Strengthening science and technology under the Biological Weapons Convention

International Science Council

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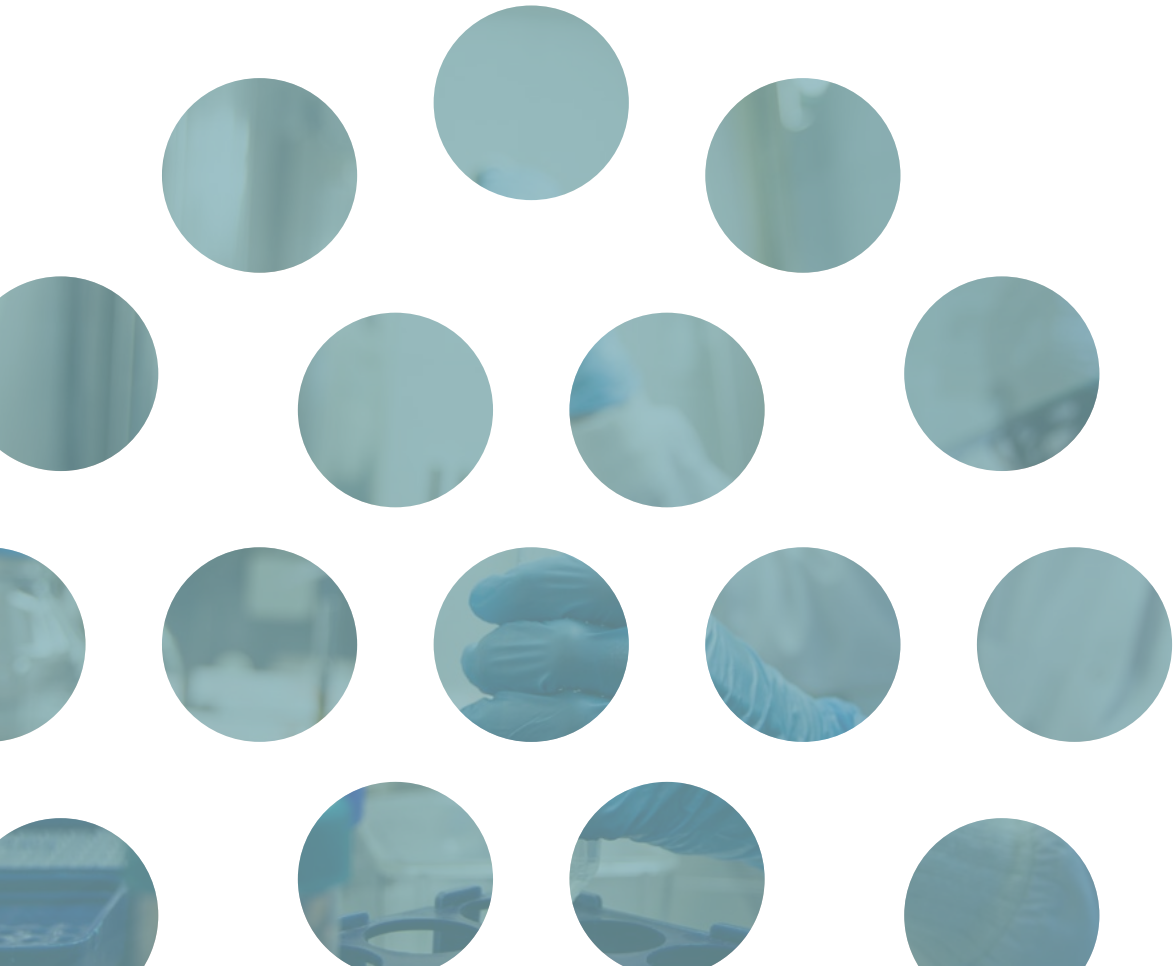

Strengthening science and technology under the Biological Weapons Convention

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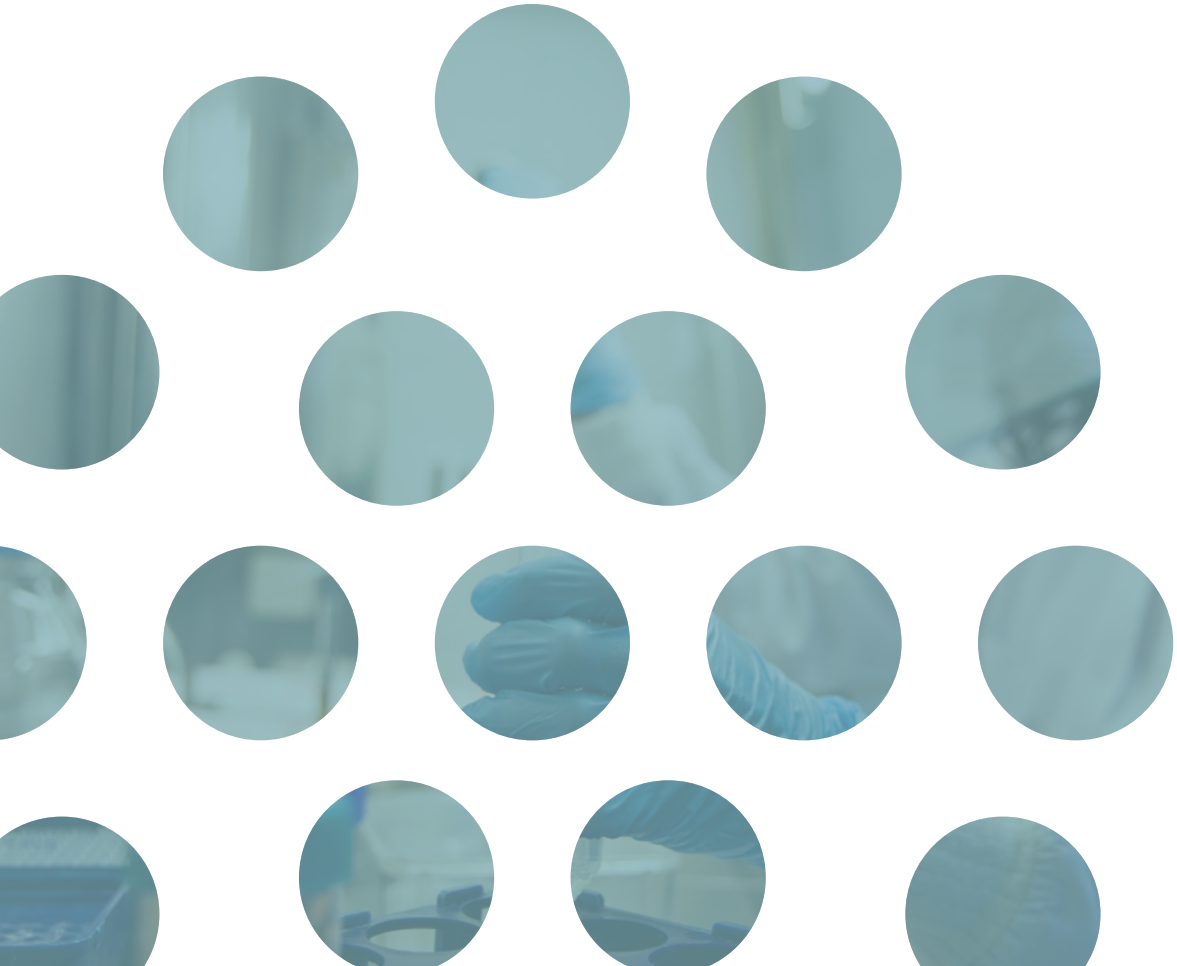

