OPCW

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SUMMARY OF THE SECOND MEETING OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP ON THE ANALYSIS OF BIOTOXINS

1. AGENDA ITEM ONE – Opening of the meeting

1.1 The Temporary Working Group (TWG) on the analysis of biotoxins of the Scientific Advisory Board (SAB) held its Second Meeting on 21 June and 23 June 2021 in a virtual format. The meeting was chaired by Dr Daan Noort on behalf of the SAB with Dr Suzy Kalb as Vice-Chairperson.

1.2 The TWG Chairperson opened the session welcoming TWG members for the second meeting of the Group and expressing hope for another productive meeting. He recalled the Thirty-Second Session of the SAB the prior week, noting that the SAB was happy with the report of the TWG and the progress achieved by the Group in such a short time.

2. AGENDA ITEM TWO – Adoption of the agenda

The TWG adopted the following agenda for its second meeting:

1. Opening of the meeting
2. Adoption of the agenda
3. Update on the report from the first meeting of the Temporary Working Group
4. Discussion on external speakers and next meeting format
5. Subgroup breakout sessions
6. Subgroup breakout sessions (second set)
7. Updates by Temporary Working Group subgroup leads
8. Recommendations on the terms of reference of the Temporary Working Group
9. Final comments and next steps
10. Closure of the meeting

3. AGENDA ITEM THREE – Update on the report from the first meeting of the Temporary Working Group

The TWG Chairperson noted that the final draft of the report of the first meeting of the Group was being finalised and reflects well the proceedings of the first meeting. He noted that it will also serve to assist the Group when it comes time to prepare its end of mandate report which will first be considered by the SAB for any questions or clarifications, after which the report will be submitted to the Director-General for his consideration.

4. AGENDA ITEM FOUR – Discussion on external speakers and next meeting format

4.1 The TWG Chairperson recalled that inviting guest external speakers to augment the work of the TWG has been an important element in previous TWGs and he would like to adopt a similar approach for this one. He noted that guest speakers can bring expertise in certain areas to complement that of the standing TWG members, helping to broaden their horizons but also get feedback on how the TWG approaches its work. He invited TWG members to share with him, the Vice-Chairperson, the SAB Secretary, and the subgroup leads any recommendations on relevant external speakers they believe could help with any of the questions that the TWG is working on.

4.2 The Group had an extensive discussion and already identified a number of relevant speakers to invite to speak and participate at future TWG meetings. The SAB Secretary asked TWG members to refrain from sending out formal invitations to any such speakers by themselves, but rather to share their recommendations, as mentioned previously, so that the list can be managed at a central level.

5. AGENDA ITEM FIVE – Subgroup breakout sessions

5.1 To allow TWG members to participate in multiple subgroup discussions, the breakout sessions were split into two groupings. Providing time during the TWG meeting gave each subgroup a chance to convene and ensure that they were working towards their objectives and goals as pertain to the questions in the terms of reference they are considering.

5.2 The first breakout session period allowed subgroup 3 (considering terms of reference (ToR) question 5(d)) and subgroup 5 (considering ToR question 5(g)) to convene.

6. AGENDA ITEM SIX – Subgroup breakout sessions (second set)

The next breakout session period allowed the remaining three subgroups—subgroup 1 (considering ToR question 5(a)), subgroup 2 (considering ToR questions 5(b) and 5(c)), and subgroup 4 (considering ToR questions 5(e) and 5(f))—to convene.

7. AGENDA ITEM SEVEN – Updates by Temporary Working Group subgroup leads

7.1 Following the breakout sessions as well as the intersessional meetings that many subgroups held, each subgroup lead was given a chance to present their group's work to date and note any ongoing challenges or questions they had for the TWG at large. The overarching questions being considered by each subgroup are:

(a) What are the underlying requirements for the analysis of biological toxins in order to investigate alleged use of toxic chemicals as weapons? (subgroup 1)

(b) What classes of biological toxins are most likely to be relevant in investigations of alleged use? (subgroup 2)

(c) Are there other relevant compounds of biological origin that should also be considered based on their potential for misuse or technological change associated with them? (subgroup 2)

