



OPCW

Organisation for the Prohibition of Chemical Weapons

Developments in Science and Technology

*Presented to the 10th Meeting of the OEWG-RC
6 June 2018*

Christopher M. Timperley, PhD; Chairperson, Scientific Advisory Board

Cheng Tang; 2019 Chairperson Elect, Scientific Advisory Board

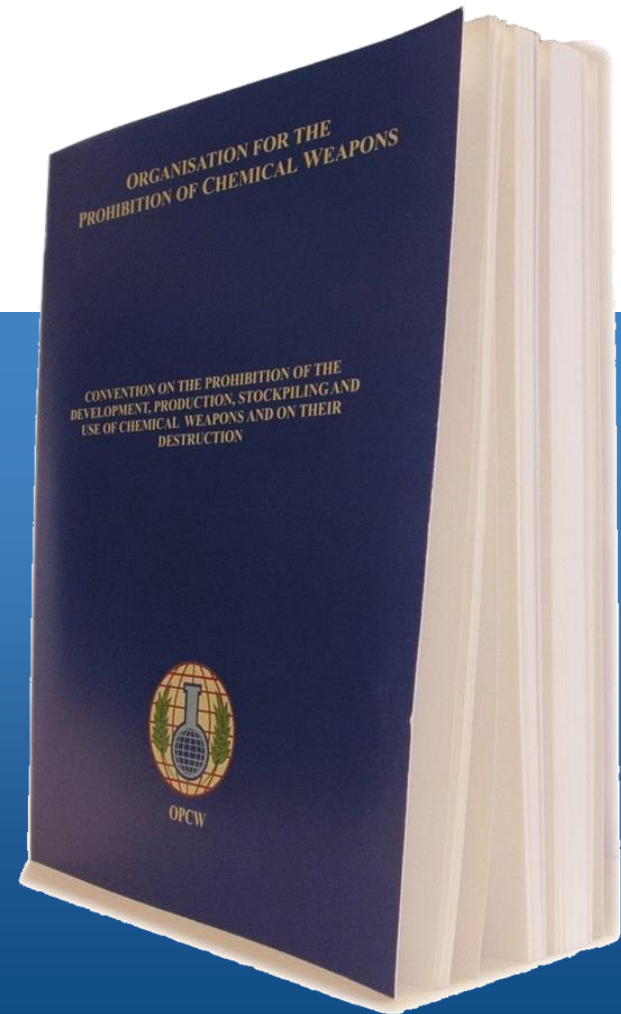
Jonathan E. Forman, PhD; Science Policy Adviser and Secretary to the Scientific Advisory Board

Bringing Us Here Today...

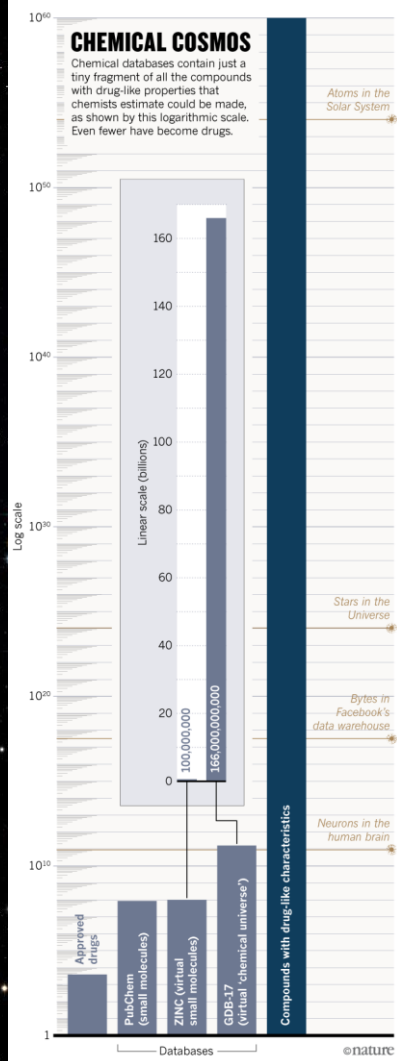
The Conference of States Parties Shall:

“Review scientific and technological developments that could affect the operation of this Convention and, in this context, direct the Director General to establish a Scientific Advisory Board to enable him, in the performance of his functions, to render specialized advice in areas of science and technology relevant to this Convention, to the Conference, the Executive Council or States Parties.”

