020).

By the 18th and 19th centuries, the use of biological agents became more frequent in colonial conflicts (Biselli et al., 2022). The intentional spread of smallpox among indigenous populations through contaminated blankets and the pollution of water wells with human and animal carcasses were common strategies used to weaken resistance during various European conflicts and historical wars (Zanandrea, 2021).

2.2 The Industrialization of State Programs

The development of modern microbiology in the 19th century allowed for the isolation and mass production of specific pathogens, leading to the industrialization of biological warfare in the 20th century (Buchholz et al ., 2013). Germany initiated a campaign of biological sabotage during World War I, targeting livestock and animal transport to disrupt Allied logistics. This was followed by the most extensive use of biological weapons in history by Japan's Unit 731 during the 1930s and World War II. (Nikolakakis et al., 2024) Japanese attacks in China utilized plague-infected fleas and contaminated water supplies, resulting in the deaths of approximately 10,000 Chinese civilians and unintentionally killing over 1,700 Japanese troops who were inadequately prepared for the environmental persistence of the agents (Paoli et al., 2018).

Table 1. Significant Events and Programs in the History of Biological Warfare

Period	Event/Program	Primary Agent(s)	Impact/Outcome
14th Century BC	Hittite-Ram Incidents	Tularemia	Weakening of enemy forces via livestock
1346	Siege of Caffa	Plague	Introduction of disease to Genoese refugees
1915–1918	WWI German Sabotage	Glanders, Anthrax	Disruption of livestock logistics
1937–1945	Japan Unit 731	Plague, Cholera, Anthrax	Massive civilian casualties in China
1942–1969	US Offensive Program	Anthrax, Botulinum	Development of aerosolization techniques
1970s–1990s	Soviet Biopreparat	Smallpox, Anthrax	Covert network of over 30,000 personnel

The Cold War marked the zenith of strategic biological programs. The United States operated an offensive program until 1969, achieving significant technical advances in the concentration, storage, and aerosolization of microorganisms at facilities like Fort Detrick (Zilinskas, 2016). This program included a "Special Operations" division that explored clandestine dissemination techniques, such as using car tailpipes to disseminate anthrax spores (Vogel et al., 2025). Simultaneously, the Soviet Union constructed a vast, clandestine network known as Biopreparat. Despite signing the 1972 BWC, the USSR expanded its capabilities to produce tons of weaponized pathogens, surpassing the U.S. program in scale and technological sophistication (WMD Commission, 2025).

3. Emerging Technological Threats and the Dual-Use Dilemma

In the 21st century, the threat landscape has shifted from massive state programs to the "democratization" of biotechnology. The convergence of synthetic biology, gene editing, and artificial intelligence has lowered the barriers for non-state actors and rogue states to develop biological agents (Del Castello & Willis, 2025).

3.1 The CRISPR Revolution and Genetic Manipulation

CRISPR-Cas9 technology has fundamentally altered the risks associated with pathogen modification. Described as the "command F" of genetic engineering, CRISPR allows for the precise targeting and editing of genetic code in any organism (Patrick & Barton, 2024). This capability introduces unprecedented dangers, as it can be used to increase the transmissibility of viruses, enhance their lethality, or even tailor pathogens to target specific genetic profiles (Gancheva, 2024). The theoretical potential of creating entirely new organisms or modifying existing ones to evade vaccines and medical countermeasures is now a practical reality (Meganck et al., 2021).

3.2 Artificial Intelligence and De Novo Pathogen Design

Artificial Intelligence (AI) serves as a "significant capability uplift" in the design-build-test-learn cycle of biotechnology. Generative AI models can now predict protein structures and viral phenotypes with high accuracy, potentially guiding the creation of de novo viruses that do not exist in nature (Bhargava et al., 2025). The use of unsupervised protein language models, such as Evolutionary Scale Modeling (ESM), allows researchers to predict viral escape the ability of a pathogen to evade host immune responses and infectivity by analyzing how mutations affect protein interactions (National Academies of Sciences, Engineering, and Medicine, 2024).

Table 2. AI Biological Models and Their Biosecurity Risk Implications

AI Biological Model	Core Functionality	Biosecurity Risk Implication
ProteinMPNN	Redesigning known toxins	Bypassing DNA sequence screening protocols
ESM (Large Language)	Viral evolution modeling	Predicting antibody escape and infectivity
Deep Mutational Scanning	High-throughput data integration	Accelerating the optimization of virulence
Predictive ML Models	Toxicity generation	Generating novel toxic chemical/biological structures

The primary risk associated with AI is its ability to bypass traditional biosecurity guardrails. For example, AI tools can redesign known toxins using different amino acid building blocks, maintaining the structural lethality of the parent toxin while limiting sequence homology, which effectively allows the synthesized DNA to slip past current screening software (Beyer et al., 2025).

