

## Memorandum for Chairman, Threat Reduction Advisory Committee

### *Annotated Bibliography on Current and Future Challenges to the Viability of International Agreements on Biological Weapons\**

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This annotated bibliography is intended to help the Threat Reduction Advisory Committee Task Force assess current and future challenges to the viability of International Agreements on Chemical and Biological Weapons. New and emerging technologies such as gene editing, synthetic biology, and open source big data are creating a paradigm shift in the life sciences and are giving new hope for medicine and societal applications, but they are simultaneously posing new biosecurity risks. When reconsidering the viability of the Biological Weapons Convention (BWC) signed in 1972, the task force should take the nature of these emerging technologies into consideration, as well as who these technologies effect. Notably, these technologies may provide countries, non-state actors, and individuals novel capacities and the capability to develop biological weapons, while bypassing many of the technical challenges they would have previously faced. The Task Force may consider both these technologies and newly empowered groups to identify how the BWC could be strengthened to reduce the threat of a biological attack, and to identify and respond to any violations. This bibliography contains some sources the Task Force might utilize to spur discussions on possible solutions to help enhance the BWC's flexibility and ability to keep up with the fast-paced changing science and technology community which constantly poses new challenges to the viability of the current international convention.

Berger, K. M., DiEuliis, D., Meyer, C., & Rao, V. (2018). *Roadmap for Implementing Biosecurity and Biodefense Policy in the United States*. Retrieved from [http://www.gryphonscientific.com/wp-content/uploads/2018/07/Roadmap\\_Roadmap-of-US-Biosecurity-and-Biodefense-Policy\\_2018.pdf](http://www.gryphonscientific.com/wp-content/uploads/2018/07/Roadmap_Roadmap-of-US-Biosecurity-and-Biodefense-Policy_2018.pdf)

Berger and her research team evaluate the implications of the evolving biotechnology landscape for biosecurity and biodefense policies. They discuss the effectiveness of the current state of biosecurity and biodefense policies, funding, and implementation mechanisms. Schematic illustrations of the current reactive nature of U.S. biosecurity and biosafety polices, as well as a diagram depicting the range of risks in biological research emphasize the need for reform. Significant limitations and gaps in current policies are described, and then a new 'Roadmap' for implementing future biosecurity and biodefense policies is proposed by the research team. The proposed roadmap includes a list of suggested primary actions to be taken in order to maximize advances in technology for biodefense while minimizing biosafety and biosecurity risks.

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\*The views summarized here are those of the workshop participants and should not be attributed to CGSR, Lawrence Livermore National Security, LLC., the United States government or any other organization.

Crowley, M., Dando, M., & Shang, L. (2018). *Preventing Chemical Weapons: Arms Control and Disarmament as the Sciences Converge*. Retrieved from [https://books.google.com/books?hl=en&lr=&id=5DtqDwAAQBAJ&oi=fnd&pg=PA193&dq=how advancing technologies affect BWC&ots=dzl7Q4Zk8c&sig=YLFLno4jmft\\_c\\_yDHB2Q\\_piGjTg#v=onepage&q&f=false](https://books.google.com/books?hl=en&lr=&id=5DtqDwAAQBAJ&oi=fnd&pg=PA193&dq=how+advancing+technologies+affect+BWC&ots=dzl7Q4Zk8c&sig=YLFLno4jmft_c_yDHB2Q_piGjTg#v=onepage&q&f=false)

With increasing research and biological advances to promote the betterment of society, new dual use risks are emerging that must be addressed by international conventions. Several chapters discuss the role of biological weapons and the changing scientific aspects that affect Arms control, these include; the history of biological and toxin weapons use, offensive weapon programs, the legal history and evolution of the Biological and Toxin Weapons Convention (BTWC) and concludes with how developments in science and technology have affected the BTWC. Following chapters discuss how the United Nations is combatting the use of chemical weapons, international legal constraints upon the weaponization of chemical toxins, and how the convergence of chemistry, biology, and nanotechnology are creating paradigm shifts in scientific research.

Dev, I. (2018). *Democratizing Synthetic Biology: Balancing Biosecurity, Biosafety, and Citizen Science*. Retrieved from [http://www.wise-intern.org/journal/2018/documents/WISE\\_AICHE-Final-Draft\\_Ishaan-Dev.pdf](http://www.wise-intern.org/journal/2018/documents/WISE_AICHE-Final-Draft_Ishaan-Dev.pdf)

With the increasing improvement of synthetic biology techniques, research and development is seeing novel changes in how research is conducted and the makeup of the research community. In this report Dev details DIYbio, reviews bioterrorism and bioterror concern and concludes with recommendations to improve biosafety and biosecurity without impeding scientific freedom. Dev focuses on concerns regarding open-access information on synthetic biology and DNA sequence data, DNA synthesis of pathogenic or harmful sequences, and genetic editing technology for unethical and potentially dangerous purposes.