- Article VIII, Section B, paragraph 21(h)



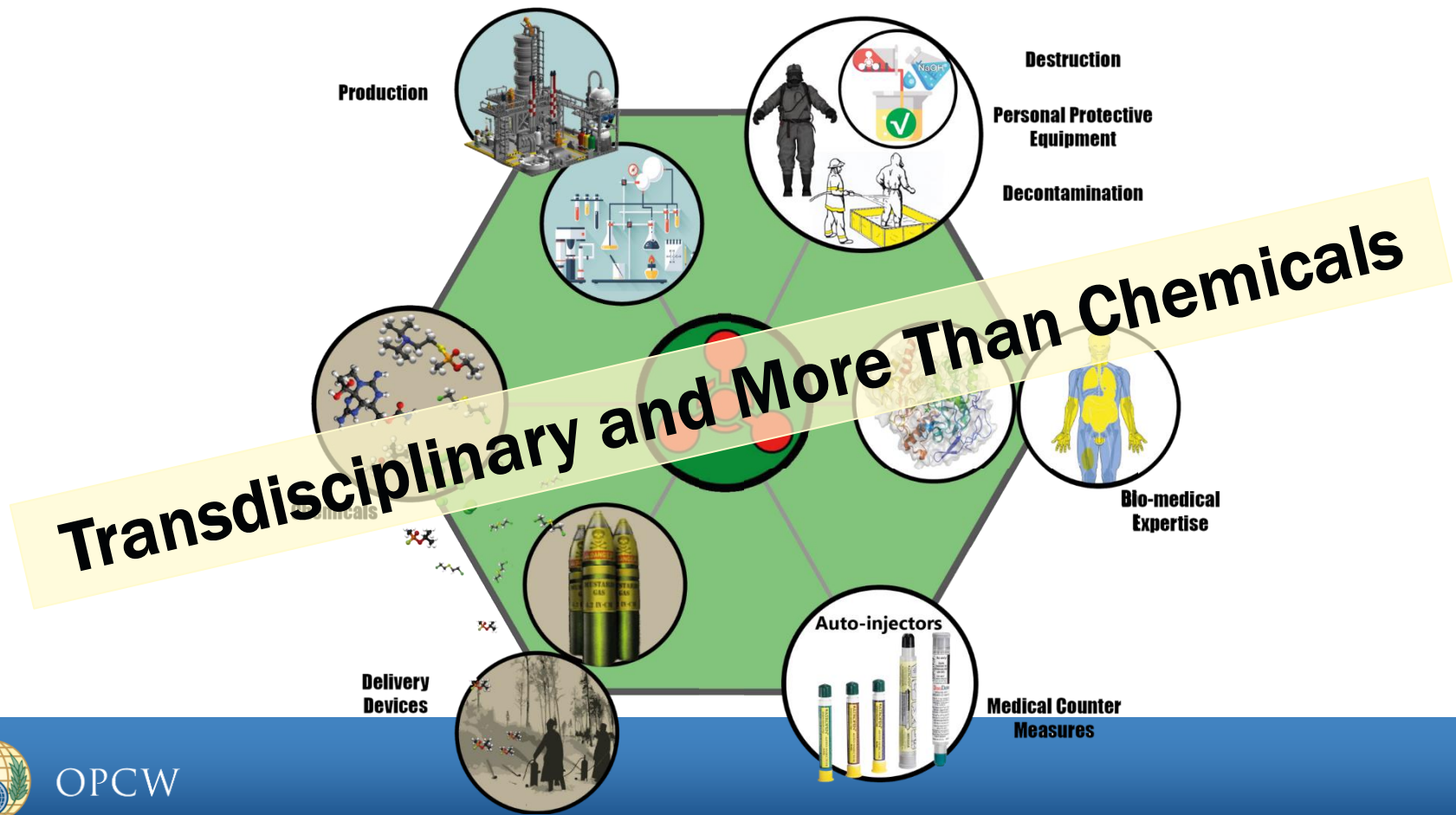
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Science is vast: how can you monitor it?