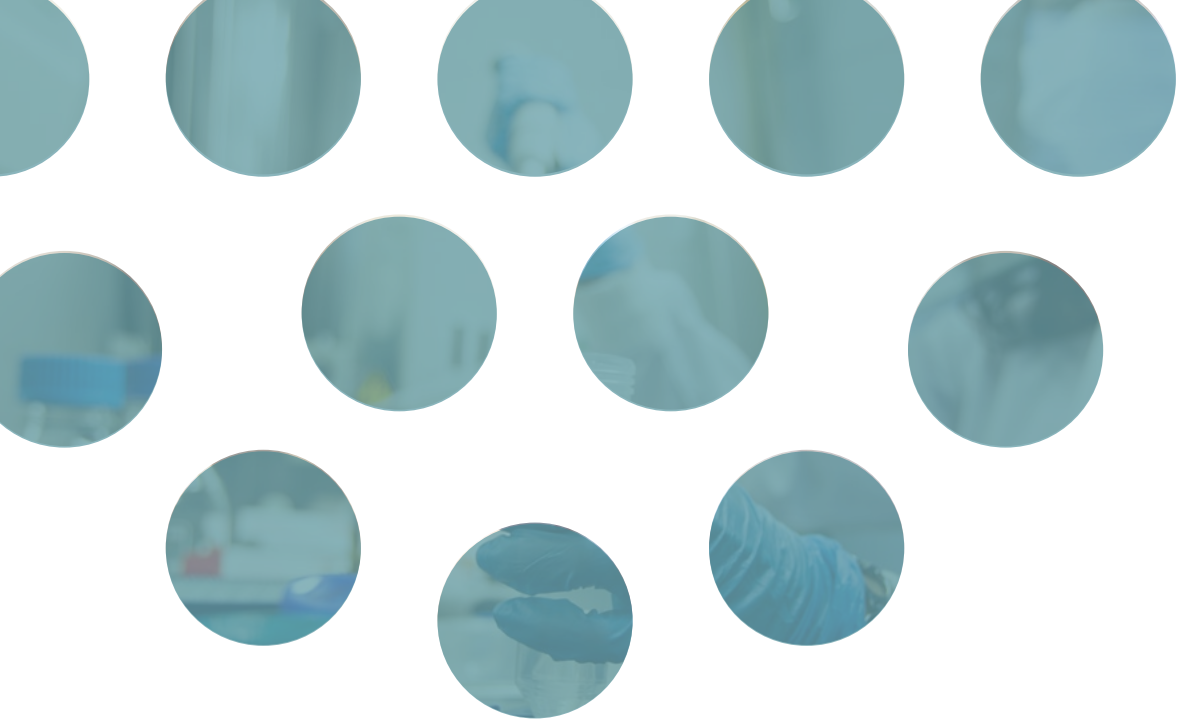

Executive Summary

This year marks the 50th anniversary of the Biological Weapons Convention (BWC), a landmark international treaty that comprehensively bans a class of weapons of mass destruction. It is a bittersweet anniversary, with the Convention confronting unparalleled challenges amid a period of swift scientific progress. The dynamic landscape of science and technology relevant to the BWC encompasses promising benefits and significant threats, requiring that BWC policy-makers have access to scientific expertise to aid their decision-making processes. Historically, however, the BWC has relied on ad hoc expert panels and occasional submissions by national delegations for scientific input. This context highlights the need for a dedicated scientific advisory mechanism to enhance scientific collaboration, foster information exchange and provide timely insights to all States Parties, regardless of their national science, technology and innovation resources.

This paper, developed by the ISC Expert Group for the Biological Weapons Convention, provides perspectives and recommendations for creating a successful scientific advisory mechanism, one that can ensure scientific and technological advances with relevance to the implementation of the BWC are identified and communicated to policy-makers in a timely, credible and independent manner.