(d) What are the technical requirements for analysis of the most relevant types of biological toxins? (subgroup 3)

(e) What are the analytical standards and requirements of other international and national investigative authorities and how do these compare and/or factor into OPCW considerations and operations? (subgroup 4)

(f) How can programmes of analytical exercises conducted by different networks of laboratories be coordinated or harmonised to minimise duplication, promote consistent practices, and develop a comprehensive picture of laboratory capabilities? (subgroup 4)

(g) What institutional or legal measures need to be established to facilitate cooperation between the OPCW and other organisations working on the development of capabilities for the analysis of biological toxins? (subgroup 5)

7.2 These updates generated fruitful discussion and were useful for the entire TWG to coalesce the work they had done in smaller teams to ensure that they were making progress collaboratively and uniformly.

Subgroup 1

7.3 The subgroup 1 lead, Dr Clark, provided a summary of the status of his group's work, incorporating discussions not just during the current meeting but intersessionally as well. He noted that the group decided to consider question 5(a) from the ToR via a whole end-to-end process and summarise what it takes in broad terms to investigate an alleged incident involving a biotoxin. In order to minimise duplication, the subgroup would focus on areas/factors not covered by other subgroups (e.g., in-field sampling/analysis, chain of custody). He reported that the subgroup has spent considerable time bounding their work and were conscious of defining what was in and out of scope for their subgroup.

7.4 The subgroup had a lengthy discussion on in-field sampling, including related technologies that can be used (hopefully relatively low-tech, such as lateral flow assays), and defined performance criteria (cognisant of limitations) and indirect indicators that biotoxins have been used (e.g., people being ill in hospitals, animals dying due to exposure, pathology, and DNA from source material).

7.5 There was a comment from the broader group that there are automated biosensors beyond lateral flow assay types that might be useful to consider. Dr Clark confirmed he would include it in the overview.

7.6 A remark was also made about science and symptoms aiding analysis, as the latter may not just be a trigger to take samples but may also guide the type of analysis required.

7.7 Dr Clark moved on to sampling and collection, noting that there is not much difference between sampling for traditional scheduled chemical warfare agents and biotoxins. There are no particular tools for biotoxins in this respect; similarly for packaging, transporting, and personal protective equipment (PPE), there already exist international standards. In terms of documentation, Dr Clark stressed the importance of starting and maintaining chain of custody for any sample collection and analysis but noted that these processes are relatively known and standardised.

7.8 Turning to the overall process of investigating an alleged use of biotoxins, Dr Clark noted the following broad needs and steps required:

(a) suitably qualified and experienced on-scene investigators;

(b) correct PPE and basic tools for collection/analysis;

(c) chain of custody (documenting);

(d) sample transportation to the laboratory (must have track record of biotoxin analysis, appropriate facilities and equipment, and there should be at least two —ideally many more—laboratories available for any biotoxin);

(e) analytical techniques (minimum two orthogonal techniques, ability to detect, identify, and characterize biotoxins to a specified level, and a need to extend the VERIFIN "Blue Book"[1]); and

(f) reporting (clear and unambiguous results corroborated by at least two independent laboratories to show impartiality).

7.9 An issue concerning microbial toxins was raised, that is whether, with regard to safety, the potential presence of original bacteria should be considered. Dr Clark confirmed that this is an important aspect that needs to be taken into consideration.

7.10 The question came up of how similar analyses from different laboratories had to be. The Group considered whether it was necessary to have two laboratories performing the same analytical techniques or if more flexibility was desired. It was noted that not every method has to be duplicated. The need for protocols was also discussed and what it means to have the same protocols. It was discussed that despite some of the advantages of having duplicate analysis techniques and protocols at different laboratories, more diverse and complementary methods of analysis that can all give similar end results might in fact generate more robust results for an investigation.