What Scientific Disciplines are Relevant?

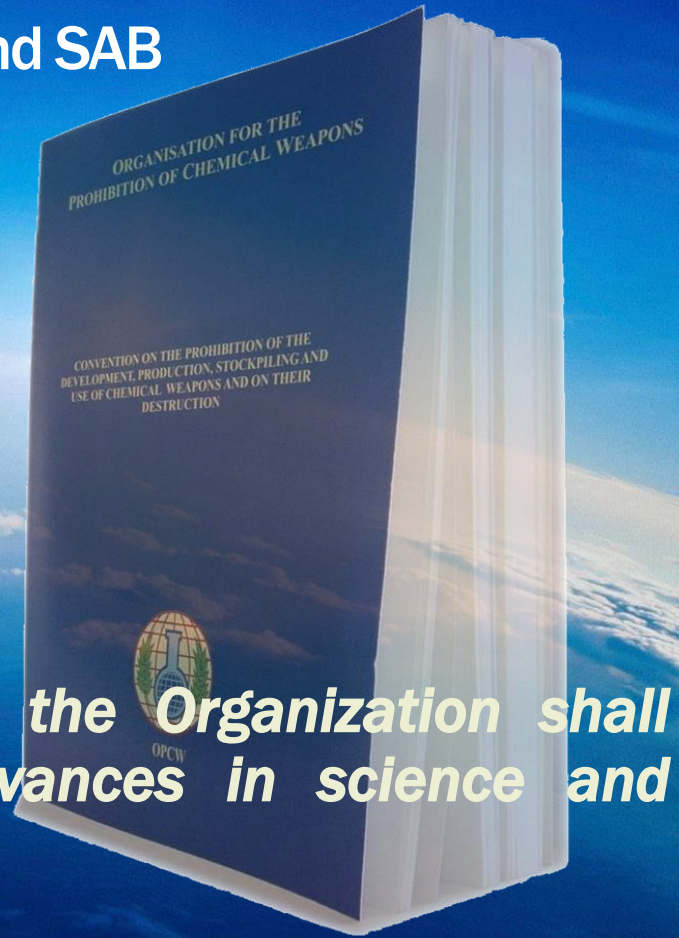


Science monitoring approaches of Secretariat and SAB

- Prioritize capability
- Must engage experts
 - Need to be visible in scientific communities

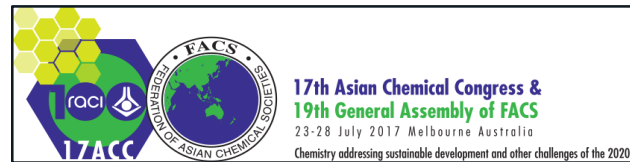
"In undertaking its verification activities the Organization shall consider measures to make use of advances in science and technology"

- *Article VIII, paragraph 6*



Building Ties into Scientific Communities

- **International Union of Pure and Applied Chemistry (IUPAC)**
 - MoU
 - Secretariat serves on IUPAC committees (chemistry education, green chemistry)
 - Conference attendance and participation
- **Regional and National Chemical Scientific Societies**
 - Conference attendance and participation
 - Basic research and applied science focus



