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The Biological Weapons Convention at 50

Perspectives from Asia and the Pacific

United Nations

OFFICE FOR DISARMAMENT AFFAIRS
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GUIDE TO THE USER

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Foreword by the Republic of Korea

The Biological Weapons Convention (BWC) stands as a landmark achievement in the history of disarmament. For half a century, it has embodied the international community's collective determination to ensure that advances in life sciences are never turned to destructive uses. As we commemorate the fiftieth anniversary of its entry into force in 2025, the Convention continues to serve as both a moral compass and a legal foundation for global efforts to prevent the development, production, and use of biological weapons.

The security landscape surrounding the BWC is, however, becoming increasingly complex. Rapid advances in biotechnology — accelerated by artificial intelligence and automation — have made it easier to design and manipulate highly dangerous pathogens. What once required vast resources and State-level capacity can now be achieved in small laboratories with minimal oversight. The wide availability and inherent dual-use nature of these technologies are aggravating evolving biological risks. Persistent proliferation concerns, coupled with the deterioration of the international security environment, represent grave challenges to the global non-proliferation regime — and a stark reminder that the norms of restraint built over decades cannot be taken for granted.

In light of these challenges, the Republic of Korea has been, and will remain, a strong and consistent supporter of the BWC. Since joining the Convention in 1987, the Republic of Korea has translated its commitment into concrete action through range of initiatives. These include the annual submission of confidence-building measure (CBM) reports, participation in the Global Partnership[1] and the Global Health Security Agenda (GHSA), and sustained contributions to capacity-building in biosafety and biosecurity. The Republic of Korea is also actively engaged in the BWC Working Group established by the ninth Review Conference,[2] working with partners to advance transparency, preparedness, and verification measures that enhance the Convention's effectiveness.

The twenty-third Republic of Korea-United Nations Joint Conference on Disarmament and Non-Proliferation Issues, held in Seoul in November 2024 under the theme "The BWC at 50: Strengthening Global Biological Security in a Rapidly Evolving Technological Landscape", provided a timely opportunity to reflect on these challenges and to explore practical pathways for reinforcing the BWC. Participants from governments, academia and international organizations engaged in in-depth discussions on science and technology review, verification, and international cooperation, and the exchanges reaffirmed that progress on biosecurity requires not only strong norms and institutions, but also adaptability, innovation, and shared responsibility among all States parties.

1 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction.
2 The Working Group on the Strengthening of the Biological Weapons Convention

Strengthening the Convention is not a matter of choice but a necessity in an era defined by rapid technological transformation and persistent global insecurity. The Republic of Korea will continue to work closely with the United Nations and the international community to ensure that progress in science and technology remains a force for peace, stability and human dignity — not a source of fear or division. If the past 50 years were about prohibiting what we must not do, let the next 50 be about empowering what we must do to protect life itself.

YOUN Jong Kwon
Director-General for International Security
Ministry of Foreign Affairs, Republic of Korea

Foreword by the United Nations High Representative for Disarmament Affairs

As we commemorate the fiftieth anniversary of the Biological Weapons Convention (BWC), we reflect upon one of the most significant achievements in the history of multilateral disarmament. Adopted in 1972 and entering into force in 1975, the Convention was the first multilateral treaty to ban an entire category of weapons of mass destruction. In doing so, it enshrined a simple yet profound principle: that the life sciences must only ever be used for peaceful purposes and for the benefit of humanity.

Over the past five decades, the BWC has served as the cornerstone of global efforts to prevent the development, production and use of biological weapons. It has established a powerful international norm against the weaponization of biology and has near-universal membership — an achievement that reflects the shared conviction of the international community that biology must never be used to harm. Through this enduring commitment, States parties have helped to safeguard global peace and security, while enabling the peaceful development of science and technology for health, agriculture and sustainable growth.

Yet, even as we celebrate this milestone, we must acknowledge that the landscape of biological risk has changed profoundly since the Convention was adopted. Advances in biotechnology, synthetic biology, artificial intelligence and related fields are revolutionizing the life sciences at an unprecedented pace. The same discoveries that offer immense benefits for humanity also create new challenges for biosecurity, safety and verification. The COVID-19 pandemic further underscored how biological events can destabilize societies, disrupt economies and test international solidarity.

These realities highlight the continued and growing importance of the BWC. They call upon all States parties to reaffirm their commitment to strengthening the Convention's implementation and ensuring that it remains fit for purpose in a rapidly changing scientific and geopolitical environment. The establishment of the Working Group on the Strengthening of the Biological Weapons Convention, with its mandate to identify and develop concrete measures to reinforce the Convention, marks a historic opportunity. It offers a platform to advance progress on key priorities, including national implementation, scientific and technological review, assistance and response, and international cooperation under article X.

This publication brings together a wealth of perspectives from across the Asia-Pacific region — one of the most dynamic and scientifically innovative regions in the world. The authors, representing governments, academia, and civil society, provide valuable insights into national experiences, regional cooperation, and

the evolving interface between science, technology, and security. Their contributions underscore both the diversity and the shared purpose of the region's engagement with the BWC.

The Asia-Pacific region has long been at the forefront of public health innovation and capacity-building. Its experiences in addressing infectious disease outbreaks, developing biosafety and biosecurity frameworks, and advancing regional cooperation through mechanisms such as the Association of Southeast Asian Nations (ASEAN) offer important lessons for strengthening the Convention globally. Ensuring that the voices and perspectives of this region continue to shape international biosecurity governance will be essential to the BWC's future success.

The United Nations Office for Disarmament Affairs, through the Biological Weapons Convention Implementation Support Unit in Geneva and its Regional Centres, including the United Nations Regional Centre for Peace and Disarmament in Asia and the Pacific (UNRCPD), remains fully committed to supporting States parties in implementing and universalizing the Convention. By promoting dialogue, fostering partnerships, and building capacity, we aim to ensure that all Member States can effectively prevent the misuse of biology and harness scientific advances responsibly.

The Biological Weapons Convention at 50 is both a moment of reflection and a call for renewed action. As we look to the next half century, we must work together to ensure that this vital treaty continues to uphold its founding vision: a world in which science and technology are used solely for peace, development, and the preservation of life.

Izumi Nakamitsu
Under-Secretary-General and High Representative for Disarmament Affairs
United Nations

Co-Editors' note

The Biological Weapons Convention (BWC), now marking its fiftieth anniversary, stands as a milestone in the history of arms control and multilateral cooperation. By prohibiting an entire category of weapons of mass destruction, the Convention has anchored the global consensus that biology must serve only peaceful purposes. Over the past five decades, it has established a strong normative barrier against the weaponization of life sciences, achieved near-universal membership, and provided a platform for dialogue and cooperation among States Parties. Yet its limitations — most notably the absence of a verification system, uneven national implementation, and difficulties in keeping pace with rapid advances in science and technology — remain pressing challenges as we look to the future.

This publication, *The Biological Weapons Convention at 50: Perspectives from Asia and the Pacific*, arrives at a pivotal moment. The next 50 years of the Convention will unfold amid rapid scientific and technological transformation, the increasing interlinkage between global health and security, and shifting geopolitical dynamics. Advances in synthetic biology, artificial intelligence, and life sciences promise great benefits for humanity, but they also bring new responsibilities. To keep the BWC effective and credible, it is essential to strengthen transparency, build national capacities for responsible science, and reinforce international cooperation.

The Asia-Pacific region — home to half of the world's population and some of its most dynamic scientific innovations — has a vital role to play in shaping the future of the BWC. Its participation in global discussions on strengthening the Convention is indispensable and its voices are essential for shaping a BWC that is inclusive, adaptive, and resilient.

The essays in this volume reflect that potential. They explore emerging biological risks, preparedness and response capacities, and the enduring challenges of verification and compliance. Together, they demonstrate the importance of regional dialogue and highlight how collaboration across governments, scientific communities and civil society can help strengthen the Convention's implementation. By bringing together these perspectives, this volume offers both a regional lens and a forward-looking agenda.

The BWC at 50 is both an achievement to celebrate and a call to action. This volume reminds us that safeguarding the future requires a reinvigorated commitment to the Convention and an inclusive dialogue across regions and disciplines. It is our hope that the reflections contained here will inspire policymakers, scientists, and civil society alike to strengthen the BWC for the challenges and opportunities of the next half-century.

We extend our sincere appreciation to all authors for their thoughtful and substantive contributions. Their reflections illuminate the opportunities and challenges facing the BWC at fifty and beyond. We

also express our gratitude to our colleagues in the BWC Implementation Support Unit and Regional Disarmament, Information and Outreach Branch of the United Nations Office for Disarmament Affairs for their cooperation and valuable support throughout the preparation of this volume. Our special thanks go to Ms. Chiara Busiol of UNRCPD, whose dedication and editorial support were instrumental in bringing this publication to fruition.