The expert group highlighted the need to establish a credible scientific advisory body, whose membership includes broad geographic diversity and gender balance to ensure a wide range of knowledge, perspectives and contexts. The inclusion of recognized experts and thought leaders in fields relevant to the BWC is crucial, along with the flexibility to draw on additional expertise as needed. The advisory mechanism must remain scientifically grounded and act as an independent subsidiary body of the BWC. The mechanism serves to share scientific advice among BWC States Parties with whom it can build trust and demonstrate transparency. As a credible scientific body, it could also serve to stimulate engagement and collaboration with scientific and expert communities beyond the BWC.

Key considerations for designing and operationalizing the scientific advisory mechanism include (1) allowing for flexibility and adaptability in tasking the mechanism to address pertinent scientific topics; (2) providing States Parties with advice developed from proactive input of the experts within the mechanism; (3) effective dialogue and communication between the mechanism and the intended recipients of its advice; and (4) visibility within the forum it serves.

Having robust governance processes, engagement with data and expertise, and the development of effective working modalities for the mechanism cannot be stressed enough. Learning from past experiences and innovating to promote science as a global public good to counter biological weapons can strengthen the evidence base for the implementation of the BWC. Insights into the operationalization of the mechanism's key functions, including monitoring, horizon scanning and foresight, are provided, emphasizing the need for scientific thought leadership and defined functions to ensure the mechanism's effectiveness, accountability and transparency.

1. **Create a scientific advisory mechanism**
    - Create a dedicated advisory body to systematically assess emerging science and technology (S&T) trends relevant to the BWC and provide continuous, independent expert input into treaty deliberations.
2. **Prioritize science and technology issues**
    - Develop and implement structured prioritization processes to focus on pressing and impactful S&T issues for BWC implementation and support the BWC decision-makers with scientific and evidence-based advice.
3. **Horizon scanning, foresight and staying abreast of scientific developments**
    - Leverage the expertise, networks and communities of the membership of the scientific body, and potentially other relevant organizations, to identify emerging risks and opportunities and remain aware of relevant scientific publications, patents and industrial trends.
4. **Peer exchange and learning**
    - Engage with the BWC States Parties, understand their uses of S&T advice from the mechanism and use their feedback to refine products of the mechanism so they are more effective.
    - Promote formal (e.g. briefings) and informal (e.g. dialogues like the Organisation for the Prohibition of Chemical Weapons' (OPCW) 'Science for Diplomats') engagements to strengthen mutual understanding between scientists and policy-makers.
5. **Transparency and inclusivity**
    - Ensure the advisory mechanism is diverse, independent and transparent, involving a broad range of scientific disciplines and regional perspectives.
6. **Countering biological weapons and supporting the norms and values of the BWC**
    - Promote responsible innovation and biosecurity principles, provide decision-makers with insight on how science benefits the implementation of the BWC and highlight how scientific and technological advances can reinforce the peaceful uses of biology and strengthen the norms against the misuse of life sciences.
7. **Science–policy interface**
    - Develop clear communication strategies to strengthen engagement between scientists

and policy-makers, ensuring that scientific insight is drawn upon by the States Parties to develop effective policy recommendations.

Integration of these elements into the workings of a scientific advisory mechanism offers a practical pathway to strengthen BWC and its implementation in a world of dynamic scientific and technological change. Equipping BWC policy-makers with access to robust and independent scientific advice is a significant step forward in the realization of a fit-for-purpose global biosecurity architecture.

Strengthening the Biological Weapons Convention (BWC) by facilitating science–policy synergies is an initiative sponsored by the Geneva Science–Policy Interface and led by the International Science Council (ISC). This initiative addresses the need, highlighted during the Ninth BWC Review Conference in 2022, to integrate scientific developments into the Convention's operations, particularly through scientific review and possible measures on compliance and verification. In May 2024, the ISC was awarded a grant by the Geneva Science–Policy Interface to strengthen the BWC. The six-month project, coordinated by the ISC, aims to support the Working Group on the Strengthening of the Convention by providing scientific insights into policy discussions, with targeted support to the Friends of the Chair on science and technology, compliance and verification, and international cooperation and assistance.

This discussion paper was drafted by the ISC Expert Group following two online discussions with the Friends of the Chair, which helped the expert group identify and respond to the needs of the Friends of the Chair on science and technology.

1 Introduction: the need for scientific review in the Biological Weapons Convention

The landscape of Science and Technology (S&T) relevant to the Biological Weapons Convention (BWC) is broad, dynamic and rapidly evolving, encompassing both threats and benefits to the now 50-year-old disarmament treaty. Threats include the potential to weaponize naturally occurring pathogens and the ever-increasing antimicrobial resistance that makes populations more vulnerable to outbreaks, along with dual-use research of concern, which could be harnessed for deliberate development of biological weapons (e.g. toxins, engineered pathogens with pandemic or catastrophic potential). The engineering of novel dispersal devices and the potential for accidental release of a pathogen from a laboratory conducting biological weapons research and development further complicate the threat landscape. Conversely, S&T benefits provide a broad spectrum of advancements that can serve to counter and prevent biological weapons and strengthen the implementation of the BWC. Assessing the impact of S&T and its relevance to the BWC is complex given the dual-use nature of life science research and development, which enables relevant technologies to provide both risks and benefit. This, coupled with advances in emerging technologies (such as artificial intelligence and quantum computing) along with technological convergence, sector spillover, and a continually increasing global diffusion of S&T knowledge, means that addressing the implications of an ever-changing portfolio of S&T issues presents a significant challenge.

Traditionally, scientific input to the BWC has relied on ad hoc expert panels, the occasional submission of working papers by national delegations, and the participation of scientists.

However, the number of delegations submitting papers has remained limited (in part due to resources and non-priorities on non-technical issues by participating delegations)[1]. There is general agreement among the BWC States Parties on the need for a dedicated scientific advisory mechanism to keep pace with advancements in S&T and inform BWC deliberations more effectively. Such a mechanism might also encourage scientific collaboration across States Parties, foster information exchange, enable more robust assessments of potential threats and their prevention, identify beneficial and enabling technologies and ensure accessible, timely insights for all States Parties, regardless of their own national science, technology and innovation resources.