7.11 The fact that the considerations are not only always technical but might also be political and legal was also raised. Legal proceedings are often the end goal of investigating alleged uses of threat materials. It is therefore necessary to demonstrate that the methods used represent best practices and are accepted and reproducible in the scientific community. Methods and techniques not well-established in scientific literature would be difficult to defend. As for the laboratories themselves, they must have already demonstrated capabilities to conduct the kind of analysis that would be performed (i.e., through an established track record).

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[1] For information on the Blue Book please see https://www2.helsinki.fi/en/verifin-finnish-institute-for-verification-of-the-chemical-weapons-convention/information/blue-book.

7.12 The idea that there may not always be multiple laboratories available or qualified to perform necessary analysis was mentioned, especially when considering both biomedical and environmental samples related to biotoxins. It was clarified that the OPCW already conducts proficiency tests into both biomedical and environmental samples, but the TWG can consider making a recommendation that the biotoxin exercise gets split into biomedical and environmental tests. The biotoxin exercise already has a split between high molecular weight and low molecular weight biotoxins, because the analysis requirements are completely different for the two. It may be possible to have a combined exercise where laboratories nominate for only one or both types of toxins, and for one or both types of matrices.

Subgroup 2

7.13 Dr Bossée, the lead for subgroup 2, provided an overview of the work performed since the first meeting of the TWG. She noted the group had been busy, included examining available open literature on toxins, adding biotoxins to the list for consideration (the goal is not to list all the toxins), creation and work on two different tables, i.e., an introductory table with chemical structures, toxic mechanism, and family (where applicable) of biotoxins identified so far, and another summary table with more details on toxicity, and information on the ease of production, stability, historical use (legal and illegal), if applicable, clinical manifestation, medical management, and detoxification. Once the criteria are defined and information gathered, the subgroup will decide which of the current criteria are the most important to define if the biotoxin is relevant for further consideration in the context of the TWG. Known medical uses of some biotoxins are being collated by Dr Ghanei and will be added to the summary table in due course.

7.14 Dr Bossée noted that the idea is to submit the initial work to all TWG members for their input during the meeting in November. This introductory table should be finalised by the end of August and reviewed by subgroup members during September and October, so that all TWG members can review it by November. For the more extensive work regarding the summary table, the hope is to have it more completed for the November meeting in order to be able to discuss how to combine all the criteria and information collected for further analysis and use. The objective is to have question 5(b) from the ToR finished by the end of the year, so that all the members of the TWG can review it between January and March 2022 and provide relevant information and feedback.

7.15 Dr Noort asked to which extent other subgroups are dependent on the progress of subgroup 2. Dr Kalb, co-lead for subgroup 3 noted that it would be helpful for her subgroup to know which toxins are included in order to understand which analytical methods are available for which toxins. Dr Bossée proposed to share the list of those biotoxins that will definitely be included in the final list so that they can already be considered.

Subgroup 3

7.16 Dr Åstot, co-lead for subgroup 3 with Dr Kalb, reported that throughout the discussion in subgroup 3, two main themes were often repeated, influencing all five areas that the subgroup is asked to consider. The first is the great diversity present in the field of biological toxins. The second is that, in many cases, the analysis of biological toxins is very different from that of traditional chemical warfare agents, and there are limitations of traditional mass spectrometry methods for detection.

7.17 Discussing analytical approaches needed for unambiguous identification of both low and high molecular weight biotoxins, Dr Åstot noted that for protein toxins, digestion of proteins, and tandem mass spectrometry (MS/MS) analysis of tryptic fragments is well-characterised, but this technique requires a certain amount of sample that may be a challenge in certain situations (e.g., biomedical samples). While mass spectrometry-based techniques are useful in the analysis of high molecular weight toxins, other analytical approaches could also be useful, such as ELISA, antibody-affinity, 2D gel, DNA sequencing, cytotoxicity analysis, and functional assays. However, none of these assays should stand alone as unambiguous identification as they are very dependent on the quality of reagents, among other variables. These approaches need good characterisation of reagents (antibodies), and information on what controls were done, in addition to how analysis was done.