Aaron Junhoung Yoo, UNRCPD
Shruti Sharma, Carnegie India

List of abbreviations

AI	Artificial Intelligence
AIxBio	Biotechnology applications of AI
ASEAN	Association of Southeast Asian Nations
BAC	Behavioural Arms Control
BATA	Singapore's Biological Agents and Toxins Act
BCIL	Biotech Consortium India Limited
BIN	Indonesia's State Intelligence Agency
BIOTEC	Singapore's National Center for Genetic Engineering and Biotechnology
BIRAC	India's Biotechnology Industry Research Assistance Council
BNPB	Indonesia's National Disaster Management Authority
BSL-3	Biosafety Level 3
BWC	Biological Weapons Convention
CBM	Confidence-Building Measure
CBRN	Chemical, Biological, Radiological and Nuclear
CAGR	Compound Annual Growth Rate
CWC	Chemical Weapons Convention
DBT	India's Department of Biotechnology
DURC	Dual-Use Research of Concern
EIDs	Emerging Infectious Diseases
GEAC	India's Genetic Engineering Appraisal Committee
GHSA	Global Health Security Agenda
GMOs	Genetically Modified Organisms
GoF	Gain-of-Function
GP	Global Partnership
IBSCs	India's Institutional Biosafety Committees
iGEM	International Genetically Engineered Machine
ISU	(Biological Weapons Convention) Implementation Support Unit
JEE	Joint External Evaluation
KDCA	Korea Disease Control and Prevention Agency
MCMs	Medical Countermeasures
MoD	Ministry of Defense
MoH	Ministry of Health
NAM	Non-Aligned Movement
NAPHS	Indonesia's National Action Plan for Health Security
NBTB	India's National Biotechnology Board
OEWG	Open-Ended Working Group
OPCW	Organisation for the Prohibition of Chemical Weapons
RCGM	India's Review Committee on Genetic Manipulation
RIDs	Re-emerging Infectious Diseases
SAB	Scientific Advisory Board (of the OPCW)
SynBio	Synthetic Biology
TNI	Indonesian National Defense Forces
UNIDIR	United Nations Institute for Disarmament Research
VEREX	Verification Experts
WHO	World Health Organization

PART 1

Tackling emerging biological risks

Mely Caballero-Anthony is Professor of International Relations and President's Chair in International Relations and Security Studies at the S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University, where she also heads the Centre for Non-Traditional Security Studies and serves as Associate Dean for External Engagement. Her research interests include regionalism and multilateralism in the Asia-Pacific, human security and non-traditional security, nuclear security, conflict prevention and global governance.

She has led numerous global and regional research projects on international security and governance. Caballero-Anthony served as Secretary-General of the Consortium on Non-Traditional Security Studies in Asia since 2008 and is a member of the International Climate Security Expert Network. She was Vice President at Large of the International Studies Association (ISA) Governing Council and a member of ISA's Global South Task Force (2018–2021). From 2013 to 2017, she was a member of the United Nations Secretary-General's Advisory Board on Disarmament Matters and chaired the Board in 2016. She is also a member of the Asia-Pacific Leadership Network on Nuclear Non-Proliferation and previously served as Director of External Relations at the ASEAN secretariat (2011–2012).

Her recent publications include Climate Security in Southeast Asia: Navigating Concepts, Approaches and Practices (Third World Quarterly, 2024), Human Security and Empowerment in Asia (Routledge, 2024), and "Conflict Management and Atrocity Prevention in Southeast Asia: making ASEAN 'Fit for Purpose'" (Journal of International Peacekeeping, Vol. 26, Nos. 2–3, 2023).

Global trends in biotechnology and other emerging biological risks: Implications for the Biological Weapons Convention and Asia

Mely Caballero-Anthony

Over the past five decades, potential biological threats have evolved significantly, while global governance has largely remained anchored in the BWC, with most substantive progress occurring at the national level. In Asia, early efforts to address biothreats focused on biosafety, leading to the development of biosafety laws in the 1990s, primarily driven by concerns over genetically modified organisms. Following the attacks on the United States on 11 September 2001 and the onset of the SARS epidemic in 2002, many countries began incorporating biosecurity measures into their local health security regulations, complementing existing domestic biosafety frameworks.

Since its entry into force in 1975, the BWC has faced new mounting challenges, particularly in adapting to the accelerating pace of biotechnology. The rise of synthetic biology (synbio), the proliferation of dual-use technologies, and the resurgence of infectious diseases underscore the urgent need to modernize global biosecurity governance. These developments pose unique risks for Asia, where capacity and regulatory gaps remain stark. This commentary explores global trends in synbio and dual-use technologies, the dynamics of emerging and re-emerging infectious diseases, and their implications for the BWC — especially in the Asian context.

The rise of synthetic biology and dual-use technologies

Synthetic biology represents one of the most transformative advances in modern biotechnology, enabling the design of organisms with novel traits or even entirely synthetic life forms. While its potential benefits in medicine, agriculture and environmental sustainability are considerable, its dual-use nature — where research can be repurposed for harmful ends — raises significant security concerns.

A central issue is accessibility. Tools for gene editing and synthetic design are increasingly available to non-State actors, including private enterprises, small research groups, and even "do-it-yourself" biologists. The convergence of synbio with artificial intelligence (AI) accelerates this trend, heightening the risk of misuse by terrorist groups or rogue actors. Experts in Southeast Asia, for example, warn that lone-wolf actors, including university students with access to biotechnological tools, could exploit AI to significantly streamline and accelerate the design of harmful biological agents. In this context, the ability to

synthetically engineer biological agents presents a real and present danger.

Despite national investments in the beneficial applications of synbio, international regulatory frameworks such as the BWC — while foundational in banning biological weapons — have not kept pace with technological advancements. Current provisions do not comprehensively address the implications of synbio or dual-use research. Without specific guidelines and frameworks that encompass these technologies, the BWC risks becoming an ineffective tool, limiting its relevance in today's rapidly evolving threat environment.

The resurgence of infectious diseases

The past two decades have seen successive waves of emerging and re-emerging infectious diseases — including SARS, H1N1, Ebola and, most recently, COVID-19. These outbreaks have exposed vulnerabilities in global health security and the limitations of international coordination. COVID-19, in particular, revealed the fragility of global governance structures. Although the World Health Organization (WHO) plays a central coordinating role, the pandemic exposed significant deficiencies in preparedness and rapid response — shortcomings that are particularly pronounced in regions with weaker health infrastructure and governance capacity.

In the Asia-Pacific, these vulnerabilities are amplified by densely populated urban centres, limited healthcare access and uneven governance capacity. Southeast Asia is a particular hotspot for zoonotic spillovers due to its high biodiversity and porous borders. The movement of animals carrying zoonotic pathogens, combined with transboundary human migration, increases the region's exposure to biological risks. Policy responses remain largely reactive, as seen in the reallocation of health budgets away from preparedness once COVID-19 became endemic, further undermining long-term resilience.

These structural vulnerabilities have significant implications for the BWC as infectious diseases experience a resurgence. Pathogens, whether naturally-occurring or deliberately engineered, pose a persistent threat. Advances in biotechnology mean that gain-of-function research could enhance a pathogen's transmissibility, virulence or resistance to existing treatments. The potential for non-State actors to exploit such capabilities presents an urgent biosecurity challenge.

Yet the current global system is ill-equipped to detect and prevent deliberate misuse, especially across borders, underscoring the need for robust intelligence sharing, coordinated surveillance and rapid response mechanisms. The Asia-Pacific region's dense populations and porous borders make it both a potential target and a conduit for the rapid spread of intentionally modified pathogens, reinforcing the importance of strengthening the global framework under the BWC. Moreover, experts from Southeast Asia highlight a critical gap: the lack of technology to detect whether a virus is laboratory-engineered, whether accidentally leaked or internationally released. Beyond current biosecurity frameworks, limited national capacities to detect, prevent and respond to biological threats remain a crucial gap in BWC implementation.

Asia's biosecurity challenges

Home to over half the global population, Asia faces distinctive challenges in managing biosecurity risks. Rapid

urbanization, biodiversity hotspots, and high mobility within and across borders create a conducive environment for both natural outbreaks and deliberate biological threats.

Many Asian countries lack comprehensive biosafety and biosecurity legislation. Despite progress by some States, such as Singapore, Thailand and China, large parts of Southeast Asia still face significant gaps in regulation, enforcement and scientific capacity. These gaps are compounded by geopolitical tensions and limited trust, which constrain regional cooperation.

Countries with more comprehensive frameworks offer useful examples of adaptive governance. Singapore's Biological Agents and Toxins Act, for instance, is complemented by oversight mechanisms that assess research in areas such as synthetic biology and gene editing for dual-use potential. In Thailand, the National Center for Genetic Engineering and Biotechnology plays a crucial role in supporting and transferring technology for the development of industry, agriculture, natural resources and the environment, contributing to social and economic well-being.

This regional context has direct implications for the BWC. Effective implementation of the Convention depends on robust national governance, regional coordination and international collaboration — conditions not yet fully realized in Asia. Regional coordination is hindered by several factors, including the absence of a uniform prioritization of biosecurity, differing stages of technological development across countries, uneven biosafety and biosecurity regulations, and varying level of scientific and technical capacity. In Northeast Asia, geopolitical tensions and limited trust among States further constrain information sharing and joint preparedness efforts, leaving the region vulnerable to numerous biosecurity challenges.

The role of biorisk and biosecurity associations, as local champions of biosecurity amidst technological advancements, is critical in raising awareness among key stakeholders on the biosecurity implications of biotechnologies. In Asia, biorisk and life science associations play a critical role in strengthening technical expertise, fostering cross-border collaboration, and standardizing best practices for biosecurity and BWC implementation, particularly in the context of dual-use biotechnologies. These associations, which bring together biosafety and biosecurity officers, laboratory professionals, and life science researchers through national and regional capacity-building conferences and workshops, serve as vital knowledge hubs on dual-use biotechnologies. Organizations such as the Asia-Pacific Biosafety Association, the BioRisk Association of the Philippines, the Biorisk Association of Singapore, the Indonesian Biorisk Association, and the Malaysian Biosafety and Biosecurity Association help develop training programmes, risk assessment frameworks, and laboratory standards essential for preventing accidental and deliberate biological threats.