Discussions on formalizing a scientific advisory function for the BWC have been ongoing for many years, with States Parties raising the issue throughout the history of the BWC, reflecting a recognition of the need for structured, regular and consistent scientific guidance. Establishing a permanent scientific advisory mechanism would allow for systematic engagement with scientific developments and offer policy-relevant insights to support the object and purpose of the BWC and its implementation.

Since 2023, the BWC States Parties have made great progress deliberating on the establishment of a science and technology advisory mechanism, open to all States Parties, to review and assess scientific and technological developments relevant to the BWC. The proposed mechanism would provide advice to States Parties. Organizationally, the mechanism would consist of three components: a Science and Technology Review Group (STRG), open to scientists from all States Parties, and a Science and Technology Reporting Committee (STRC) with up to 25 members nominated from the STRG. The STRG is intended to provide inputs and review scientific issues that can be compiled and provided to the smaller STRC to synthesize into a report and develop recommendations for the BWC States Parties. The terms of reference also allow for temporary working groups to provide access to specific technical expertise from outside the STRG. The proposal, if adopted, would request the President of the Review Conference to facilitate establishment of the mechanism. Funding for the board's activities, including meetings and administrative support, would be from assessed contributions by States Parties, with additional funding by voluntary contribution. The Review Conference would provide guidance and oversight, with the mechanism's mandate subject to renewal at the next Review Conference. While the proposal has not been agreed on at this time, a draft decision outlining the terms of reference and rules of procedure is very mature.

In August 2024, the ISC constituted an expert group to provide scientific advice in the context of the Working Group on the Strengthening of the BWC. This initiative is a significant step towards integrating scientific advancements into the operations of the BWC, addressing the critical need for a structured mechanism to review relevant science and technology developments. The inputs provided by the ISC Expert Group for the BWC are based on the non-paper developed by the Friends of the Chair on S&T entitled 'Draft elements for consideration by State Parties for the establishment of a mechanism to review and assess scientific and technological developments relevant to the Convention and provide States Parties with relevant advice' that was discussed at the December 2024 meeting of the Working Group on the Strengthening of the BWC, as well as two informal discussions with

[1] *From the Eighth to the Ninth Review Conference, only twelve States Parties and the NAM submitted working papers on S&T topics or on science advice mechanisms more broadly. In relation to the Working Group, eight working papers have been submitted by five State Parties since August 2023 (UN Office for Disarmament Affairs, 2024).*

the Friends of the Chair on S&T and deliberations among the ISC Expert Group.
While deliberations among State Parties of the BWC to define the scope and institutional arrangements of a potential new scientific and technological advisory mechanism are ongoing, there are important dimensions to consider for the design and operationalization of such a mechanism to promote the credibility, legitimacy and impact of the science advice that would be delivered.

This discussion paper is intended to provide perspective and recommendations for creating a successful scientific advisory mechanism for the BWC, to ensure scientific issues are addressed and communicated to the policy-making organs and the science advice and advisors are seen as credible and independent of the political environment in which they operate. ■

2 Science advice in the context of a multilateral arms control, disarmament and non-proliferation treaty

While many discussions around the BWC are S&T centred, it must be appreciated that the BWC is a political agreement intended to ban an entire class of weapons of mass destruction; it is not an agreement that governs science – rather it seeks to eliminate biological weapons. A scientific advisory mechanism serves as a valuable resource to inform decision-makers, yet in the BWC, the deliberations among the policy-makers are not about science. While BWC policy-makers may not render scientific decisions, the scientific basis for the potential weaponization of biological agents is inherently multidisciplinary, involving a growing number of pathogen reservoirs and vectors, rapid biotechnological advances and dual-use applications that may be difficult to discern. Furthermore, countries vary widely in their science, technology and innovation capabilities and their capacity to deploy and derive benefits from them. For example, according to the 2021 Global Health Security Index, 183 out of 195 countries (94 per cent) lack national-level oversight measures for dual-use research of concern, and many do not have dedicated agencies for biosecurity and biodefence oversight (Bell and Nuzzo, 2021). This disparity in science, technology and innovation capacity heightens global biosecurity risks and underscores the importance of equitable access to scientific insight and resources and international collaboration to counter biological threats. The Pact for the Future adopted by UN Member States in September 2024 also highlights the need to better anticipate, prevent and prepare for evolving biological risks (United Nations, 2024). Science advice can inform States Parties on how to best navigate these issues.

Biological weapons encompass both the biological agents intended to cause harm (microbes – bacteria, viruses and fungi – and toxins) and their means of delivery and dispersal as weapons (UN Office for Disarmament Affairs, 1972: Article 1). The definition of a biological weapon within the BWC also requires intent to use biology as a weapon. This implies that the risk of an emerging pathogen arising from the effects of climate change or the release of an infectious agent (that was not being developed intentionally as a biological weapon) from a laboratory accident would not constitute a biological attack. The response to an outbreak that is not a biological attack would also fall outside the purview of the BWC.

If the BWC is to have a single scientific advisory mechanism, that mechanism must be prepared to take on any scientific question or topic that the policy-makers need advice on. This is not limited to identifying what might be a bioweapon, dual-use technology and/or biodefence. Issues that the mechanism might be tasked to consider would likely also include beneficial technologies for BWC implementation, international scientific cooperation, fundamental scientific concepts to enhance the scientific literacy of policy-makers, and scientific dimensions of approaches to compliance and verification measures. ■

3 Key considerations in designing and operationalizing scientific advice in the context of the BWC

Science advice in a multilateral system takes many forms depending on the issues that need to be considered, the mandates of the agreement that the scientific advice will support, the objectives and functions of the advisory mechanism and the intended recipients of the advice. There are many scientific advisory bodies that serve multilateral forums (Revill et al., 2021). Some, like the Organisation for the Prohibition of Chemical Weapons (OPCW) Scientific Advisory Board (SAB) (Organisation for the Prohibition of Chemical Weapons, n.d.a), are well known to the BWC community, while others outside disarmament communities can offer important transferable lessons on how to convene and draw upon expertise to inform decision-making. What makes these advisory bodies successful and impactful is how they interact within the 'ecosystem' in which they serve, and how well the information and advice they provide speak to the priorities and needs of their stakeholders. There is no one-size-fits-all model, and success may require approaches and modalities that have flexibility in how they are used, while still working within agreed terms of reference and established rules of procedure.