3.3 Bottlenecks and Physical Barriers

Despite the rapid advancement of design capabilities, the physical production of a biological agent remains a critical bottleneck. Biological systems are inherently chaotic, and viral evolution is subject to a "butterfly effect" where small mutations can lead to unpredictable outcomes in fitness and virulence (Tang et al., 2021). Furthermore, the requirement for resource-intensive experimental validation in "wet labs" currently prevents small, non-specialized groups from producing high-impact bioweapons (Wang et al., 2022). However, the proliferation of automated science platforms, cloud labs, and benchtop DNA

synthesizers is expected to erode these barriers over the next decade (Del Castello & Willis, 2025).

4. The Current International Legal Framework: Deficiencies and Stagnation

The international community relies on a "regime complex" of treaties and organizations to govern biological risks, but this architecture is increasingly viewed as inadequate for the challenges of 2025 (Patrick & Barton, 2024).

4.1 The Biological Weapons Convention (BWC)

The 1972 BWC remains the foundational treaty, prohibiting the development, production, acquisition, and stockpiling of biological agents for non-peaceful purposes (African States Parties, 2025). However, the convention suffers from several structural weaknesses. Most notably, it lacks a formal verification mechanism to monitor compliance (Revill, 2023). Unlike the Chemical Weapons Convention, the BWC does not mandate on-site inspections or declarations of biological facilities. Efforts to negotiate a verification protocol in the late 1990s collapsed in 2001, leaving the convention dependent on voluntary Confidence-Building Measures (CBMs) that are often incomplete or omitted by many states parties (African States Parties, 2025; Sindhushree et al., 2025).

Furthermore, the BWC's Implementation Support Unit (ISU) is chronically under-resourced, with a staff of only a few individuals and a budget that is insufficient to provide robust technical assistance to its 189 members (Arms Control Association, 2024). This lack of institutional support hinders the treaty's ability to adapt to rapid scientific changes (Kazakhstan Ministry of Foreign Affairs, 2021).

4.2 The Role of UNSCR 1540 and Other Frameworks

In the absence of BWC verification, United Nations Security Council Resolution 1540 (2004) has become a vital tool. It requires all states to implement domestic controls to prevent non-state actors from acquiring biological, chemical, or nuclear weapons (International Science Council, 2025). Additionally, the "Australia Group" functions as an informal multilateral export control regime, aiming to prevent the proliferation of dual-use materials and equipment (Pandiyan et al., 2025).

However, the governance of emerging biotechnologies remains difficult within these traditional bounds (Atlantic Council, 2025). The "dual-use" nature of life science research where the same technologies used to develop lifesaving vaccines can be used to create pathogens makes it impossible to treat verification as a simple binary assessment of compliance (Sandbrink, 2023).

5. 2024-2025 Legal Innovations and Policy Initiatives

The 50th anniversary of the BWC has spurred a flurry of activity aimed at modernizing the global biosecurity framework. The current focus is on institutional strengthening and the integration of public health with national security (Lee et al., 2023).

5.1 Amendments to the International Health Regulations (IHR)

The World Health Organization (WHO) achieved a historic milestone in June 2024 with the adoption of amendments to the International Health Regulations, which entered into force in September 2025 (World Health Organization, 2024). These amendments introduced a new level of global alert: the "Pandemic Emergency". This designation triggers stronger international collaboration when a health risk escalates beyond a Public Health Emergency of International Concern (PHEIC), emphasizing equitable access to medical products and sustainable financing for developing countries (Pagotto et al., 2024).

Table 3. Key 2024 Amendments to the International Health Regulations

Key IHR Amendment	Purpose	Biosecurity Implication
Pandemic Emergency Tier	Higher alert for extreme outbreaks	Faster mobilization of international response
National IHR Authorities	Intra-governmental coordination	Moving beyond a purely health-centric response
Art. 13 (Equitable Access)	Mandatory facilitation of medical products	Reducing global disparity in pandemic response
Coordinating Financial Mechanism	Sustainable funding for LMICs	Strengthening the "weak links" in global surveillance

The shift from a purely technical tool to a regulatory and political document reflects the lessons learned from the COVID-19 pandemic, emphasizing that biosecurity is a shared responsibility that requires a "One Health" approach (INTERPOL, 2017).