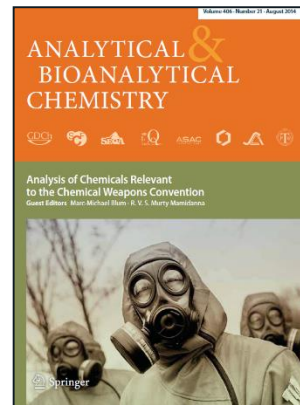
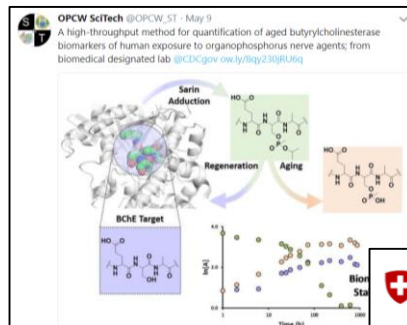
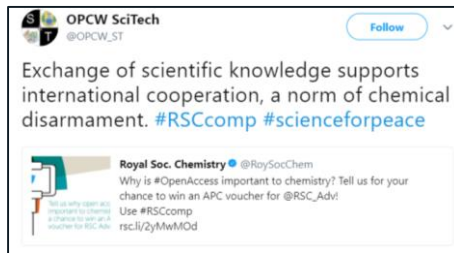
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Building Ties into Scientific Communities

- **Peer-Reviewed Scientific Publications**

- Secretariat, SAB, Designated Labs

- **Scientific Social Media**



- **Transdisciplinary (convergent) subject areas**

- Share experiences in security communities



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Defence,
Civil Protection and Sport DDPS
Federal Office for Civil Protection FOCP
SPIEZ LABORATORY

Spiez CONVERGENCE
11 – 14 September 2018

The Swiss Government started a workshop series focusing on advances in chemical and biological sciences in 2014 under the title **Spiez CONVERGENCE**. The series is dedicated to informing participants about significant advances in chemical and biological sciences. The objective of this series is to share experiences in security communities which may have implications for the Chemical Weapons Convention (CWC).



The Science Review

- Temporary Working Groups
- Regular Sessions of SAB
- Intersessional Reports
- International Workshops
- **Insights from scientific communities**



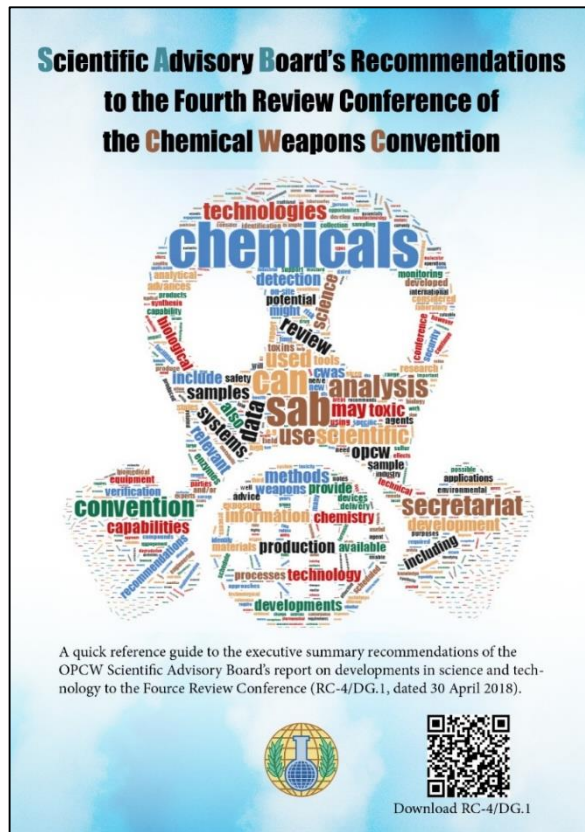
Chemical Forensics: Capabilities across the Field and the Potential Applications in Chemical Weapons Convention Implementation
Helsinki, Finland, 20 to 22 June 2016
SAB-24/WP.1, dated 14 July 2016, URL: <http://q-r.to/bap16r>
Coorganizer: VERIFIN