In general, multilateral scientific advisory bodies that reflect the diversity of the forum they serve and provide independent consensus-based expert advice are seen as highly credible. The importance of maintaining this credibility cannot be overstated, especially for a forum such as the BWC where treaty implementation takes place at the national level. A disadvantage of multilateral scientific advisory bodies, however, is that they often have limited visibility and access to national-level decision-making forums. Their impact on national-level decision-making then relies on the initiative of States Parties to take the advice back to national capitals (Hutchings and Stenseth, 2016). The more credible a scientific advisory body is seen to be, the greater the attention it is likely to receive from delegations, which increases the likelihood that capitals will take notice.

3.1. Credibility through inclusive and diverse expertise and experience

A robust understanding of risks and benefits from biological advancements requires engagement with a wide breadth of expertise across and beyond the life sciences. Due to the complex nature of biological risks and benefits, expertise within the mechanism would ideally encompass a wide breadth of biological science disciplines and biotechnology (especially those that allow for the 'engineering' of biological systems such as gene editing

technologies) and be complemented with experts from epidemiology and public health, biosecurity and biosafety, bioinformatics, emerging technologies (especially artificial intelligence and robotics), forensics and investigative science, and various engineering domains. Outside of science, technology, engineering and mathematics (STEM) disciplines, social scientists, public policy experts and ethicists can provide insights on what factors might motivate or deter the pursuit of bioweapons and on recognizing a dual-use application of a technology. Those with expertise in providing scientific advice in legal and regulatory environments can bring practical experience in developing advice that speaks to the interests and needs of decision-makers. Holistic frameworks such as One Health do bring together relevant transdisciplinary expertise; however, it should also be appreciated that the scope of the BWC is about security.

To be effective, scientific experts with experience in science brokerage and science communication with diplomats and policy-makers are needed to help to frame questions that the mechanism can address from a scientific point of view, while remaining relevant to the needs and concerns of States Parties. This speaks to the need for communicating scientific information, its implications, limitations and uncertainties effectively to non-experts. Such translational skills are extremely valuable and can be easily (and unintentionally) overlooked when establishing scientific advisory mechanisms. While the areas of expertise noted above are by no means exhaustive, they illustrate the value of adopting a transdisciplinary approach to providing well-developed and actionable scientific advice.

3.2. Credibility through gender and geographical balance

Geographical diversity and gender balance ensure that a range of perspectives and contexts are brought to bear, and that the scientific advisory mechanism reflects the make-up of the multilateral forum that it serves. Demonstrating that scientific agreement can be obtained across this diversity of experts provides high levels of credibility in a multilateral forum.

3.3. Scientific credibility and leadership

A credible scientific advisory body will be made up of recognized experts and thought leaders in their fields at both national and international levels. Across the diversity of existing scientific advisory body models, participants might be nominated by States and selected by the leadership of the multilateral forum, while in other cases, participants self-nominate in response to an open call and institutional criteria are used to make selections (this has been successful in the World Health Organization, which forms advisory bodies with a well-defined focus and mandate). Strong scientific credentials are required, regardless of the model. The current proposal within the BWC will see States Parties submitting nominations, and the Chair and Vice-Chairs of the scientific advisory mechanism (themselves appointed by representatives of States Parties) helping to select members. Some scholars have suggested that the open-call model enables a 'transparent recruitment process and facilitate[s] diverse representation' (Revill et al., 2021). With this in mind, the States Parties might consider the open-call model for selecting their nominees from their national-level communities.

As currently proposed, the scientific advisory mechanism will have a Chair and multiple Vice-Chairs. As these individuals will preside over scientific discussions, for credibility reasons they should be scientists themselves. The Chair and Vice-Chairs play key roles in managing the scope of work of the mechanism, balancing broad outlooks and narrower

focus on specific issues, eliciting meaningful engagement from the broad membership, helping to identify the range of expertise required to address issues under consideration (and identify where additional expertise may be needed), steering discussions to ensure that they focus on scientific considerations and facilitating expert elicitation and scientific deliberations towards consensus where possible.

3.4. Flexibility to draw on additional expertise as needed

The membership of a BWC scientific advisory mechanism is unlikely to fully capture all the possible life-science-related and adjacent expertise that could foreseeably be relevant. The current proposal has useful provisions to overcome gaps in expertise, such as the use of temporary working groups and the ability to invite observers. Both are useful options for reaching out to targeted expertise that would allow the mechanism to address mandated and recommended topics without being prescriptive on the exact make-up of experts appointed to the mechanism. Formal cooperation agreements could also be considered to allow for routine engagement of relevant international organizations, the private sector and other stakeholders.

3.5. Independence and transparency

The nature of the debates within the BWC can be sensitive and intersect with development, security, defence, geostrategic interests and more. As a result, the advisory mechanism must be seen as an independent subsidiary body of the BWC that is focused on S&T and not as supporting or recommending policy positions of individual States Parties or otherwise biased in its advice.

