Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction

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Convergence between biology and chemistry: latest findings of relevance to the Biological and Toxin Weapons Convention

Submitted by Switzerland

I. Introduction

1. The Biological and Toxin Weapons Convention (BTWC) and the Chemical Weapons Convention (CWC) are arms control treaties strongly linked to developments in science and technology. The increasing overlap between chemical and biological sciences – generally referred to as convergence in chemistry and biology, or short 'Convergence' – has been noted by the treaties' States Parties in recent conference reports, and they recommended exploring its potential implications. 'Convergence' describes an integrative and collaborative approach in the life sciences that brings together theoretical concepts, experimental techniques as well as knowledge of different (science and engineering) disciplines at the crossroads of chemistry and biology.

2. To address 'Convergence', Spiez Laboratory, the Swiss Federal Institute for NBC-Protection, started the workshop series Spiez CONVERGENCE. The series is dedicated to inform participants about significant advances in chemical and biological sciences, and to serve as a forum for discussion. The objective is to identify developments in chemistry and biology which may at some point have implications for the BTWC or the CWC, and therefore may warrant further study. The series is designed as a Swiss contribution to a science and technology review.

3. This first Spiez CONVERGENCE was held 6 - 9 October 2014 in Spiez, Switzerland and brought together experts from academia, industry and policy making. The workshop introduced participants to the concept of 'Convergence' from the perspectives of the CWC, the BTWC and from an NGO perspective, and looked at previous reviews conducted on the subject. The scientific and technical presentations dealt with the subjects of 'chemistry making biology and biology making chemistry' and 'enabling technologies'. Topics discussed included genome editing (e.g. CRISPR/Cas-system), directed evolution,

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systems biology, biological circuits, surface-coated nanoparticles as well as additive manufacturing.

II. Findings

4. The separation between biology and chemistry – as established in the BTWC and CWC treaty regimes – has never been as pronounced in the chemical and biological sciences, thus an overlap between the disciplines is not a new development. However, certain scientific advances in this overlap continue to blur even further the boundaries between what constitutes biology and chemistry. This is reflected for example in how chemicals will be produced in the future: by traditional chemical methods, with the help of biological catalysts such as enzymes, or through the specially designed metabolic process of a self-replicating organism or an organism-like system. Drivers for pursuing a particular method of production will be based on economic, environmental and other factors. Organisms known in nature will be engineered to exhibit altered or new functions. Or their genetic functions may be reduced to a minimum 'chassis' type organism, which can serve as a building block for the design of new biological systems. Alternatively, organism-like systems with specific functionality may be chemically built from scratch.

5. How far and at what speed such advances will progress depends largely on developments in other disciplines acting as enabling technologies. These include data computation and management of large databases, nanotechnology, robotics, systems automation and many others. The resulting scientific and technological advances will open up new areas of application of chemistry and biology in society. The impact will largely be beneficial. But 'Convergence' also creates new opportunities and possible risks for chemical and biological arms control.

6. Applications of 'Convergence' will assist in developing new means of protection against toxic chemicals and infectious diseases: methods for their detection, diagnostics and identification, pre- or post-exposure medical treatment and countermeasures as well as decontamination. But 'Convergence' will also permit the production of known toxic chemicals, including toxins, by different new methods, and it may lead to novel toxic chemicals. Scientific advances will permit the engineering of known organisms that cause infectious diseases, in order to change how the disease progresses or can be treated. It will become possible to design and create new organisms based on the study of existing ones, which in turn may cause new forms or types of infectious diseases. 'Convergence' may enable new methods for distributing or administering toxic chemicals, or provide the necessary expertise to design new vectors or systems for the distribution of infectious organisms and their specific targeting.

7. It is important to emphasise in this context, that advances in science and technology will not transform themselves into weapons. Application of 'Convergence' to weapons development requires a weapons program. The development of a weapon based on a new biological or chemical agent requires a managerial decision followed by a development and scale-up program, a testing phase and a doctrine for its use. How would such a program look like at state level? It would most certainly be very different from programs of the past.

8. 'Convergence' may simplify certain technical procedures and at the same time reduce the necessary level of tacit knowledge required. It therefore might open up new opportunities for sub-state actors trying to develop or acquire some form of a biochemical weapon. This risk, however, is often overstated. The relative gains for sub-state actors from these technological advances remain unclear – especially if compared to the capabilities they already possess. Should certain technical steps become easier to undertake, the challenges for weaponization of a biological or chemical agent still remain considerable.

9. Toxic chemicals and infectious organisms will remain prohibited as weapons through the provisions of the BTWC and the CWC. But the impact that 'Convergence' has on the provisions of the two regimes needs to be kept under review to avoid new gaps opening. Furthermore, new technical opportunities created by 'Convergence' might weaken the commitment of states to continue adhering to the regimes. But this is a question of political will. What are the forces that drive scientific progress and its practical application in society? Technology development follows directions that are determined by a desired outcome, even if not all intermediate steps are yet clearly understood. It is not likely – but also not impossible – that decisions could be made for deliberate small-scale breakout attempts from a regime.

10. Today the life sciences are advancing at an unprecedented pace. The amount of data and knowledge acquired should lead to non-linear progress in the future. Speakers from academia and industry convincingly showed in their presentations how the rate of progress in their domains is clearly outpacing treaty review cycles. Therefore, advances in the life sciences, in related technologies and industrial application require constant monitoring. Given the pace and complexity of current scientific and technological advances, today's review mechanisms, even if executed in best faith, may lack sufficient breadth, depth and quality of expertise to provide dependable results.

III. Outlook

11. Spiez CONVERGENCE cannot develop specific policy recommendations for the arms-control regimes and does not intend to do so. It also does not issue a consensus report. It is dedicated to assist its participants and readers with their own science and technology assessments, and to trigger, if possible, further discussions in other *fora*. The full report can be obtained online at www.spiezconvergence.com. The workshop series Spiez CONVERGENCE will continue with a second edition in September 2016.