Chemical Warfare Agents: Toxicity, Emergency Response and Medical Countermeasures
Paris, France, 26 to 27 September 2016
SAB-24/WP.2, dated 14 October 2016, URL: <http://q-r.to/bap1h4>
Coorganizer: SCDSN

Innovative Technologies for Chemical Security
Rio de Janeiro, Brazil, 3 to 5 October 2017
SAB-26/WP.1, dated 21 July 2017, URL: <http://q-r.to/bap1hC>
Coorganizers: The National Academy of Sciences Engineering Medicine, ACADEMIA BRASILEIRA DE CIÊNCIAS

International Workshop on Trends in Chemical Production
Zagreb, the Republic of Croatia, 3 to 5 October 2017
SAB-26/WP.2, dated 19 October 2017, URL: <http://q-r.to/bap1hD>
Coorganizers: Zagreb, MINISTRY OF ECONOMY, ini

The Outcome



27 Events

747 Attendees

- 289 individuals
- 58 Nationalities

453 Speakers

- 201 individuals
- 58 Nationalities

33 Reports

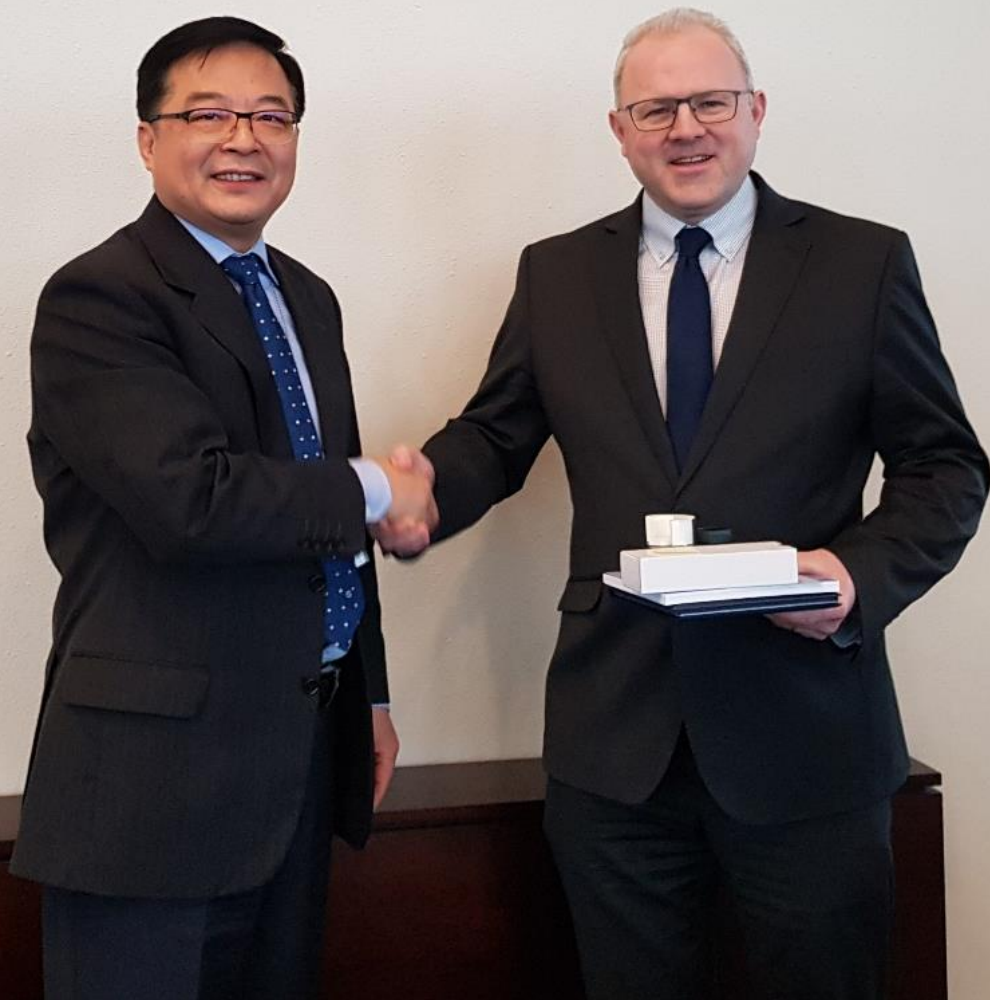


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Presentation from
Dr Christopher Timperley
SAB Chair

and

Mr Cheng Tang
2019 SAB Chair Elect



Overview – SAB's advice :

- Advances in science in technology (S&T)
- Chemicals
- S&T of relevance to verification
- Technologies for delivery of toxic chemicals
- Developments in chemical production and discovery
- Assistance and protection
- S&T of relevance to chemical safety and security
- Science literacy and science advice

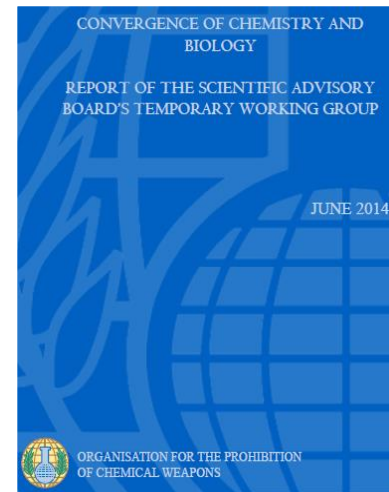


Advances in science and technology

- Given potential impact on CWC of convergence of chemistry and biology, SAB and TS should keep under review developments in:

- biological and biomediated processes
- metabolic engineering
- synthesis of replicating organisms
- use of enzymes for decontamination
- biotechnology and related aspects relevant to the CWC

and report on their implications for the Convention



Advances in science and technology



- SAB and TS should continue to
 - work across areas of overlap between CWC and BWC and promote joint discussions among international experts in these areas
 - assess developments in technical fields of increasing relevance to CWC: computational chemistry, big data, informatics and artificial intelligence, forensic science, remote sensing, and unmanned automated systems