Here, the mechanism has an opportunity to stimulate collaboration in scientific and expert communities beyond the BWC, for instance on emerging issues or areas where there is limited consensus. As seen in numerous other scientific advisory mechanisms (see Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, n.d.), the mechanism could help catalyse new research, inspire scientific collaboration and identify where scientific capabilities (whether existing or to be developed) are needed both nationally and internationally. To this end and given the increasingly complex and globalized biotechnology landscape, it is important for the scientific advice to be shared and made accessible to the States Parties and broader BWC stakeholders in support of building trust and demonstrating transparency.

3.6. Flexibility, adaptability and scope of science advice

Given the pace of change and discovery across the life sciences, flexibility and adaptability in the tasking of the mechanism are needed to ensure that pertinent discoveries and advances (whether they pose risks or benefits) can be discussed across a wide spectrum of disciplines and sectors at the speed of relevance. This includes flexibility in the tasking of the mechanism, as constraining its work to topics decided on a yearly (e.g. Meeting of States Parties) or five-yearly (e.g. Review Conference) basis may not allow the focus of the advice to shift with the pace of developments in science and technology. While scientific change is often rapid, especially in biotechnology and informatics, the mechanism will need to balance the alure of new trends and breakthroughs with practical scientific facts and concepts – a biological weapon need not be solely derived from a cutting-edge technology – and likewise for countering biothreats.

The demand for scientific advice coming from BWC States Parties and the provision of proactive inputs by the scientists within the mechanism will need to be balanced to ensure that the outputs of the mechanism are relevant to the policy-makers' needs (and their ability to absorb and act on the advice). As an example to follow, the history of the OPCW SAB provides a good benchmark for balancing the immediate needs of the States with future-looking consideration of scientific and technological evolution for treaty implementation (Forman and Timperley, 2018; Forman et al., 2018; Clapham and Hotchkiss, 2024).

3.7. Dialogue, iteration and learning

Effective dialogue and communication between the mechanism and the intended recipients of its advice is one of the most crucial elements for making a science advisory mechanism successful. For the BWC, the recipients of the advice are the States Parties. Establishing a process through which the Chair and Vice-Chairs can review and provide feedback on any requests from the policy-makers would be helpful in ensuring the mechanism will address scientific questions rather than issues that may be difficult to separate from policy debates and non-technical concerns. Likewise, requests that provide context for why the advice is needed and how the decision-makers intend to make use of it can provide valuable guidance to the scientists in the mechanism, ensuring clarity of topic and objective.

To be effective, it is essential to ensure the scientific advisory mechanism has visibility within the forum it serves (e.g. its 'science advice ecosystem'). This visibility could be achieved in a variety of ways, including formal documents and informal briefings. The OPCW SAB has developed an effective process for science–policy dialogue that might be drawn upon. All SAB session reports and its reports to Review Conferences receive a formal response as an official document from the OPCW Director-General (see Organisation for the Prohibition of Chemical Weapons, 2023a, 2023b). This response highlights key topics that touch on immediate operational issues at the OPCW, points to scientific issues that are relevant to current deliberations among the Chemical Weapons Convention (CWC) States Parties, and most importantly helps to frame the policy-making relevance of the topics being considered in the SAB. While there is no BWC implementing body with a Director-General, a respected official from the United Nations Office for Disarmament Affairs (UNODA) might be able to provide a similar response to a BWC scientific advisory mechanism report.

Embedding peer exchange and learning by encouraging feedback from States Parties on the impact of any advice from the mechanism that their decision-makers have taken forward would provide helpful context for States Parties to recognize where they may want to propose more refined or focused requests in the future. Spaces for formal (e.g. briefings to the Meeting of States Parties) and informal (in the spirit of OPCW's 'Science for Diplomats' Initiative; see Organisation for the Prohibition of Chemical Weapons, n.d.b) dialogue between State Parties and the mechanism should also be considered to support a shared understanding of the science relevant to the BWC.

There is a broad range of issues on which parties to a treaty on disarmament and non-proliferation of weapons of mass destruction might request science advice on. Again, the experiences of the OPCW SAB serve as a relevant example. The SAB has touched on issues that range from clarifications of technical definitions, overviews of scientific trends (in chemistry and beyond), identification of risks and benefits of scientific developments, designing analytical proficiency testing schemes, and more. SAB outputs have also impacted national-level decision-making in unexpected ways. For example, a 2016 question

on molecular-level structural features of chemical substances (something seemingly far removed from the macroscopic world needs of CWC policy-makers) resulted in updates to national-level CWC implementation practices in the United Kingdom (Timperley et al., 2018). This example is noteworthy as it did not identify new types of chemical weapons or threats to the CWC, but it did have real impact. There are many other examples of advice from the SAB with actionable outcomes that benefited the CWC. Recent examples include launching crowdsource challenges to bring experts from outside CWC communities to propose ideas with benefits for CWC implementation – specifically, identifying new types of chemical exposure markers and exploring how AI tools might enable more effective treaty implementation practices (Organisation for the Prohibition of Chemical Weapons, n.d.c, n.d.d). ■

4 Prioritizsation of issues and work arrangements

Under the current proposal, the BWC science advisory mechanism will provide specialized advice on scientific and technological developments relevant to the BWC and prepare a broad study of the implications of developments in S&T for each Review Conference. The mandate is broad in terms of the scientific issues it may cover, which allows the mechanism to provide scientific advice on any issue that the States Parties require, and it provides a large degree of flexibility for the mechanism to identify pertinent topics and developments as a component of the comprehensive review.

Identifying and prioritizing topics for the mechanism to consider will not be trivial given the rich depth of topics and research areas within the life sciences and their implications for biosecurity and biological weapons disarmament and non-proliferation. One approach to this issue could involve a decision matrix and scoring of topics by the scientists within the mechanism to prioritize the technical issues they may wish to inform policy-makers about.