5.2 The African States Parties Declaration (2025)

In November 2025, the first African Conference on the BWC was held in Nairobi, Kenya. Representatives from African States Parties reaffirmed their commitment to a world free of biological weapons and called for a coordinated approach to biological risk prevention that aligns with the African Union's Agenda 2063 (African States Parties, 2025). The declaration emphasized the importance of Article X of the BWC, which advocates for international cooperation and the peaceful use of biotechnology, while simultaneously stressing the need for effective national export controls (Tanaka, 2023).

5.3 The Kazakhstan IABS Proposal

A significant proposal currently debated in the BWC Working Group is Kazakhstan's initiative to establish an International Agency for Biological Safety (IABS) (Kazakhstan Ministry of Foreign Affairs, 2021). Modeled after the International Atomic Energy Agency (IAEA), the IABS would serve as a specialized body accountable to the UN Security Council, with mandated powers to conduct inspections and promote biological research and development for peaceful purposes (Lentzos, 2025).
Proponents argue that the IABS would fill a critical gap in the disarmament architecture, providing the BWC with a compact, expert staff to ensure predictability and transparency (Yeh et al., 2021). However, the proposal faces challenges regarding its estimated costs noting the IAEA's regular budget is hundreds of millions of Euros and concerns that it might create parallel processes or duplicate WHO functions (Peintner et al., 2021).

6. Geopolitical Tensions and the Multilateral Impasse

The effort to strengthen international law is complicated by severe geopolitical friction, particularly between the United States, Russia, and China (Orford, 2021).

6.1 Allegations and Disinformation in the Ukraine Conflict

The Biological Weapons Convention has become a forum for geopolitical tensions arising from the war in Ukraine. Russia has repeatedly charged the United States and Ukraine with violating the BWC through clandestine biological activities (Revill, 2023). While these allegations have not been proven and were refuted by the international community, they have led to a "deep freeze" in diplomatic cooperation (Sundelson et al., 2025). These claims represent a fundamental clash of worldviews that threatens to erode the existing non-proliferation architecture (Becker-Jakob, 2024).

6.2 The US-China Strategic Competition

China has elevated biotechnology to a strategic national priority, with military strategists describing biology as a "new domain of warfare". The U.S. has responded by imposing sanctions on Chinese dual-use suppliers and emphasizing the need for robust AI guardrails (Moore, 2020). This competition makes consensus on verification regimes extremely difficult, as states are reluctant to allow inspections that might compromise their economic competitiveness or strategic biotechnology advantages (Wu 2020).

6.3 The Path of Compartmentalization

Despite these tensions, there are "promising cracks" in the deadlock. Some analysts suggest a strategy of "compartmentalization" separating existential risks like biological weapons from broader geopolitical conflicts. A modest agreement on core principles for verification and the use of AI in Geneva could generate the goodwill necessary for future negotiations (Harzheim, 2020).

7. Operational Response: Law Enforcement and Attribution

When preventative law fails, the international community relies on law enforcement and scientific attribution to respond to bioterrorism (Nwakoby et al., 2025)

7.1 INTERPOL's Global Biosecurity Enhancement Programme

INTERPOL's Bioterrorism Prevention Unit (BTPU) provides critical support to national law enforcement through police data management and specialized expertise. The BTPU's BioTracker tool serves as an early warning system, analyzing criminal intelligence to identify emerging threats and potential individuals of interest (Danelyan et al., 2022). INTERPOL also promotes a "One Health" approach, coordinating between health and security sectors to manage biological incidents whether they are natural, accidental, or deliberate in origin (INTERPOL, 2017).

7.2 Microbial Forensics and the Challenge of Attribution

Attribution determining who is responsible for a biological event is the primary policy tool for deterrence. Microbial forensics is the foundational science used to trace a pathogen back to its source, as seen in the 2001 Anthrax case (Amerithrax), where the FBI used genomic data to link the spores to a specific laboratory (Center for Security Studies, 2016).

However, the field faces significant hurdles in 2025:

- Database Gaps: Unlike human DNA databases, there is no comprehensive global repository for microorganisms (Dias et al., 2020).
- Scientific Uncertainty: Genetic similarity may only infer a common lineage rather than a unique identity, making absolute attribution difficult (Stevens et al., 2017).
- Legal Standards: Forensic evidence must meet both scientific and legal scrutiny to be admissible in the "court of public opinion" and in formal legal proceedings (Martí et al., 2025).