The Biological Weapons Convention: Limitations and recommendations

While the BWC has been instrumental in establishing a global norm against biological weapons, technological advances have introduced new and evolving threats. The Convention's original architecture, which predates the genomic revolution, has

not kept pace with the sophistication of current biotechnologies.

Although the BWC recently marked its fiftieth anniversary, its implementation at the national level remains uneven — particularly across Asia, where many States still lack national legislation and institutional mechanisms to operationalize its provisions. The absence of specific guidance in the Convention for emerging fields such as gene editing, synthetic biology, and AI-driven bioengineering further limits its contemporary relevance. Compounding those challenges, the BWC lacks a verification mechanism and institutional capacity to monitor compliance or assess emerging risks. Its primary transparency tool, the confidence-building measure (CBM) reporting forms, has received criticism for outdated data collection methods, cumbersome compliance procedures, the absence of a legal requirement for submission, and a limited capacity to reflect current technological and biosecurity developments.

Calls for reform underscore the need for a more adaptive, forward-looking governance framework. As the BWC enters its sixth decade, updating and strengthening its mechanisms to address emerging threats has never been more urgent.

Enhancing National Implementation

Building institutional capacity and raising awareness among domestic stakeholders are critical. While CBM reporting can support transparency and national assessment, it is not alone sufficient for promoting transparency. Many States face capacity limitations in monitoring BWC-related activities and lack consistent participation by relevant national stakeholders.

Capacity-building workshops in Southeast Asia have begun to address these gaps, but further efforts are needed to institutionalize best practices and extend outreach to front line implementers. Such efforts could include developing standardized national protocols for biosafety and biosecurity, establishing regular training programmes for laboratory personnel and public health officials, creating inter-agency coordination mechanisms for emerging biological risks, and integrating biosecurity into university curricula and work by other relevant institutions.

Promoting regional cooperation

Regional organizations must play a proactive role in reinforcing the BWC. ASEAN member States have increasingly launched joint initiatives to strengthen national and regional capacities in areas such as chemical, biological, radiological and nuclear preparedness, disease surveillance, and biorisk management.

A key milestone is the ASEAN Leaders' Declaration on Regional Biosafety and Biosecurity, adopted in October 2024. The declaration commits to establishing the ASEAN Biosafety and Biosecurity Network, a platform for knowledge-sharing and cooperation among member States and partners.

Through workshops and collaborative exercises — often conducted with United Nations agencies and external partners — ASEAN has fostered regional dialogue and built technical expertise in implementing the BWC and advancing broader biosecurity governance. Its efforts have also strengthened CBMs, contributing to greater trust and cooperation across the region.

A notable example of progress is Cambodia's submission of its first CBM

report in 2022, followed by consistent annual reporting. Cambodian national agencies have significantly enhanced their implementation capacity through participation in regional workshops and exercises, demonstrating the tangible benefits of sustained regional engagement.

Engaging the private sector and scientific community

Biotech companies, pharmaceutical firms and scientific researchers are central to both the risks and solutions made possible by biological innovation. Targeted outreach — through awareness campaigns, training programmes and ethical guidelines — can help align industry practices with the norms championed under the BWC.

In Southeast Asia, professional associations such as the Asia-Pacific Biosafety Association and national biorisk networks (e.g., in the Philippines, Singapore, Indonesia and Malaysia) serve as vital platforms for building technical capacity and fostering cross-border collaboration. These associations play a key role in developing risk assessment tools, laboratory safety protocols, and training programmes critical to national and regional biosecurity.

Enhancing transparency and accountability

Transparency in biological research is essential, and CBM reports should be regularized and expanded to include updates on dual-use research and national biosecurity capacities. Strengthening CBM reporting practices will not only enhance national preparedness but also build trust among States. It will also help countries promote broader security awareness among agencies and stakeholders regarding the potential misuse of dual-use biotechnologies that could threaten national security and public safety.

Modernizing compliance and verification mechanisms

The BWC must be equipped with modern verification tools. Strengthening the role and resources of the Convention's Implementation Support Unit (ISU) is a critical first step. There is also merit in considering a new international monitoring mechanism that would continuously monitor technological developments, assess compliance risks, facilitate rapid sharing of intelligence on emerging threats, and provide technical oversight. Such a mechanism would complement conventional verification approaches rather than replace them, helping to address the challenges posed by rapid advances in synthetic biology, gene editing and AI-driven biotechnology.

Conclusion

The convergence of synthetic biology, dual-use technologies and emerging infectious diseases presents complex and evolving threats to global security. These risks are particularly acute in Asia, a region characterized by high exposure, capacity gaps and growing geopolitical complexity.

Strengthening the BWC requires a multifaceted approach: from national capacity-building and regional cooperation to integrating cutting-edge science and engaging industry stakeholders. As the Convention enters its sixth decade, this static legal instrument must be developed as a dynamic platform for twenty-first-century biosecurity governance.

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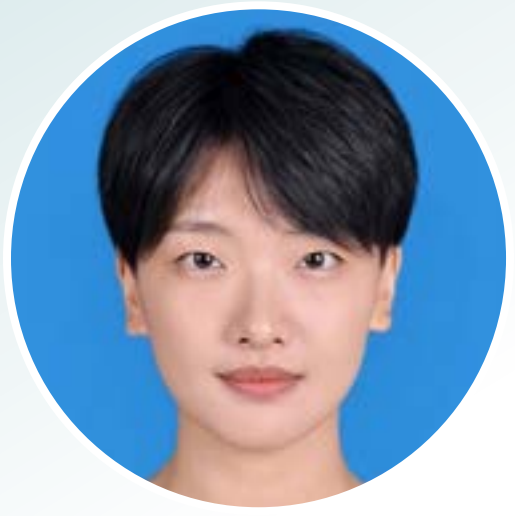

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China's approach and policies towards verification and compliance mechanisms under the Biological Weapons Convention

Fujian Li and Yizhe Li

Since entering into force in 1975, the BWC has served as the foundation of global efforts to prohibit and eliminate an entire category of weapons of mass destruction. Yet its authority and effectiveness have been undermined by a critical gap: the absence of a legally binding verification mechanism.

Core position: Promoting a legally binding verification mechanism

China's stance on BWC verification is clear and unwavering: it strongly supports a non-discriminatory, balanced, effective and legally binding multilateral verification mechanism — the only viable path to addressing compliance concerns and remedying the Convention's shortcomings.

At meetings of States parties, review conferences and working group sessions, China has repeatedly stressed that a multilateral verification mechanism is vital for ensuring strict compliance by all States parties and fostering mutual trust. This position reflects the common aspirations of most States parties, particularly developing countries. China maintains that verification to ensure compliance is a well-established norm in the field of international arms control and disarmament — and biosecurity should be no exception. This principle underpins all of China's related policies and proposals.

Domestic compliance practices: Legal system and institutional guarantees

China not only advocates for verification at the multilateral level but also embeds BWC obligations into domestic law and governance structures, demonstrating its commitment and capacity to comply fully with the Convention.

China's Biosecurity Law: A legal foundation for domestic compliance

The Biosecurity Law of the People's Republic of China, effective 15 April 2021, represents a landmark in China's implementation of the BWC. By explicitly incorporating obligations such as prohibiting biological weapon development and possession, it ensures full implementation of the BWC's core provisions within China's legal system. The text also formally acknowledges biosecurity as a national security concern and establishes a robust legal framework for biorisk management and prevention.

To enforce the law, China established a national biosecurity coordination mechanism, jointly led by the Ministry of Foreign Affairs, the Ministry of Agriculture and Rural Affairs,

the Ministry of Science and Technology, the National Health Commission, and the armed forces. This interagency system clearly defines rights and responsibilities to promote efficient coordination.

Export controls on dual-use biotechnology: Strengthening non-proliferation

Preventing the uncontrolled spread of dual-use items, equipment and technologies with both peaceful uses and weaponization potential is central to meeting national BWC commitments. China has built a comprehensive export control system based on laws and regulations, such as the Export Control Law of the People's Republic of China (2020) as well as the 2021 Biosecurity Law . The revised Regulations of the People's Republic of China on the Export Control of Dual-Use Items, effective 1 December 2024, further streamline and strengthen this system.

Future-oriented technological approaches: Integrating frontier technologies into verification

China believes that any future verification mechanism must keep pace with scientific progress. Incorporating cutting-edge technologies can enhance efficiency, accuracy and accessibility.

For example, microbial forensics can apply techniques such as high-throughput sequencing to trace biological samples to their origin, helping to distinguish natural outbreaks from deliberate events. Similarly, AI can analyse vast datasets, monitor global pandemics and detect irregular biological research activities — boosting verification efficiency and early warning capabilities.

International cooperation: Towards a collective biosecurity shield

China recognizes that biosecurity is a global challenge requiring collective action. It advocates creating a multi-level, cross-sectoral network to strengthen biosecurity cooperation across multilateral, regional and bilateral channels.

Addressing threats from non-State actors: Promoting responsible scientific research and codes of conduct

To address the threat of biotechnology misuse by non-State actors — including for bioterrorism — China advocates placing greater emphasis on "soft governance" in biological research. A flagship achievement of this effort is the Tianjin Biosecurity Guidelines for Codes of Conduct for Scientists, developed by an international group of experts at the initiative of China and Pakistan. These guidelines establish ethical and behavioural standards for scientists worldwide, aiming to foster a culture of responsibility and mitigate risks at their source.