4.1. Possible criteria for prioritization of issues (decision matrix)

Prioritization of issues could be built into the proposed two-body mechanism, where the STRG identifies a broad range of issues and uses a decision matrix to prioritize topics for the smaller STRC to focus on. This method would provide a ranking (on a scale from 1 = low priority to 5 = high priority) assigned to a set of criteria that could be used to score the topics with input from the entirety of the STRG. Criteria for inclusion into such a decision matrix might include some or all of the following:

Criteria	Description
Relevance	Does the topic align closely with the BWC's mandate and core objectives, focusing on preventing the development, production, stockpiling, acquisition and use of biological weapons and the implementation of any and all Articles of the BWC?
S&T maturity	When considering risks and benefits from S&T developments, the mechanism might look at technology readiness levels and capabilities demonstrated by adopters and developers of the technology.
Novelty	Does the topic represent a significant advancement or shift in S&T with relevance to the BWC? Does the technology represent something truly novel, or does it just provide a new way of doing something that can be done already?

Degree of uncertainty	What is the level of uncertainty presented by the S&T topic? For S&T with high levels of uncertainty about whether it can be safely used, are there substantial concerns regarding unintended consequences or novel risks?
Urgency	How pressing an issue does a new S&T topic present for the implementation of the BWC?
Enhancing awareness	Is there a critical need for advice on or understanding of a new S&T development or trend for BWC stakeholders?
Potential for weaponization	Does the S&T have a clear risk potential for harmful use?
Potential benefits	Does the S&T have a clear potential for benefiting the implementation of the BWC?
Global impact	Will the S&T topic have impact on a global scale?
Feasibility of regulation	Are there clear approaches for regulation and oversight?

The criteria described above are provided as a starting point for further refinement. Ultimately, the mechanism would need to determine how they prioritize and take issues forward.

Approaches used in other scientific advisory mechanisms might also inform prioritization. For example, the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES) includes urgency of action, anticipated level of complexity, geographic scope and availability of scientific literature (UN Environment Programme, 2013); and the Intergovernmental Panel on Climate Change (IPCC) selects topics based on criteria that include addressing gaps identified in previous assessments, fostering interlinkages among its three working groups and incorporating significant new scientific findings related to the topic under discussion. Such comparative analysis across science–policy interface mechanisms can provide valuable insights for the development of new scientific advisory bodies (Schäfer et al., 2023).

4.2. Process

Other processes employed for prioritization in existing scientific review mechanisms also provide transferrable lessons. For example, both the IPCC and IPBES employ procedures that respond to requests by governments and multilateral environmental agreements and consider inputs and suggestions from various observers and stakeholders. A prioritized list of topics based on the aforementioned criteria is prepared by a Bureau in the case of the IPCC and by the Multidisciplinary Expert Panel and Bureau in the case of IPBES and then submitted for consideration by their respective plenary bodies (Schäfer et al., 2023; see also section 4.2). In the case of the European Commission Science Advice Mechanism (EC SAM), topics are selected based on requests from the EU Commission or suggestions from the Advisors themselves and can be inspired by topics suggested by the consortium of the Science Advice for Policy by European Academies (SAPEA) project (European Commission, n.d.). Requests must outline the topic's EU policy relevance, timing and scope for scientific advice, avoiding duplication with other advisory bodies (European Commission, 2019).

The OPCW SAB receives guidance and requests to explore specific scientific or technical issues of interest from the OPCW's Director-General, while for the comprehensive science and technology review it undertakes, topics are also proposed and agreed on by the SAB members themselves. Additionally, many of these mechanisms undertake a scoping process to ensure that the resulting scientific advice is relevant, actionable and effectively addresses key issues related to the policy areas under discussion. For example, for the EC SAM, the draft advice is presented to relevant EU Commission services before adoption by the Advisors to ensure it addresses the questions posed, allowing for any necessary clarifications to be sought from the Advisors (European Commission, 2019).

These examples highlight the value of a defined framework for determining priorities and addressing requests in scientific advisory mechanisms. Clear, defined procedures that involve member state input enable advisory mechanisms to deliver timely, relevant and impactful advice. They also highlight the importance of clearly established processes and defined roles for contributing bodies, working groups and secretariats, which in turn impacts the effectiveness and utility of a scientific advisory mechanism.

4.3. Output development, including associated roles and responsibilities within the proposed mechanism

The mechanism's outputs could vary, from specific recommendations on implementation to broader information aimed at enhancing the scientific literacy of decision-makers, equipping them to address the S&T dimensions of their work. Outputs might include insights on current trends and advancements in S&T, with some topics focused on short-term treaty impacts and others on long-term developments. For emerging technologies, where immediate action may not be feasible, the mechanism's advice may serve to raise awareness and encourage proactive thinking. For any topic the mechanism is requested to address, clarifying the request's intent and purpose would better position it to provide clear and well-reasoned recommendations.

In the current proposal, the STRG would encompass a very large group of scientists, as each State Party may propose one expert. Such a body can gather a wealth of S&T information; however, this is unlikely to be concise or focused enough for policy-makers' needs. Yet such a report uniquely benefits the smaller STRC by providing an in-depth foundation and supporting materials that may otherwise be beyond the reach of a small scientific team to compile. In this structure, the STRG acts as a well-resourced international research body. The STRC might then use the scoring matrix envisioned in the previous section to prioritize and focus the inputs received. For practicality, a procedural report from the STRG might be submitted to the States Parties, while a detailed report – including any additional materials and citations – could be provided to the STRC to aid in preparing its summary.

4.4. Consensus reporting

Consensus reporting is vital in a multilateral forum to ensure that reports and recommendations reflect the unified viewpoint of the mechanism. The current proposal for the BWC science advice mechanism is that outputs must be taken by consensus and include minority perspectives. Recognizing that scientific debates may not always yield consensus, the mechanism must provide comprehensive insights on points of agreement and disagreement, articulating the consensus on a given topic and offering a clear rationale

when consensus cannot be reached. This approach would allow the mechanism to deliver balanced and transparent advice, enhancing credibility even in the face of scientific divergence.