7.18 Turning to the question of instrumentation and/or procedures that should be standardised across laboratories to ensure reproducible and consensus results, Dr Åstot commented that standardisation of instrumentation is expensive, thus limiting the number of laboratories. Good approaches needed include recommended methods and highly characterised reagents available for all; development of a minimum data set on antibodies that would be acceptable; sticking with requirements reporting, performance-based or standardisation of reporting (good methods published in literature). Lastly, Dr Åstot noted that it is hard to have one laboratory that has expertise over the entire range of toxins and methods of analysis. For example, laboratories that specialise in high molecular weight toxin analysis are typically not as equipped to analyse low molecular weight toxins, and vice-versa.

7.19 Dr Kalb then continued the presentation highlighting some of the questions raised in relation to the analytical criteria that should be in place to match forensic evidence, including what is possible in provenancing (matching of toxin samples to deduce a common origin; geographical source attribution; toxin purification method attribution). However, the potential to utilise impurities and degradation products in the provenancing of toxins is likely not as viable as for chemical weapons agents. Because toxins are not synthesised, per se, the impurity profile will be different. While this might present some opportunity, it will be a challenge, again due to the large span of molecular weights of compounds that may be present.

7.20 Moving to the role and utility of degradation products and other markers, Dr Kalb noted that in the context of biotoxins, degradation could mean loss in size, or also degradation through toxin inactivation. Inactivated toxins bring new challenges not present with typical chemical warfare agents, including what to do with a di-chain toxin where one chain is inactive so the toxin is not toxic, and what to do if a batch of inactivated toxin is found—i.e. what that means for an investigation. This differs from traditional chemical warfare agents. She continued that with biotoxins, if there is no biological activity, then there is no public health threat, though this is separate from the intent to commit a crime. It was noted that many nerve agents have two stereoisomers, and only one is toxic yet both are regulated. It was posed whether this is a precedent that could be followed when thinking about inactive toxins.

7.21 Lastly, Dr Kalb summarised the discussion on the role of markers and biomedical samples. It is believed that toxins will not react with human proteins to form adducts, as with classical chemical weapons agents, and only the identification of the toxin or

detection of toxin activity is possible. The biggest challenge is that toxin levels in biomedical samples are often very low (especially with high molecular weight toxins), and often too low to use traditional MS/MS techniques for detection. For an investigation, detection of a toxin, and especially toxin activity in biomedical samples (human exposure), is critical information. She pointed out several differences between high molecular weight toxins and traditional chemical warfare agents, including delayed onset of symptoms after exposure with large biotoxins and the fact that large biotoxins are not excreted through urine and remain in the body longer. In conclusion, it was noted during the discussion that there is a huge gap of knowledge about what toxins actually do when they hit the body, so this makes it difficult to think of biomarkers for analysis.

7.22 A robust discussion followed on what biomarkers might be usable in an investigation and how. It was noted that the term biomarkers could represent both those that reflect the chemical structure of a biotoxin (e.g., de-amidated version of a toxin, or part of the toxin that results from proteolysis) as well as endogenous biomarkers that are present in response to a biotoxin's activity in the body. The former type of biomarkers may be useful but may also depend on the characteristics of the biotoxin, such as molecular weight. For the latter type of biomarker, it was pointed out that different sets of toxins can have very similar symptomatic readouts; there is thus variability in both toxins and in target structures and it may be difficult to understand both sides. It would be a challenging exercise to do this and would require an improvement of methods. The TWG Chairperson agreed, adding this could be one of the longer-term recommendations the group might consider making.

7.23 The Group also considered the point that the question that is likely to be asked by whoever may launch an investigation is if toxins have been used, and not necessarily who used them or where they came from. Circumstantial information will also be used in addition to laboratory analysis to reach further conclusions regarding attribution, and in some cases, depending on the investigation, attribution will not be considered at all.