Providing global public goods: Sharing experience and offering assistance

China fulfils its role as a major power by offering biosecurity-related public goods, particularly to developing countries. It championed the adoption of United Nations General Assembly resolution 76/234, which promote international cooperation on peaceful uses in the context of international security — upholding the right of all States to access such benefits. China has organized international workshops on biosafety laboratory management and provided timely assistance during crises, such as the Ebola outbreak in West Africa and the COVID-19 pandemic.

Conclusion

China's policies on verification and compliance under the BWC are clear and steadfast. At their core is an unwavering commitment to establishing a legally binding multilateral verification mechanism — an essential means of addressing the Convention's fundamental shortcoming and meeting today's global biosecurity challenges.

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India and Biorisks

Ajey Lele

Biorisk refers to the potential for a biological event to occur that could negatively impact human health.[1] Such events can stem from naturally occurring diseases — both chronic and infectious — as well as accidents or the deliberate misuse of biological agents and toxins. Assessing biorisks involves both quantitative and qualitative approaches.

Biotechnology and related scientific research are advancing at an unprecedented pace, reshaping medicine, agriculture and industry. Yet these same innovations introduce new layers of complexity and vulnerability. Laboratory accidents, the misuse of dual-use technologies, and the growing interface between humans and wildlife all amplify the potential for harmful biological events — whether accidental or deliberate. Global travel and trade mean these risks do not remain local; they ripple across borders, creating security challenges that demand coordinated responses.

This situation requires coordinated international action — strengthening non-proliferation norms, enhancing outbreak preparedness and implementing comprehensive risk mitigation strategies.[2] This chapter examines India's approach to managing biological risks and offers recommendations to strengthen its capabilities.

India's history of biological research can be traced to at least the fourteenth century, when the study of medicinal plants was already under way. The twentieth century marked transformative growth in India's science and technology ecosystem with an expansion of research laboratories in biology, zoology and related fields. This era saw the establishment of numerous research organizations, private companies and universities, alongside landmark developments such as the Green Revolution, which introduced high-yield crop varieties and dramatically improved agricultural productivity. Around the same time, India emerged as a leading global supplier of generic drugs and vaccines, reinforcing its role in the life sciences sector.

In 1982, the Government of India created the National Biotechnology Board (NBTB) to identify priority areas and chart a biotechnology innovation roadmap. This was followed by the 1986 establishment

1 While the term "biorisk" may also refer to potential events affecting plants and animals, this article focuses exclusively on human health implications. For definitions of other terms used, see https://www.ncbi.nlm.nih.gov/books/NBK305036/.

2 Established in August 2020 by the Secretary-General under Decision 2020/59, the United Nations BioRisk Working Group (UN-BRWG) brings together a diverse range of expertise from across the United Nations system. Co-led by the Office for Disarmament Affairs and the World Health Organization (WHO), the group aims to enhance the United Nations' capacity to address and respond to biorisks. It focuses on three core objectives: (a) strengthening capacities and coordination within United Nations system organizations to ensure a cohesive and effective response to biorisks; (b) fostering collaboration with key stakeholders outside the United Nations system through a robust multi-stakeholder engagement strategy; and (c) enhancing outreach and partnerships to align global efforts in mitigating and managing biorisks.

of the Department of Biotechnology (DBT), which provided institutional support to for research, innovation and industry linkages. More recently, the Biotechnology Industry Research Assistance Council (BIRAC), launched in 2012, has catalysed India's biotech startup ecosystem by fostering innovation, entrepreneurship and translational research. Alongside agencies such as DBT and BIRAC and their associated research and development institutions, private companies and startup industry associations — including Biocon, Serum Institute of India, Bharat Biotech and Biotech Consortium India Limited (BCIL) — collaborate and compete to drive innovation, research and commercialization in the sector.

Building on this momentum, DBT periodically releases its *National Biotechnology Development Strategy,* outlining a five-year vision to expand research capacity, infrastructure and talent development. These efforts are reflected in India's bioeconomy, which grew from US$10 billion in 2014 to US$165.7 billion in 2024, contributing 4.25% to GDP with a compound annual growth rate of 17.9% over four years. With a target of US$300 billion by 2030, biotechnology is emerging as a crucial sector India's knowledge-driven economic future. Advances in vaccines and recombinant therapeutics are propelling much of the industry's current growth.

As biotechnology advances, policymakers in India increasingly recognize the associated risks and need for effective management. Risk mitigation broadly falls under two categories: biosafety and biosecurity. While often used interchangeably, these terms differ in focus — biosafety aims to prevent unintentional exposure or release of biological agents, whereas biosecurity seeks to prevent deliberate misuse by malicious actors. Together, they provide broad protection against biological threats.

To safeguard its biotechnology ecosystem, India has enacted several domestic regulations to prevent laboratory accidents and, in some cases, deliberate misuse.

DBT has introduced various regulations and guidelines to strengthen biosafety, most notably the Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/ Genetically Engineered Organisms or Cells, commonly known as "Rules 1989". Issued under the 1986 Environment (Protection) Act, these rules govern activities involving genetically modified organisms and hazardous microorganisms. Oversight is provided by multiple authorities, including the Recombinant DNA Advisory Committee, Institutional Biosafety Committees, the Review Committee on Genetic Manipulation, and the Genetic Engineering Appraisal Committee. Biotechnology committees also monitor safety compliance at the state and district levels.

By contrast, India's biosecurity framework remains fragmented due to the absence of a dedicated authority or unified policy. Multiple laws regulate the protection of humans, plants, animals and the environment from disease-causing organisms, including the Weapons of Mass Destruction and Their Delivery Systems (Prohibition of Unlawful Activities) Act of 2005 and the Livestock Importation Act of 1898.

India is a State party to the BWC which bans the development, production, use or storage of biological weapons. However, to strengthen its biosecurity infrastructure — particularly in light of recent technological

advances — and enhance compliance with the BWC, India should establish a National Authority for the Convention. Additional priorities include improving disease surveillance and response capabilities and investing in research to bolster biodefense, particularly in areas such as dual-use technologies, virology, vaccine development and rapid diagnostics.

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Perspectives from the Republic of Korea

Jacob Lee

Building a network of infectious disease experts for bioterrorism preparedness

The Republic of Korea has established a robust network of infectious disease specialists and public health authorities as the backbone of its bioterrorism preparedness. In the wake of the 2001 anthrax incidents in the United States, the Government introduced comprehensive countermeasures against bioterrorism. Central to these countermeasures is a dual-pronged surveillance system for early threat detection: one arm focuses on syndromic surveillance — the monitoring of non-specific clinical signals that may indicate an unusual outbreak — while the other comprises a professional network of clinical microbiologists and infectious disease experts responsible for diagnosing and responding to illnesses caused by any intentional release of biological agents.

Specialists are integrated into a nationwide reporting system coordinated by the Korea Disease Control and Prevention Agency (KDCA). Hospitals, laboratories and local public health centres are connected through real-time communication channels to ensure swift reporting of unusual cases. When a front-line doctor suspects a potential bioterrorism-related infection, such as anthrax or smallpox, clear protocols guide immediate notification of KDCA's emergency hotline and national disaster control centres. Infectious disease experts also collaborate with local health departments to develop practical response plans for their institutions, reinforcing preparedness at every level of the healthcare system. The result is a multi-tiered expert network capable of detecting bioterror incidents quickly and coordinating responses across agencies and medical facilities.

Nationwide training exercises and the smallpox scenario

To strengthen preparedness and inter-agency coordination, the Republic of Korea conducts annual bioterrorism response exercises at both metropolitan/provincial and municipal levels. Earlier drills focused on "white powder" incidents, such as anthrax hoaxes, but recent exercises emphasize high-consequence pathogens. A detailed smallpox outbreak scenario now provides a model for testing national response capabilities.

In the simulation, the timeline mirrors a realistic outbreak:

- **D-Day**: A covert release infects an initial cohort of individuals.
- **D+28**: Health authorities recognize the outbreak, commencing non-pharmaceutical interventions such as movement restrictions and preparing vaccinations. Aggressive contact tracing is initiated, with a goal

of identifying 80% of close contacts, while community transmission rates are reduced through social distancing. Thanks to the expert network, cases identified through contact tracing are rapidly isolated, lowering the effective reproduction rate of smallpox by more than 80 percent.

- **D+31**: Vaccination campaigns commence. Initially, vaccination capacity is limited, but it scales up rapidly as resources are mobilized. A ring vaccination strategy is prioritized, followed by expansion to mass vaccination for the general public. By D+140, approximately 40 million people are projected to be vaccinated nationwide.

Exercises often occur in four stages:

1. **Initial diagnosis and epidemiological investigation** of the first confirmed case.
2. **Peak outbreak response**, testing surge capacity in healthcare facilities.
3. **Nationwide vaccination campaign,** including logistics and adverse event monitoring.
4. **Post-outbreak recovery**, focusing on lifting emergency measures and rehabilitating affected communities.

These drills ensure that every phase of a potential bioterrorism response is practiced and refined.