A concern with reporting minority or dissenting views is that in a political environment such as that of the BWC, the nationality of those in the minority may influence how the States Parties accept or reject and respond to the scientific advisory mechanism outputs. This makes a strong case for only providing recommendations and definitive perspectives where agreement can be reached, and for disagreement indicating what issues remain before a definitive conclusion can be drawn (reflecting all the views and not identifying the nationalities of the scientists providing them). Other approaches to reflect divergent views could be in the use of rankings such as previously described for prioritization, or providing a likelihood or confidence level (high, medium, low) and characterizing uncertainty that the scientific body can agree on as an output, as practised by other scientific bodies (Mastrandrea et al., 2010).

4.5. Communication and outreach

Beyond the advice and outputs for State Parties, additional communication efforts by members of scientific advisory bodies might include outreach activities such as university lectures, ethical discussions with students, training workshops, and raising awareness within scientific societies and industry associations. Such efforts can contribute to enhancing the dissemination and visibility of scientific advice while also raising the prominence of the BWC within academia, scientific communities, industry and civil society. These activities might also be reflected in STRG and STRC reports to give States Parties visibility to these efforts. The OPCW SAB provides a model for such outreach that can be drawn upon (Organisation for the Prohibition of Chemical Weapons, 2016). ■

5 Governance

Clear governance and defined functions are essential for a scientific advisory mechanism's effectiveness, accountability and transparency. They ensure that roles, responsibilities and decision-making processes are well understood, fostering trust and effectiveness. Governance structures enable the mechanism to stay focused on its mandate, avoiding redundancies and optimizing resources. Additionally, a clear structure facilitates coordination with other bodies, preventing duplication and promoting timely, relevant responses to emerging issues. Such strategic clarity enhances the ability to provide high-quality, impactful scientific advice.

In this section, we provide insights into the operationalization of the mechanism's key functions, including foresight. It also highlights potential interlinkages with the compliance and verification and international cooperation and assistance processes also under discussion within the Working Group on the Strengthening of the BWC, as well as connections with other relevant organizations. These interlinkages provide opportunities for better coordination and resource use while avoiding duplication of efforts.

As previously mentioned in this paper, the mandates for the BWC scientific advisory mechanism imply that critical aspects of the work of the mechanism include monitoring and horizon scanning and foresight.

5.1. Monitoring

The frequency and methods used for monitoring scientific developments should be carefully considered and allow for adaptation to the rapidly evolving scientific and technological landscape. Different mechanisms might be established to be able to identify and report on developments in a timely manner, including through regular review meetings of the STRG and monitoring of the scientific literature, patents, industry reports, think tank and government reports, and any other relevant data sources.

5.2. Horizon scanning and foresight

Horizon scanning is a useful tool for identifying emerging risks or opportunities in S&T that could have an impact on the implementation of the BWC (whether as a risk of bioweapon proliferation or a benefit for supporting the treaty). Horizon scanning and foresight refer to systematic approaches to stimulate thinking about the medium- to long-term future (more than ten years) (International Science Council, 2024). Horizon scanning and foresight activities involve exploring trends and emerging issues to be able to identify future challenges, opportunities and threats, disrupting the focus on immediate concerns and debates in the present to recognize and respond to future challenges and opportunities. The focus of horizon scanning may be on issues or weak signals that may be poorly recognized at present but may become significant in the future. Foresight can build on horizon scanning and can evolve into 'a systematic, participatory, future intelligence-gathering and medium-to-long-term vision-building process aimed at enabling present-day decisions and mobilizing joint action' (UN General Assembly, 2015).

While the mechanism may not be explicitly set up and resourced to conduct extensive foresight analysis, there is a focus on identifying emerging risks and opportunities as part of the foreseen mandate, which requires adopting an approach and associated data-gathering tools to monitor publications, patents, and global S&T trends and sensemaking methods (e.g. Delphi, participatory dialogues) to scan the horizon on a continuous basis. Foresight approaches can be combined with activities related to compliance and verification, for instance, by considering scenarios that help to identify vulnerabilities or provide a means to stress-test ideas and approaches. However, such kinds of foresight exercises are time-consuming and resource-intensive and require pluralistic inputs (e.g. intelligence agencies, experts in risk management in specific industries and sectors, insurance companies, etc.) to be useful. In this regard, drawing on outside experts as members of technical working groups and/or guest speakers may be a way to bring in those involved with horizon scanning to share their insights and results with the mechanism.

Regarding the value of foresight and horizon scanning activities, with so many studies published in the bioweapons space, it may be useful to consider a retrospective analysis of past BWC-relevant horizon scanning outputs. Such an exercise may be useful in learning about the process, methods and use of such insights and more fundamentally reflecting on how to communicate risk to decision-makers. ■

Conclusion

The effectiveness of a BWC S&T mechanism will rely on the quality and breadth of expertise it encompasses, robust governance processes to support timely and relevant inputs, and engagement with data, expertise and knowledge from experts on topics relevant to the BWC. The considerations given in this brief are intended to inform BWC stakeholders on sound practices that can be adopted into working modalities and processes for the scientific and technological advisory mechanism that is currently under discussion (and to make the most effective uses of the STRG and STRC two-body structure). The suggestions described here are not intended to be prescriptive. Any scientific advisory mechanism will need to develop its working methods to best fit the ecosystem within which it functions (and the development of successful working practices in a new mechanism will certainly involve some amount of trial and error). As a reference point, the OPCW SAB has had more than 27 years to develop the processes it follows, and these have evolved over time with the influence of membership changes and evolving stakeholder needs and priorities. The agreement among BWC States Parties on the need for a dedicated S&T mechanism provides an opportunity to learn from past experiences and innovate to promote science as a global public good that can be drawn upon to strengthen the evidence base for the implementation of the Convention and its objective of eliminating and preventing the proliferation of biological weapons. ■

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