Subgroup 4

7.24 Subgroup lead, Dr Dorner, reported on the deliberations within subgroup 4 on ToR questions 5(e) and 5(f). In considering question 5(e) the group noted several subquestions, including what other international/national investigative authorities there are that should be considered, and how and on which (legal) basis they work. To that end, the group is considering the Chemical Weapons Convention (hereinafter "the Convention") and its mandates, as well as the International, Impartial and Independent Mechanism (IIIM) created by the United Nations General Assembly to assist in the investigation of crimes committed in the Syrian Arab Republic since March 2011.[2] In addition, there is the United Nations Secretary-General Mechanism (UNSGM), including UNSGM guidelines and procedures for laboratory analysis tasks related to the identification of biological toxins and pathogens;[3] and possibly the International Criminal Court.[4] Referring to the UNSGM, Dr Dorner noted the challenges associated with lack of an implementation body overseeing the Biological Weapons Convention, making inter-laboratory exercises critical to ensure the validity and accuracy of laboratory analysis in the absence of an overarching body.

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2 See https://iiim.un.org/.

3 See https://www.un.org/disarmament/wmd/secretary-general-mechanism/.

4 See https://www.icc-cpi.int/.

7.25 Other authorities to be considered include regional networks focusing on dedicated tasks for surveillance of food or health-related risks, such as European Union reference laboratories targeting different relevant pathogens and agents in the food and feed sector. Also, there are regional networks focusing on CBRN[5] threats, including networks dedicated to biological toxins of potential bioterrorism threat (formerly EQuATox, EuroBioTox with 63 laboratories in 23 countries),[6] the Laboratory Response Network (LRN) in the United States of America and Canada,[7] and networks working on CBRN agents in Asian countries (e.g., Australia, China, Japan, or Singapore). As for relevant regulations and investigative authorities identified at the national level, Dr Dorner provided examples of relevant national regulations in Canada and France.

7.26 Turning to question 5(f), Dr Dorner noted a couple of considerations, including on the quality system requirements for the laboratories that should be in place (e.g., consideration of ISO 17025 for OPCW designated laboratories), and on how the analytical exercises can be harmonised yet remain flexible to address new or emerging biotoxin threats. Related topics considered include identifying national and international networks performing exercises on biotoxins, their approach to the work and points of overlap, similarities, and clear differences. The subgroup identified three such networks:

(a) Regarding the OPCW Laboratory, they have conducted five toxin exercises so far into ricin, abrin, STX, and neo-STX, working on identification and activity determination (quantitative analysis optional) and with no request to detect impurities that could give information on purity of preparation, and no request of isoforms differentiation. The reporting time is two months for an extensive report with strict criteria for reporting of primary data.

(b) RefBio, a German-funded initiative integrating many laboratories worldwide, has had two toxin exercises so far (ricin in 2019/2020 and a BoNT exercise upcoming in 2021), where identification, activity determination, and quantitation is requested, including extended reporting to include information on impurities, and toxin isoforms (with a focus on forensic analysis). However, no written criteria per technique are requested and no final reporting format is dictated. The reporting time is to submit the first report within four days, and the second more extensive report within weeks (no primary data requested).

(c) The third network identified is EuroBioTox, which has had 10 toxin exercises so far on ricin, abrin, STX, BoNTs, and SEs, and on-site detection (beyond list 1 toxins), where identification, quantitation, and activity determination were requested, as well as optional reporting on toxin subtypes and isoforms. The requested reporting time is three to four weeks in order to include qualitative and quantitative analysis.

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5 CBRN = chemical, biological, radiological, and nuclear.

6 See https://eurobiotox.eu/.

7 See https://emergency.cdc.gov/lrn/.

7.27 Turning to the question of quality system requirements, Dr Dorner noted the European standard ISO/IEC 17025 (requirements for competence of testing and calibrating laboratories for environmental samples)[8] and the European standard ISO 15189 (requirements for competence of medical laboratories for clinical samples), [9] which is very restrictive. She noted that more flexibility might be needed, as too restrictive guidelines could be counterproductive, and suggested that laboratories involved in an international investigation need to conduct their work under an overarching quality mechanism (QM) system ensuring regular QM measures (e.g., pipet calibration and lot documentation). The exact procedure applied in the investigation should be a robust method that at best has been reviewed and/or published so that the science behind it can be documented and is visible and transparent, with accreditation of the exact method being helpful but not critical.