Key components of bioterrorism preparedness

The Republic of Korea's strategy emphasizes:

- **Capacity-building:** Strengthening laboratories and hospitals with stockpiles of antibiotics, antivirals, antitoxins and vaccines, alongside continuous training for healthcare workers.
- **Early detection and surveillance**: A nationwide electronic reporting system linking hospitals, clinics, laboratories and public health centres, supported by clinician training to recognize early indicators of unusual diseases.
- **Contact tracing and containment:** Rapid identification and monitoring of exposed individuals, with clear and standard protocols for isolation, quarantine and infection control.
- **Vaccination rollout**: Prioritizing ring vaccination, followed by mass vaccination if necessary. Medical institutions can scale within months from thousands to millions of vaccinations per day, supported by public communication strategies to ensure rust and compliance.

Limited international cooperation and future potential

International cooperation on bioterrorism preparedness is currently limited, with most action occurring at the domestic level. However, the Republic of Korea is well positioned to help lead in regional collaboration against transnational biological threats. Future initiatives could include joint simulation exercises with neighbouring countries, information-sharing platforms, professional training exchanges and regional health security mechanisms.

Leveraging its domestic success in organizing a nationwide expert network and conducting rigorous exercises, the Republic of Korea could help establish a regional framework for bioterrorism preparedness by

sharing expertise and lessons learned with neighbouring States.

Conclusion

The Republic of Korea's experience demonstrates that a strong domestic network of infectious disease experts is the cornerstone of bioterrorism readiness. By integrating clinicians, laboratories, and public health authorities into a coordinated system, the country has built an agile framework for early detection and rapid response. Regular training exercises — particularly through the smallpox simulation — translate lessons from real epidemics into preparedness for potential biological threats.

This domestic model also offers a template for international collaboration. The Republic of Korea's investment in expert networks, capacity-building and realistic drills not only protects its own citizens but also contributes to collective global security. Ultimately, robust national readiness is a foundation for international cooperation and a vital contribution to reinforcing the Biological Weapons Convention in an era of evolving technological and security challenges.

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PART 2

Strengthening assistance, response and preparedness

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Emerging technology risks and the Biological Weapons Convention

Anita Cicero, Alanna Fogarty, Tom Inglesby and Matthew P. Shearer

As the BWC celebrates its fiftieth anniversary, States parties are actively addressing long-standing issues around treaty compliance and verification, while also confronting risks posed by rapid technological advancements across the life sciences and beyond.

Today's global landscape is vastly different than when the BWC entered into force in 1975. Its prohibitions remain comprehensive — covering biological agents, toxins, equipment and materials developed or possessed for hostile purposes, regardless of origin, target or pathogenesis, and including any associated technological tools.

Yet translating these prohibitions into practice has grown increasingly complex. Accelerating progress in biology and biotechnology continues to outpace regulatory and governance systems, particularly as biology converges with other technical domains. The Working Group on the Strengthening of the Biological Weapons Convention aims to address these and other priority issues, including through concrete proposals for consideration at the tenth Review Conference in 2027 or an earlier special conference. States parties must vigilantly track cutting-edge technologies that could reshape the biological weapons risk landscape and implement effective mitigation measures. Striking a balance between rapid innovation and robust governance mechanisms will be critical to preventing biological weapons development and use over the next 50 years, while ensuring humanity's ability to harness these capabilities for peaceful purposes.

Governance of emerging technologies

AI and synthetic biology exemplify fields with transformative potential for both benefit and harm. AI can process vast datasets, uncover patterns in genomic information and accelerate scientific discovery, including through cloud-based laboratories. These capabilities promise breakthroughs in medical countermeasures, diagnostics and genomic characterization. However, the same tools could lower technical barriers to pathogen modification, enabling the creation of biological weapons with novel and potentially more lethal properties.

Synthetic biology, particularly gene synthesis, offers similar dual-use concerns. While it supports enhanced disease surveillance and rapid development of diagnostics, vaccines and therapeutics — as observed during the COVID-19 response — it could also enable malicious actors to design and construct high-consequence pathogens without physical specimens. Combined with powerful bioinformatics and AI systems, nucleic acid synthesis could facilitate the creation of pathogens engineered to evade medical countermeasures or diagnostics.

Governments worldwide struggle to keep pace with these developments. Regulatory frameworks lag behind emerging risks, especially as biology intersects with computing and automation. Governance strategies must address AI-biotechnology convergence (AIxBio) and gene synthesis through practical measures that preserve scientific benefits while mitigating security risks. These should include a priori security reviews of AI models that are trained on, or capable of, meaningfully manipulating biological data and that exhibit capabilities posing serious threats to international security. Examples include models that could simplify, accelerate or enable the creation of a biological weapon. While a growing community of developers has committed to conducting such risk assessments, robust and standardized methodologies are still under development.

Governments should also consider implementing managed access controls for highly sensitive biological datasets. Additional work is needed to identify which types training data could realistically confer AI models with the technical ability to design dangerous pathogens with enhanced transmissibility, virulence or immune evasion properties. These may include certain sequencing data, functional assay results and protein-protein interaction data from pathogens with pandemic potential.

A critical challenge is that some of these sensitive datasets are held by private companies, limiting government oversight and complicating governance of their use in AI models or other applications. In the absence of international agreements, national approaches to defining and assessing these risks may diverge significantly, creating an inconsistent patchwork of policies. Such fragmentation could leave gaps in global governance for tools and data that are widely accessible and utilized across borders.

Access to synthetic DNA and RNA sequences is essential for scientific progress, but robust national-level governance is critical to preventing misuse. Currently, few governments have such mechanisms in place. Effective governance should require synthetic sequence providers to implement "know your customer" practices, screening both the identity of customers and the content of their orders before fulfilment. Providers should also have clear, streamlined channels to report concerns to government authorities for official assessment. These measures help ensure that high-consequence sequences remain within legitimate research and development contexts.

Manufacturers of desktop gene synthesis equipment should adopt similar screening protocols and take steps to prevent circumvention of protective measures by individuals synthesizing nucleic acids on-site. Key challenges include accurately characterizing the risk of misuse — whether deliberate or accidental — and ensuring that safeguards implemented by governments and the scientific community are effective without unnecessarily hindering benefits to health, environmental sustainability or economic development.

A science and technology review mechanism

A key mandate of the Working Group on the Strengthening of the Biological Weapons Convention is developing a science and technology review mechanism to inject technical expertise into BWC deliberations. This mechanism would complement national horizon-scanning efforts; help States parties assess opportunities and risks posed by emerging technologies, and identify priorities

for protective action. Success will depend on sustained political will and resources, as well as a technically informed, apolitical body of experts — including representatives from civil society and the private sector — capable of providing rapid and rigorous assessment based on current knowledge. Diverse representation is essential to ensure that governance approaches reflect varied geographic contexts (potentially beyond BWC regional groups), as well as economic and technical realities.

Biosecurity codes of conduct

Beyond formal legislation, biosecurity codes of conduct can extend oversight to institutional and facility levels. The Tianjin Biosecurity Guidelines for Codes of Conduct for Scientists provide a foundation for promoting responsible scientific practice and catalysing national or organizational codes. While most researchers adhere to ethical norms, clear and practical codes can strengthen a culture of responsibility, expand awareness and enable risk assessment and monitoring.

Building awareness of biological weapons non-proliferation norms, risks and obligations can extend well formal national governance systems, particularly in countries where such frameworks are still evolving. Tailored biosecurity codes of conduct offer practical pathways for identifying risks, implementing protective measures, and preventing accidental or deliberate misuse of biology and biotechnology.

Top-down frameworks provide leadership oversight of research activities, while bottom-up frameworks empower front-line scientists to flag potentially risky practices and apply safeguards. Importantly, other technical fields — such as AI — could also benefit from codes of conduct as they increasingly intersect with life sciences research. Embedding responsibility into the development and application of these tools promotes safety by design, ensuring protections are implemented proactively rather than reactively.

Responsible use of these transformative technologies not only mitigates safety and security risks but also enables researchers to advance scientific frontiers and deliver health, social and economic benefits.

Confidence-building measures

In the absence of a formal protocol and associated compliance verification regime under the BWC, States parties must rely on alternative mechanisms to demonstrate adherence to their obligations. Confidence-building measures are one of the Convention's few formal tools to increase transparency on biological activities, programmes and capabilities. However, their development in the closing years of the cold war means they do not fully reflect today's technical realities — particularly as advanced biology expands beyond large, State-sponsored programmes into private industry, academia and even citizen science, while converging with other fields such as advanced computing.

States parties should consider updating their forms for reporting under confidence-building measures to capture the distributed nature of modern biotechnology and strengthen confidence in compliance. Beyond transparency on biological programmes and activities, confidence-building measures also cover national legislation, regulations, and other steps to implement BWC obligations. As States parties develop and implement mechanisms to address emerging risks — including from

gene synthesis, automated and cloud-based laboratories, and AI — confidence-building measures provide a platform to States parties to exchange information about their diverse and layered national implementation efforts. This transparency builds confidence in States parties' commitment and capacity to mitigate biological threats.

Moreover, sharing good practices through confidence-building measures can encourage broader adoption of effective governance measures worldwide. Confidence-building measures also provide an important tool for identifying potential partners for international cooperation and assistance under article X, helping States parties adapt national measures to meet their unique systems and needs.