DiEullis, D., & Giordano, J. (2017). Why Gene Editors like CRISPR/Cas May Be a Game-Changer for Neuroweapons. *Health Security*, 15(3). Retrieved from <https://www.liebertpub.com/doi/full/10.1089/hs.2016.0120>

DiEullis and Giordano examine how novel gene editing techniques, like CRISPR, are changing how international communities should assess bioweapon risks, particularly neuroweapons. Because of the easy “spillover” from medical and clinical applications into dual use for weapon development, the authors emphasize the need to create a governance model to assess dual use risks and encourage forms of responsible conduct as well as exercising the precautionary principle. The authors’ analysis emphasizes the importance of emerging technologies and agents that are not lethal, however could be used to manipulate physiology and cause harm. They suggest the current BWC and CWC

list of select agents and toxins is inadequate and argue a more reasoned systematic approach to characterize neuroactive agents needs to be taken.

DiEuliis D., Gronvall GK. 2018. A holistic assessment of the risks and benefits of the synthesis of horsepox virus. Retrieved from <https://msphere.asm.org/content/3/2/e00074-18>

This article highlights an exemplary case of how scientific advances are challenging current biosecurity policies and suggests that a risk/benefit analysis might be included when creating new policies. The authors address the controversial publishing of the recreation of the naturally extinct horsepox virus that has similarities to the smallpox virus. The scientists behind the research had no malign intent, however the publishing of their findings spurred great public concern over the dual use potential of their experiments. The authors discuss how this incident has emphasized the need for dual use risks and benefits to be assessed at the beginnings of scientific research as well as throughout the development of the experiments. Importantly, the article also discusses how this research might then be communicated.

Getz, L. J., & Dellaire, G. (December 2018). Angels and Devils: Dilemmas in Dual-Use Biotechnology. *Science Direct*, 36(12), 1202-1205. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0167779918302075>

Much of the advanced scientific research intended for beneficial uses has the potential to be misused for nefarious purposes. The scientific and security communities have struggled to find a way to control this issue. Authors Getz and Dellaire provide a historical outline of the development of the term 'dual-use research of concern' (DURC), an important issue plaguing much of modern-day scientific advancements. Getz and Dellaire then explore and discuss three prominent examples of dual-use research involving gene editing, synthetic biology, and CRISPR technologies. The authors conclude with their proposal of a multi-faceted solution that involves public engagement, government regulation, and stakeholder education.

Gronvall, G. K. (July 2018). Safety, Security, and serving the public interest in synthetic biology. *Journal of Industrial Microbiology and Biotechnology*, 45(7), 463-466. Retrieved from <https://link.springer.com/article/10.1007/s10295-018-2026-4>.

Gronvall emphasizes the need for practitioners of synthetic biology—whether a part of the government, academic, or DIYBio community—to consider the safety and security implications that their research has on the public. Gronvall describes what may be done by scientists and the biotechnology industry to address the challenges synthetic biology advances pose to safety and security.

Kahl, L., Molloy, J., Patron, N., Matthewman, C., Haselhof, J., Grewal, D., . . . Endy, D. (2018). Opening Options for Material Transfer. *Nature: Biotechnology*, 36, 923-927. Retrieved from <https://www.nature.com/articles/nbt.4263>

The Open Material Transfer Agreement (OpenMTA) is a newly passed legal framework that allows for broader access to scientific data and researcher. The motivation behind the OpenMTA is to allow for simple, broad sharing of biological research that will play important roles in genetic engineering research and synthetic biology research. The OpenMTA is just one part of a larger movement in the scientific community that is pushing for more openly shared data, however this increase in openness is likely to pose new security and safety concerns that should be considered.

National Academies of Sciences, Engineering, and Medicine. 2016. *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/23405>

This book includes descriptions of the emerging Gene Drive technologies which are playing important roles in attempts to eradicating disease and will certainly have many other beneficial uses for society. However, these gene drives pose new and considerable biosecurity risks if they are used instead for malignant purposes. The chapters address the technology, human ethics of gene editing, and considerations on how to govern gene drive research and its applications. Gene drives are an important emerging biotechnology that pose challenges to the viability of international agreements such as the BWC which attempt to regulate biotechnology research. This book reflects on some current issues with these regulations, as well as proposes new possible solutions.