7.28 In conclusion, Dr Dorner noted that the most difficult question is how to harmonise those approaches and yet remain flexible to address new or emerging biotoxin threats, and that no suggestions have been provided on this question so far.

Subgroup 5

7.29 Dr Mikulak (subgroup lead) recalled the question for subgroup 5: "What institutional or legal measures need to be established to facilitate cooperation between the OPCW and other organisations working on the development of capabilities for analysis of toxins?" The main question can be deconstructed into three categories. The first concerns possible forms of cooperation (e.g., occasional vs. regular), common standards/criteria, coordination of activities or even joint activities between the OPCW and other organisations, and reciprocity regarding recognition of laboratory qualifications and steps to facilitate exercises. Secondly, there is the question of cooperation between the OPCW and other international organisations (e.g., the United Nations Office for Disarmament Affairs), individual countries or a group of countries, or possibly even with an individual laboratory or a group of laboratories (e.g., EuroBioTox). The third and final category relates to possible institutional or legal measures, such as informal arrangements, exchanges of letters regarding cooperation, memorandums of understanding, and formal agreements on cooperation and contractual arrangements (e.g., the technical agreements that the OPCW has with designated laboratories). In conclusion, Dr Mikulak noted that the specifics will largely depend on the outcomes of other subgroup discussions identifying investigative authorities and networks working on the development of capabilities.

8. AGENDA ITEM EIGHT – Recommendations on the terms of reference of the Temporary Working Group

8.1 Prof Mostafa Ghanei, TWG member, gave a presentation on the clinical approach to biotoxins. He noted that when talking about clinical medicine, it is important to talk about the epidemiology of biotoxins, and gave an example of cyanobacteria which is present in almost all freshwater bodies of the world. Prof Ghanei noticed a rapid growth in scientific articles in the field of biotoxins published in Scopus since 2000, including articles on the application of biotoxins.

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8 See https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html.

9 See https://www.iso.org/obp/ui/#iso:std:iso:15189:ed-3:v2:en.

8.2 Turning to the geographical distribution of marine poisoning, Prof Ghanei reported the increase in the frequency and severity of such cases, suggesting a worldwide public health risk. The poisoning is caused by toxins including saxitoxin, brevetoxins, domoic acid, okadaic acid and its derivatives, pectenotoxins, azaspiracids, and ciguatoxins found in fish and shellfish. He further provided an overview of marine food poisoning occurrences worldwide, noting that, for example, ciguatera fish poisoning is the most common food-borne illness worldwide with over 50,000 incidents per year. Quoting published literature, Prof Ghanei reported that plant and bacterial toxins produced more than 600 million food-borne illnesses and 420,000 deaths in 2010 alone.[10] Therefore, plant and bacteria toxins have a large effect on human health and early detection of the disease, and outbreak and prevention are very important.

8.3 Turning to the mechanism of biotoxins and their clinical application, Prof Ghanei noted the diverse beneficial applications of biotoxins in medicine, such as the use of saxitoxin (a sodium channel blocker) in anaesthesia and for the treatment of sciatica pain, yessotoxin in the treatment of MCF-7 breast cancer cells and disorder of calcium homeostasis, brevetoxin for the treatment of cystic fibrosis, and gambierol for Alzheimer's disease. Prof Ghanei presented a table with an overview of clinical applications of different biotoxins.

8.4 Prof Ghanei noted that the clinical use of biotoxins has become a big business around the world with at least 140 studies published on ClinicalTrials.gov[11] and 9951-related studies on Google Patents.

8.5 In conclusion, bearing in mind all the beneficial applications of biotoxins in medicine, the challenge will not only be understanding the differentiation of the legitimate use of biotoxins for beneficial purposes in medicine versus their misuse for nefarious reasons, but also the determination of the criteria for triggering an investigation in case of an alleged use of biotoxins.

8.6 The TWG Chairperson commented that the increasing use of biotoxins in medicine stresses the importance of the work that the TWG is doing. In contrast to Convention Schedule 1 compounds, which have no use in regular chemical industry, biotoxins appear to have a lot of uses which are of importance for a variety of research and reasons.