Priorities going forward

The BWC's fiftieth anniversary is both a milestone and a call to action. While the Convention has succeeded in deterring the development and use of biological weapons, strengthening it for the decades ahead is imperative. Key priorities should include:

- **Developing national governance** strategies for powerful biotechnologies, such as oversight of AIxBio capabilities and security-oriented screening for gene synthesis customers and orders
- **Establishing a science and technology review mechanism** to provide States parties with timely technical analysis of emerging biology and biotechnology capabilities and their implications for treaty implementation
- **Promoting national and institutional biosecurity codes of conduct**, leveraging resources such as the Tianjin Biosecurity Guidelines to foster a culture of responsibility across the life sciences.
- **Harnessing confidence-building measures** as a centralized platform for sharing information on biological activities and national implementation.

Together, work in these areas can enable States parties to reaffirm and strengthen norms against biological weapons, mitigate risks posed by emerging technologies, and maximize biotechnology's benefits to humanity.

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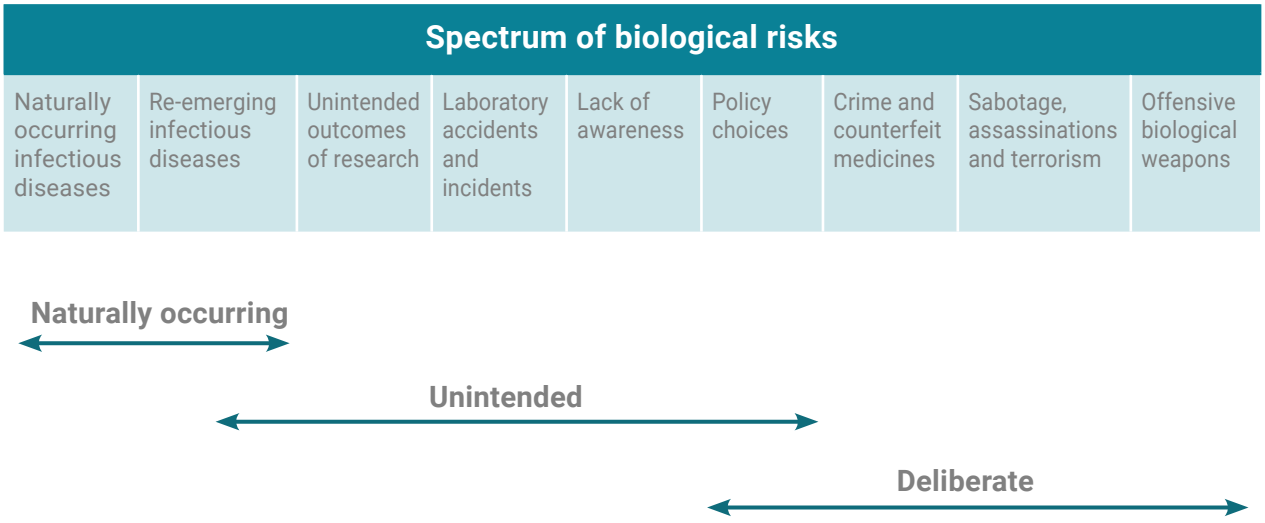
Perspectives from Japan

Nariyoshi Shinomiya and Kiwako Tanaka

Understanding biological threats

Biological risks fall into three broad categories: naturally occurring, unintended and deliberate (Figure 1).



- **Naturally occurring risks** call for strengthened surveillance, preparedness and training for rapid response
- **Unintended risks** require education, ethical standards, codes of conduct and robust governance
- **Deliberate risks** that directly impact human health demand heightened policy attention and international cooperation through oversight, deterrence and stronger global frameworks.

Across all these categories, two priorities remain constant: improving medical response capabilities and reinforcing public health infrastructure.

Japan's experience with Aum Shinrikyo illustrates the devastating consequences of inadequate safeguards. The group's clandestine development of biological and chemical weapons caused immense human suffering and prompted sweeping legal reforms. Domestic laws and regulations were revised for determining the legitimacy of religious organizations, infectious disease legislation was strengthened to control

microorganisms and toxins and manage their transfer. The Infectious Diseases Act, enacted in 1999, and amended in 2003 following the anthrax attacks in the United States and the SARS outbreak in Asia, introduced measures to prevent terrorism and the spread of communicable illnesses. For instance, research involving anthrax now requires notifying the Ministry of Health, Labor and Welfare, and its transport must be reported to the police. Since 2000, Aum Shinrikyo has also been subject to official monitoring under the Anti-Aum Law.

Scientific and technological progress adds complexity. Assessments of dual-use risks and potential weaponization cannot rely solely on political judgement; experts analysis is essential. Yet experts differ in approach and methodology for interpreting information, complicating the work of determining appropriate countermeasures. The Aum Shinrikyo case remains a critical reference point for these debates.

Recent AI advances have significantly expanded capabilities to design microorganisms and toxins, widening the risk spectrum. Responding effectively requires expertise beyond microbiology — including in information and communication technologies and engineering — as well as new governance models drawing on cross-disciplinary collaboration among academia, government, defence and other fields.

Strengthening the role of the Implementation Support Unit

When the BWC entered into force, it lacked an institutional mechanism for implementation. That gap was addressed at the sixth Review Conference in 2006, which established the Implementation Support Unit (ISU) within the Geneva Branch of the United Nations Office for Disarmament Affairs. The ISU provides administrative support to BWC-related meetings, assists States parties in implementing Review Conference decisions and recommendations, and facilitates confidence-building measures. Initially staffed by three, the Unit gained one additional position at the ninth Review Conference in 2022.

The ISU faces structural challenges, however. Its mandate must be renewed every five years, hindering long-term planning, and its lack of funding for capacity-building and training means it must leave those tasks to States parties. Most troublingly, its mandate of "comprehensive implementation" is vague, creating uncertainty about specific responsibilities.

While personnel costs are covered by assessed contributions, outreach and capacity-building rely largely on voluntary funding — an unstable basis for sustainability. In today's fragmented international environment, mobilizing resources for peacebuilding is increasingly difficult. Stronger leadership and coordination are needed, including through platforms such as the G7 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction, as well as joint activities linking the BWC with global health and security sectors. These steps could enhance visibility, diversify funding, and integrate the BWC into broader international efforts.

States' reluctance to contribute stems partly from the absence of catastrophic biological incidents, which reduces perceived urgency. Yet the consequences of such an event would be irreversible — making proactive investment and cooperation imperative.

How can the BWC be strengthened?

The dual-use nature of science and technology highlights the need for systematic reviews, risk identification and the development of mitigation strategies — priorities that have shaped discussions over the past decade. These debates have also emphasized strengthening ethics and codes of conduct for scientists, alongside building capacity to prevent the development of biological weapons. At the ninth Review Conference (2022), States parties established the new Working Group on the Strengthening of the Biological Weapons Convention, tasked with developing concrete measures to enhance effectiveness and implementation. The Working Group was expected to meet for 15 days annually from 2023 to 2026.

While most States parties agree on the need for a scientific and technological review mechanism, opinions diverge on its structure. Key questions concern ensuring equitable geographical representation — balancing participant numbers between the Global North and South — while accounting for disparities in scientific and technological development.

A survey by the United Nations Institute for Disarmament Research (UNIDIR) examined the Scientific Advisory Board of the Organisation for the Prohibition of Chemical Weapons (OPCW) as a potential model. In the BWC context, such a framework would face challenges around ensuring independence, avoiding undue political influence and securing resources. Moreover, simply maintaining lists of dangerous biological agents would be insufficient; must shift to emerging technologies that could enable their creation. A small advisory body may not meet this need.

Efforts to establish a verification protocol under the BWC have been stalled for decades. The Ad Hoc Group[1]established in 1994 to discuss a verification protocol concluded its work in 2001, leaving the issue unresolved. The new Working Group established in 2022 has revived discussions on compliance and verification, but obstacles persist: technical limitations, political disagreements, financial constraints, and the sheer number of relevant facilities means make OPCW-style inspections impractical. Agreement remains distant.

Some experts have begun advocating alternative approaches, such as behavioural arms control (BAC), which emphasizes transparency and responsible conduct. Current confidence-building measures focus narrowly on factual disclosures of research facilities and assets, overlooking critical dimensions such as. how countries and researchers are biosecurity-related education ethics and codes of conduct. These factors, though harder to assess, are central to risk reduction. Future frameworks must consider who is involved in research how national leadership promotes prevention.

Above all, strengthening the BWC will require clarity of purpose and sustained commitment. Creating new structures without a clear mandate will not suffice.

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1 The 1994 Special Conference of the States Parties to the Biological Weapons Convention agreed to establish an Ad Hoc Group, open to all States parties, "to consider appropriate measures, including possible verification measures, and draft proposals to strengthen the Convention, to be included, as appropriate, in a legally binding instrument" (BWC/SPCONF/01, para. 36).

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Strengthening assistance, response and preparedness in implementing the Biological Weapons Convention: An Indonesian perspective

Tjahja Nurrobi and Daniel Tjen

Indonesia, an archipelagic nation of more than 17,000 islands, faces widespread challenges from emerging and re-emerging infectious diseases, including dengue, malaria, HIV/AIDS, tuberculosis, hepatitis and other viral illnesses. The difficulty is compounded by a population exceeding 280 million, diverse ecosystems, and uneven healthcare infrastructure. Beyond naturally occurring infections, Indonesia is also vulnerable to anthropogenic risks associated with emerging diseases and dual-use research. The high incidence of dengue, malaria, HIV/AIDS, tuberculosis, hepatitis and viral diseases such as avian influenza (H5N1) and COVID-19 illustrates these vulnerabilities. Dense populations, extensive animal husbandry and close human-wildlife interactions are the root causes.