Overview of Potential Agents of Biological Terrorism. (2017). *Southern Illinois University School of Medicine*. Retrieved from <https://www.siumed.edu/im/overview-potential-agents-biological-terrorism.html>

This website has an extensive list of types of Bioterrorism Attacks and Bioterrorism agents split up into categories based on their ease of transmission, severity of morbidity, mortality, and likelihood of use. This framework might be utilized when considering the possibilities of bioterrorism attacks and might help create policies that encompass all categories of agents. Considering types of bioterrorism agents on this categorical level can aid in creating countermeasure plans that are comprehensive, but also focus on the more likely and more severe agents.

Schopf, J. (2017). Open Access to Scientific Information in Emerging Countries. *The Magazine of Digital Library Research*, 23(3/4). Retrieved from <http://dlib.org/dlib/march17/schopf/03schopf.html>

Advances in science and technology provide tools that enable countries to emerge as new scientific players. This leads to new groups of people having access to information,

techniques, and technologies which support development within the country but also poses potential new international biosecurity risks. This article discusses how five countries- Brazil, Russia, India, China, and South Africa- are utilizing open access to scientific information to become leaders in scientific development. The wide dissemination of access to scientific information and capabilities create new threats which should be kept in mind when considering international biological weapons agreements.

Solloch, S. (2018). The dual use of research ethics committees: Why professional self-governance falls short in preserving biosecurity. *BMC Medical Ethics*. Retrieved from <https://bmcmedethics.biomedcentral.com/articles/10.1186/s12910-018-0295-0>

Solloch uses Germany as an example to describe two highly discussed options related to oversight of dual use research of concern (DURC). The two main competing options are self-governance and governmental oversight. Solloch analyzes the scope and limits of each option of dealing with DURC issues and how they affect society. He illustrates the current situation in Germany involving the German Research Foundation and the National Academy of Sciences, and how these two professional bodies of scientists are attempting to deal with the DURC issue by confining regulation to the scientific system. However, Solloch suggests that a more balanced and multifaceted strategy should be utilized.

Synthetic Biology Products/Applications. (2018). Retrieved from <http://www.synbioproject.org/cpi/applications/>

The Synthetic Biology Project has crowd sourced expertise to create a list of current and upcoming synthetic biology technologies. Though not comprehensive, the list provides a resource—a living inventory—for the public, researchers, developers, and policymakers who may have interest in keeping up to date on emerging synbio discoveries. The list identifies a technology/technique, tells whether it is “on the horizon” or “on the market”, provides information on its intended uses, and provides links to data and sources for each.

Technologies to Address Global Catastrophic Biological Risks. (2018). *Johns Hopkins Bloomberg School of Public Health*. Retrieved from [http://www.centerforhealthsecurity.org/our-work/pubs\\_archive/pubs-pdfs/2018/181009-gcbr-tech-report.pdf](http://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2018/181009-gcbr-tech-report.pdf)

A project team from Johns Hopkins Center for Health Security collaborated to create a list of emerging technologies that provide significant potential to reduce global catastrophic biological risks (GCBR). The authors highlight that this list of technologies, though they are intended to promote the safeguards of society, may also pose potential for misuse. The authors discuss the technologies’ promises as well as limitations. This list is not an extensive list of all emerging technologies that will likely play a role in future natural and intentional GCBRs, but it does provide some important examples worth focusing on when considering future biological attack possibilities. The list

includes technologies that will change detection methods, delivery methods, surveillance, diagnostics, and medical countermeasures.

United Kingdom of Great Britain and Northern Ireland. (2018). Meeting of the State Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological and Toxin Weapons and on Their Destruction. *United Nations Documents*. Retrieved from <http://undocs.org/en/BWC/MSP/2018/MX.2/WP.4>

This article submitted by the United Kingdom to the State Party Meeting of the BWC considers the implications the convention could have on the field of genome editing. The article highlights emerging challenges and questions that ought to be addressed when thinking about the relationship between scientific research in genome editing and the policies and conventions that will regulate it. The article is meant to spur discussion and ideas on how to face these challenges.

The Biological and Toxin Weapons Convention: Consideration for a science advisory mechanism. (2016). *The Royal Society*. Retrieved from <https://royalsociety.org/~media/policy/projects/biological-toxin-weapons-convention/biological-toxin-weapons-convention-btwc-april-2016-meeting-summary.pdf>.

The Inter Academy Partnership (IAP), the UK Royal Society, and the Polish and US National Academy of Sciences convened a meeting to discuss the possible workings of a Science Advisory Process for the Biological and Toxin Weapons Convention (BTWC). The meeting consisted of technical experts, science advice practitioners and key stakeholders from multiple countries. This summary of the roundtable discussion includes proposed answers to the key questions of how a Science Advisory Process would work for the BTWC including: Why? Who? What? How? When? Where?