8.7 It was also pointed out that a lot of investigations may start not from an alleged crime scene but rather from a medical diagnosis or in a hospital setting. Therefore, it is important to rethink how an investigation may be structured, as it may be very different than in the case of an alleged use of a traditional chemical weapons agent.

8.8 The Group concluded that the dual-use aspect of biological toxins, given their many potentially beneficial applications, should be considered.

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10 World Health Organization. (2015). WHO estimates of the global burden of foodborne diseases: foodborne diseases burden epidemiology reference group 2007-2015.

11 See https://clinicaltrials.gov/.

9. AGENDA ITEM NINE – Final comments and next steps

9.1 The TWG Chairperson applauded yet another productive TWG meeting filled with fruitful discussions. He called on TWG members to provide their ideas for guest speakers to generate a pool of potential guest speakers.

9.2 The SAB Secretary noted that the next SAB meeting is planned to take place in person the week of 15 to 19 November 2021. He suggested that the TWG members consider holding its next meeting, also in-person, some time the week prior. This is so that those members who sit on both the SAB and the TWG do not have to make multiple trips.

9.3 The TWG Chairpeson also noted that it would be good to have a brief, one-afternoon online intersessional meeting in September to touch base on the work happening and to prepare for the expected in-person November meeting. It was agreed that an online survey would be sent to TWG members for them to indicate their preferred date(s).

10. AGENDA ITEM TEN – Closure of the meeting

The Chairperson ended the meeting at 17:05 on 23 June 2021.

ACKNOWLEDGEMENTS

The TWG members thank the guests and members of the Secretariat who participated in discussions. The TWG also wishes to acknowledge Ms Ernesa Ademagić of the OPCW Office of Strategy and Policy for her support and contributions to the meeting and its preparations. Lastly, the TWG thanks the OPCW Director-General for his establishment and support of the TWG, and acknowledges the generous contribution of the European Union that helps to cover the costs of the Group's work.

Annex: List of Participants at the Second Meeting of the Scientific Advisory Board's Temporary Working Group on the Analysis of Biotoxins

Annex

LIST OF PARTICIPANTS AT THE SECOND MEETING OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP ON THE ANALYSIS OF BIOTOXINS

	Participant	Institution
1	Dr Isel Pascual Alonso*	University of Havana, Cuba
2	Dr Crister Åstot	Swedish Defence Research Agency (FOI), Umeå, Sweden
3	Dr Anne Bossée*	DGA CBRN Defense, France
4	Dr Graeme Clark	Defence Science and Technology Laboratory, Porton Down, Salisbury, United Kingdom
5	Dr Cindi Corbett	National Microbiology Laboratory, Public Health Agency of Canada
6	Dr Christophe Curty*[12]	Spiez Laboratory, Switzerland
7	Dr Brigitte Dorner	Robert Koch Institute, Germany
8	Dr Mostafa Ghanei*	Baqiyatallah University of Medical Sciences, Islamic Republic of Iran
9	Dr Suzy Kalb[13]	Centers for Disease Control and Prevention, United States of America
10	Dr Zrinka Kovarik*	Institute for Medical Research and Occupational Health, Croatia
11	Dr Andrea Leisewitz*[14]	Universidad San Sebastián, Chile
12	Dr Robert Mikulak*	Department of State, Washington, D.C., United States of America
13	Dr Daan Noort*[15]	TNO, Netherlands
14	Dr Yulia Polyak	Russian Academy of Sciences, Russian Federation
15	Dr Fengxia Sun*	Hebei University of Science and Technology, People's Republic of China
	Technical Secretariat Staff	**Division**
16	Dr Peter Hotchkiss[16]	Office of Strategy and Policy
17	Dr Stuart Thomson	OPCW Laboratory
18	Dr Timothy Wood	OPCW Laboratory

* Member of the SAB.

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12 Chairperson of the SAB.

13 Vice-Chairperson of the TWG.

14 Vice-Chairperson of the SAB.

15 Chairperson of the TWG.

16 Secretary to the SAB.