While national and international collaborations have advanced vaccines and diagnostic development, such research carries the potential for misuse, including the engineering of dangerous pathogens. Experts assess that naturally occurring infections pose the greatest risk, the laboratory accidents a moderate risk and deliberate use of biological agents an extremely low risk. Large-scale biological weapon use has not been documented, yet security agencies remain vigilant due to the accessibility of biological materials. In response, Indonesia ratified the BWC through Presidential Decree No. 58 of 1991, affirming its commitment to global security and the peaceful use of biotechnology.

Despite this commitment, Indonesia lacks a comprehensive law addressing chemical, biological, radiological and nuclear security. There is no dedicated agency or ministry, nor specific Government funding for oversight on these issues. Responsibilities are dispersed across multiple ministries, often without effective coordination. As rapid advancements in biotechnology and life sciences introduce new risks, particularly related to bioterrorism and accidental releases, strengthening assistance, rapid response and preparedness is critical for Indonesia to implement the BWC effectively.

Strengthening assistance

Indonesia actively engages in ASEAN initiatives on chemical, biological, radiological and nuclear risk mitigation activities, including workshops, training exercises and information-sharing initiatives administered through the ASEAN Center of Excellence. In a recent milestone,

ASEAN Leaders issued their Declaration on Strengthening Regional Biosafety and Biosecurity in 2024. Internationally, Indonesia collaborates with United Nations entities, including the World Health Organization (WHO), as well as the Global Health Security Agenda network to enhance technical capabilities and readiness. Article VII of the BWC empowers Indonesia to request and provide assistance during biological emergencies, underscoring its proactive role in global biosecurity.

Rapid response

Indonesia's experiences with avian flu outbreaks and the COVID-19 pandemic have been pivotal in shaping its biological threat management initiatives. The crises fostered comprehensive civil-military collaboration, integrating health authorities with the National Defense Forces to support logistics, enforce social distancing, and disseminate public health information. They also gave rise to a culture of collaboration among academia, industry, government and media.

The response strengthened biosafety, biosecurity and risk management practices, several laboratory safety protocols having originated as part of avian flu preparation and response. The COVID-19 pandemic accelerated digital adoption and multisectoral coordination — lessons now embedded in Indonesia's BWC preparedness framework. However, as a middle-income country, Indonesia faces financial burden to develop the BWC infrastructure.

Preparedness strategies

Article IV of the BWC obliges State parties to take any necessary measures — whether legislation, regulations or administrative provisions — to prohibit and prevent the development, production, stockpiling, acquisition or retention of biological weapons. Indonesia has enacted the following:

- **Law No. 17 of 2023 on Health,** consolidating and revising prior health regulations
- **Law No. 6 of 2018 on Health Quarantine**, governing infectious disease control at borders
- Law No. 4 of 1984 on Outbreak Management, and Law No. 36 of 2009 on Health System Administration
- **Ministry of Defense Regulation No. 5 of 2015**, establishing protocols for on hazardous biological agents.

These regulations govern the export, import and transfer of certain biological agents and technologies. However, Indonesia lacks a unified Biological Security Bill. Efforts are under way to harmonize and modernize existing laws in line with international standards, but the bill's pending status limits enforcement.

Preparedness relies on a multisectoral biodefense system spanning local health centres to national agencies. The Ministry of Health has enhanced laboratory capabilities, including Biosafety Level 3 (BSL-3) facilities. Emergency responses involve the National Disaster Management Authority, Ministry of Defense, Ministry of Health, National Defense Forces, National Police and the State Intelligence Agency, supported by digital tools for disease mapping and contact tracing. The 2019 National Action Plan for Health Security, developed following a WHO-led Joint External Evaluation, aligns national preparedness with BWC obligations.

Future challenges

Indonesia faces five key challenges in implementing the BWC:

1. **Verification gaps**: The absence of an international verification mechanism results in heavy reliance on domestic enforcement.
2. **Technological advances**: Rapid progress in synthetic biology, gene editing and bioinformatics demand responsive legislation and expert oversight. Stronger dialogue between scientists and policymakers is essential, as current structures feature siloed communities with limited opportunities for ongoing interaction.
3. **Geographic constraints:** Archipelagic geography and uneven infrastructure hinder nationwide biosafety and biosecurity readiness, with remote provinces often lacking basic capacity, trained staff or rapid response mechanisms for a biological emergency.
4. **Institutional fragmentation**: Despite progress, compartmentalized organizations and poor in information-sharing continue to undermine efficiency. Clearer mandates, integrated whole-of-government mechanisms, and real-time data-sharing channels are critical to harmonize actions among government departments and scientific agencies.
5. **Public awareness**: Limited understanding of biosafety, biosecurity and BWC obligations necessitate broader education and outreach to civil society, academia and the private sector to help improve early detection, reporting and resilience.

Strategic investments in legal frameworks, infrastructure, training and regional cooperation are essential address these challenges.

Conclusion

Indonesia's commitment to the BWC is evident in its legal frameworks, preparedness measures, and regional and global engagement. Lessons from the COVID-19 pandemic underscore the importance of multisectoral cooperation, especially civil-military partnerships, as demonstrated by the key contribution of the Indonesian Defense Forces in public health efforts. Moving forward, adaptive policies, capacity-building and public engagement will be crucial to strengthening Indonesia's resilience against biological threats and upholding international security norms.

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PART 3

Verification and compliance

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Transparency and confidence-building in the Asia-Pacific region

Filippa Lentzos and Isabelle Wilson

Asia and the Pacific host rapidly expanding biotechnology sectors, increasing investments in biodefence, and diverse capacities in biosafety and biosecurity oversight. Even as these advances offer enormous benefits for human, animal and plant health, they also raise concerns about dual-use applications.

The region faces unique biological security challenges, particularly its vulnerability to emerging infectious diseases. Past outbreaks — SARS, avian influenza and most recently COVID-19 — have shown how naturally occurring diseases can destabilize societies and economies while fuelling misperception about outbreak origins and the intentions behind dual-use research and biodefence programmes. The controversy surrounding COVID-19's origin illustrates how uncertainty can quickly amplify suspicion, making transparency through the BWC's confidence-building measures (CBMs) especially valuable.

Confidence-building measures not only reassure States about peaceful intentions — critical in a region marked by nuclear-weapon States, territorial tensions and historical trust deficits — but also strengthen regional preparedness, cooperation and resilience.

This chapter focuses specifically on Southeast Asia, particularly the ASEAN Member States, as a distinct subregion within the broader Asia-Pacific. While many dynamics apply across the region, ASEAN's cooperative mechanisms offer important insights into enhancing transparency, trust and resilience under the BWC.

Demonstrating responsible behaviour

ASEAN States have consistently emphasized their regional biological security priorities and recognized that confidence-building measures as essential for reducing ambiguities, building trust and enhancing transparency among BWC States parties. In a joint statement to the 2023 BWC Meeting of States Parties, ASEAN highlighted such measures and their reporting practices for their role in maintaining international peace and security, ensuring national security and assessing national implementation of the BWC — including biosafety and biosecurity oversight — as well as identifying needs and capacities for cooperation.

States parties adopted the Convention's confidence-building measures at the second Review Conference in 1986 as a compromise following calls for a legally binding verification regime. At the time, many States anticipated a verification system that included declarations and on-site inspections, similar to the arrangement then under negotiation for the Chemical Weapons Convention. In that context, numerous BWC States parties argued that it would be preferable to first conclude the CWC negotiations, which could then serve as a model for a potential BWC verification protocol. The confidence-building measures were therefore adopted

by consensus as an interim measure "to prevent or reduce the occurrence of ambiguities, doubts and suspicions, and in order to improve international co-operation in the field of peaceful bacteriological (biological) activities".

Although a verification protocol proved unattainable in the 1990s and 2000s, confidence-building measures remain the core mechanism for voluntarily exchange compliance-related information exchange. Asia-Pacific States, like others, stress that these measures are not a substitute for formal verification and support ongoing discussions on compliance assessment within the Working Group on the Strengthening of the Biological Weapons Convention.

Recent discourse has shifted from technical verification towards a more "behavioural arms control" approach — initially applied in the nuclear context — focused on demonstrating responsible behaviour. Regular, high-quality submissions under confidence-building measures allow States to uphold article I norms exemplify responsible science and transparency. Given the geopolitical and dual-use realities of the biological security landscape, it is in the interest of all states to voluntarily exemplify responsible behaviour.

Towards greater regional engagement on confidence-building measures

Confidence-building measure submissions across ASEAN have been uneven but improving (see Table 1). Malaysia, the Philippines, Singapore, Thailand and Myanmar have generally submitted consistently over the past decade. Brunei, Lao People's Democratic Republic and Cambodia began reporting more recently but now do so regularly. Indonesia has submitted only once (2015), while Viet Nam and Timor-Leste made their first submissions in 2025.

Most ASEAN submissions remain private, except for Myanmar's public reports in 2016 and 2018. Globally, confidence-building measures were designed to reduce ambiguities and uphold norms under articles V and X. Submission volumes are rising: 2024 saw a record 113 States reporting, and 2025 appeared on track to surpass that with 111 submissions as of September. However, only a fraction is public, although more States around the world are beginning to share reports openly.

Regional training initiatives — such as the 2023 Southeast Asia workshop in Bangkok and the 2024 Shenzhen workshop — have helped build capacity and share best practices for reporting. ASEAN States welcomed these efforts as vital for strengthening regional capabilities.