7.3 DNA Synthesis Screening and IBBIS

A critical step in strengthening biosecurity is the global oversight of the DNA synthesis industry. The International Biosecurity and Biosafety Initiative for Science (IBBIS) has launched a Global DNA Synthesis Map to inform policy on safeguarding emerging biotechnologies (International Biosecurity and Biosafety Initiative for Science, 2025). Establishing a universal norm for screening synthetic DNA orders is essential to prevent the unauthorized creation of regulated or extinct pathogens (Kane et al.,

2024).

8. Deep Research Insights: The Second and Third-Order Implications

8.1 The Erosion of Sovereignty via Interdependence

The 2024 IHR amendments and the proposed WHO Pandemic Agreement represent a significant shift in global health law, moving from technical tools to regulatory documents. This indicates a growing recognition that national sovereignty cannot be maintained in isolation from an epidemiologically interdependent world (Patrick & Barton, 2024). The requirement to establish National IHR Authorities suggests that future biosecurity will be managed by "whole-of-government" architectures that blur the lines between civilian and military sectors (World Health Organization, 2024).

8.2 The "Sovereign AI" Dilemma in Disarmament

As AI becomes a general-purpose technology, the military and civilian sectors are becoming inextricably linked (Trapp, 2024). For the BWC, this means that traditional state-focused verification is insufficient; a new model must be developed that incorporates private-sector transparency and "denial-based" approaches to prevent the misuse of widely available AI tools (Schmidt et al., 2021).

8.3 The Paradox of Article X

A recurring theme in BWC negotiations is the tension between security and economic development. Developing nations view stringent biosecurity controls as a potential barrier to the legitimate transfer of scientific knowledge under "Article X" (Houser, 2023). Unless the international community can create a mechanism that facilitates cooperation and capacity building while maintaining security perhaps through the IABS model the BWC will likely remain in a state of political stalemate (He, 2022).

9. Synthesis and Recommendations for Global Biosecurity (2025–2030)

The analysis of the current threat and legal landscape leads to the following synthesized conclusions for policy leaders and the international security community (Tasker et al., 2025).

9.1 Establishing a Nuanced Verification Regime

The international community must move away from binary compliance assessments. A 21st-century verification framework should be data-driven, triangulating information from BWC CBMs, WHO IHR reports, and other monitoring tools (Wyandt, 2024). This framework should focus on:

- Building Confidence: Establishing trust through voluntary peer reviews and institutionalized information sharing (Odhiambo, 2020).
- Deterrence by Denial: Reducing incentives for misuse by strengthening laboratory safety standards and DNA synthesis screening worldwide (Privette et al.,2020).
- Trigger-Based Detection: Establishing mechanisms to investigate specific "trigger scenarios" where non-compliance is suspected (Robertson, 2019).

9.2 Institutionalizing the BWC

The BWC cannot continue to operate as a "treaty without a home." Whether through the expansion of the ISU or the creation of the IABS, a dedicated implementation body is required to manage a registry of scientific discoveries, provide technical assistance, and conduct investigative missions. This body must be politically independent and technically proficient (Lentzos, 2025).

9.3 Promoting "Responsible Innovation"

The scientific community must be a primary partner in biosecurity governance. This includes:

- Biosecurity Education: Integrating biosecurity awareness into life science curricula to foster a culture of responsibility among researchers ((Peintner et al., 2021).
- AI Guardrails: Developing international standards for AI developers to prevent their models from being used to design pathogens or bypass DNA screening (Tang et al., 2021).
- The INTENT Framework: Adopting tiered-risk assessments for biological facilities to evaluate conduct without the need for proof of hostile intent (Bijl et al., 2025).

10. Conclusion

The evolving nature of bioterrorism reflects a convergence of historical precedent, technological acceleration, and geopolitical tension. While the prohibition of biological weapons is firmly established in international law, existing governance frameworks, particularly the Biological Weapons Convention, remain structurally ill-equipped to address contemporary threats driven by synthetic biology and artificial intelligence. The absence of verification mechanisms, limited institutional capacity, and politicization of compliance processes continue to undermine global confidence and deterrence. Recent legal innovations, including the amended International Health Regulations and emerging regional and institutional initiatives, signal a gradual shift toward integrating public health, security, and scientific governance. However, these measures alone are insufficient without sustained political commitment and meaningful institutional reform. The analysis demonstrates that future biosecurity cannot rely on binary notions of compliance but must instead adopt nuanced, risk-based, and data-driven verification models supported by international cooperation and transparency. Ultimately, strengthening international law against bioterrorism requires institutionalizing the BWC, embedding responsible innovation within scientific practice, and fostering trust among states in an increasingly fragmented global order. Without coordinated action that reconciles security imperatives with the peaceful advancement of biotechnology, the international community risks remaining reactive rather than preventive in the face of emerging biological threats.

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