Voicing Asia-Pacific realities and priorities

Beyond regular and accurate confidence-building measure submissions, it is crucial that Asia-Pacific States' perspectives shape international discussions. The region's strategic complexity, diverse capabilities, and growing role in biotechnology and biosecurity governance make its contributions indispensable. Asia-Pacific States highlight practical challenges such as capacity constraints, dual-use oversight, and the need for tailored support. Their participation ensures that global CBM processes are more inclusive, reflecting the realities and priorities of the Asia-Pacific region and not just the interests of major global powers.

In an era of rapid biotechnological advances and heightened dual-use concerns, confidence-building measures as more than reassurance tools. They reinforce norms, foster responsible research, and promote a culture of transparency and trust within the broader biosecurity landscape.

Table 1. Confidence-building measure submissions from ASEAN states, 2015–2025

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Brunei Darussalam						Private				Private	Private
Cambodia								Private	Private	Private	Private
Indonesia	Private										
Lao People's Democratic Republic									Private	Private	Private
Malaysia	Private	Private	Private	Private	Private	Private	Private	Private	Private	Private	
Myanmar		Private		Private		Private	Private	Private	Private	Private	Private
Philippines			Private	Private	Private	Private	Private	Private	Private	Private	Private
Singapore	Private	Private	Private	Private	Private	Private	Private	Private	Private	Private	
Thailand		Private	Private		Private	Private	Private	Private	Private	Private	Private
Timor-Leste											Private
Viet Nam											Private

Source: **https://bwc-cbm.un.org**.

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Verification and compliance under the BWC: An Asia-Pacific perspective

Kirsten Angeles, James Revill and Ryan Teo

In 2022, the ninth BWC Review Conference established the Working Group on the Strengthening of the Biological Weapons Convention to address compliance and verification, among other issues. This marked the first time that verification returned to the multilateral BWC agenda since the collapse of the protocol negotiations under the Ad Hoc Group in 2001.

The Working Group has convened six times as of this writing. Compliance and verification have featured prominently, guided by two Friends of the Chair: Ambassador Robert in den Bosch (Netherlands) and Mr. Alonso Martínez (Mexico). These discussions have clarified key verification concepts and underscored the unique challenges biological verification poses compared to other arms control regimes. Unlike chemical or nuclear verification, which rely on material accounting, biological agents are often naturally occurring and self-propagating — making traditional approaches less effective. The dialogue has also prompted reflection on the scope and objectives of BWC verification and the evolving biological threat landscape.

States from the Asia-Pacific region have actively engaged in this process. Regional groups such as ASEAN have delivered joint statements to the Working Group reaffirming their commitment to the BWC and the need for a verification mechanism.

Yet, consensus remains elusive. Developing such a mechanism will likely extend beyond Working Group's mandate and require a dedicated expert process to bridge significant differences — particularly regarding routine on-site activities.

Biotechnology growth in the Asia-Pacific

Building a shared understanding of verification is critical if the 50-year-old global prohibition on biological weapons is to endure for another half-century. This is especially true as biotechnology advances and diffuses globally.

The Asia-Pacific region is central to this discussion. It hosts several biotechnology hubs and an expanding market projected to grow rapidly through 2033. The region already accounts for 19% share of the global biotech market and is expected to lead growth. Patent data from the World Intellectual Property Organization places China, India, Japan and the Republic of Korea among the top 10 biotechnology patent applicants worldwide.

Several States of the region have developed biotechnology-related strategies, and interest from the younger generations is rising. In 2025, 125 Asian high-school teams registered for the International Genetically

Engineered Machine (iGEM) competition. Inspired by iGEM, China launched the SynBio Challenges in Shenzhen, now the world's second-largest synthetic biology competition, with participation doubling annually since 2022.

Despite this dynamism, capacities and legal frameworks for biosafety and biosecurity vary widely across the region. The member States of ASEAN have taken steps to strengthen cooperation through initiatives such as the ASEAN Biosafety and Biosecurity Network and the ASEAN Leaders' Declaration on Strengthening Regional Biosafety and Biosecurity. However, these entities often operate independently, limiting the development of binding regional mechanisms or centralized oversight.

Other regional powers have also contributed: China advanced the Tianjin Biosecurity Guidelines for Codes of Conduct for Scientists and enacted a comprehensive Biosecurity Law, while India established licensing and inspection systems for work with biological agents and toxins.

Regional perspectives on verification

Asia-Pacific States have long expressed concern over the absence of a verification mechanism both in their individual capacities and through the Non-Aligned Movement, which has advocated consistently for a legally binding protocol. In a recent statement, the Non-Aligned Movement called for resuming "multilateral negotiations for a legally binding Protocol to the BWC, addressing all Articles".

Lessons from past efforts, including the Ad Hoc Group negotiations and the Verification Experts (VEREX) findings, remain relevant. However, as Ambassador Frederico Meyer (Brazil), Chair of the Working Group of the Strengthening of the Biological Weapons Convention, notes, "amazing advances in the life sciences" have transformed the context since those earlier initiatives.

While many regional States favour a legally binding protocol, there is less clarity on what such a mechanism would entail or how it would align with national legislation and capacity. Cost concerns further underscore the need for an equitable, capacity-sensitive approach.

Asia-Pacific regional input is essential for three reasons.

1. **Diverse threat perceptions**: Biological threats vary across regions. For many Asia-Pacific States, related concerns may centre on public health and zoonotic disease outbreaks rather than bioweapons proliferation. Any future mechanism must reflect those priorities.
2. **National foundations:** Verification will require national-level actions such as declarations and on-site visits. While several States in the Asia-Pacific have drafted or enacted BWC-implementing legislation, progress remains uneven due to resource constraints and differing priorities. The Working Group can play a pivotal role in identifying verification measures that are both and operationally feasible for all States parties. In addition, informal mechanisms — such as engagement with — could help build trust, particularly in contexts where formal verification may be politically sensitive.
3. **Collective leadership**: Biological disarmament diplomacy demands champions. Asia-Pacific States have

played this role: China and Pakistan co-led initiatives on responsible science, and States from the region hold key positions in the Working Group. Such leadership ensures diverse perspectives in shaping the Convention's future.

Looking ahead

Chaired by Brazil, the Working Group began negotiating a "rolling text" in July 2025, including proposals for an open-ended working group on compliance and verification. Suggested issue areas include on- and off-site activities, declarations, institutional arrangements, and investigative measures. The text also calls on States parties to conduct trials of verification measures in cooperation with industry to assess feasibility and cost — an opportunity for Asia-Pacific States to demonstrate leadership.

Verification will not be cheap. It will require resources far beyond the BWC's current modest budget of US$2.1 million. Yet, as biotechnology advances amid geopolitical tensions, the value of a politically acceptable, technically feasible and financially sustainable verification mechanism cannot be overstated. Achieving this would strengthen confidence in the BWC and help avert a future where biological weapons pose an even greater threat.

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Conclusion

Conclusion

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As the essays in this volume make clear, the global biological landscape has changed profoundly since the BWC entered into force in 1975. Advances in synthetic biology, AI and gene synthesis have created extraordinary opportunities for human health and innovation but also lowered barriers to misuse. The Asia-Pacific region's rapid biotechnology growth, regional security dynamics and varied governance capacities underscore both the urgency and the complexity of safeguarding against biological risks.

Several themes emerge across the contributions.

First, there is broad recognition that the BWC must adapt structurally and substantively to remain relevant. This includes strengthening transparency through more regular and accurate confidence-building measure submissions, integrating private-sector and scientific voices into review processes, and expanding opportunities for regional cooperation.

Second, national case studies — from India's growing biotech ecosystem to the Republic of Korea's public health surveillance model, from China's integrated legal and diplomatic approach to Indonesia's institutional gaps — highlight the diversity of experiences in translating BWC obligations into practice. These examples underline the need for context-sensitive but globally coordinated approaches.

Third, verification and compliance remain the Convention's most pressing challenge. While the Working Group on the Strengthening of the Biological Weapons Convention has revived long-stalled discussions, consensus is still elusive. The Asia-Pacific region has consistently advocated for a legally binding verification mechanism, but moving forward will require bridging political divides and developing mechanisms that are politically acceptable, technically feasible and financially sustainable.

Looking ahead, the next 50 years of the BWC will demand not just incremental adjustments, but systemic renewal. This means exploring a stronger institutional base, perhaps through a standing secretariat with adequate funding — akin to the OPCW — to support implementation, training and outreach. It means building scientific and technical advisory structures suited to today's realities: less focused on static lists of pathogens, and more attuned to fast-moving developments such as AI-enabled biology, cyberbiosecurity and the challenges of screening DNA synthesis to prevent misuse. It also means creating inclusive working groups that balance Global North and Global South perspectives, ensuring that governance frameworks reflect the voices of those most exposed to biological risks.

Finally, the BWC's future must embrace both top-down leadership — through State-level frameworks, oversight, and diplomacy — and bottom-up responsibility, empowering front-line scientists, technologists and industry actors to identify risks and uphold norms of responsible conduct. The Tianjin Biosecurity Guidelines and similar initiatives show the value of voluntary codes and shared practices at the laboratory level, complementing national regulations and multilateral commitments.

The message from this volume is clear: the BWC has been indispensable for 50 years, but its continued relevance will depend on renewal. The Asia-Pacific region's experiences, innovations and perspectives will be central to shaping that process. With sustained political will, practical governance innovations and inclusive dialogue, the BWC can rise to the challenges of the next half-century — and continue to safeguard humanity against the deliberate misuse of biology.