- Although biological or biomediated processes do not currently appear likely to be suitable for production of traditional CW agents, the TS should continue to monitor developments closely





Advances in science and technology

- SAB continues to emphasise that any process for formation of a chemical should be covered by term “produced by synthesis”
- As number and variety of facilities using a biological or biomediated process to produce chemicals increase, the degree of relevance of these facilities to the object and purpose of the CWC will need to be assessed to determine whether there are grounds to exempt certain types of facilities or a need to review thresholds for declaration and inspection of other chemical production facilities (OCPFs)





Advances in science and technology

- TS is encouraged to consider ways in which interesting and potentially enabling technologies identified by the SAB may
 - be valuable in enhancing its capability to verify compliance with CWC
 - assist States Parties in improving their own capabilities
- Technological change is best considered from practical perspective, focusing on capabilities relevant to CWC, irrespective of scientific discipline



Advances in science and technology

- SAB recommends the TS adopts a systematic approach to the continued professional development of its technical experts to ensure they possess the knowledge and expertise to identify, evaluate, and apply S&T advances relevant to its work



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Given changes in chemistry and chemical industry since schedules were finalised 25 years ago, a review of the schedules should be considered to assess whether:

-
- The collage is a collection of chemistry-related images and text, organized into sections labeled 'Schedule 1', 'Schedule 2', and 'Schedule 3'. The text is in Hindi, discussing chemical reactions and their applications.
- Schedule 1:** This section is titled 'Schedule 1' and contains a large diagram of a chemical reaction network. The diagram shows a central molecule, CH3COOH, reacting with various other molecules to form a complex network of products. The reactions are labeled with numbers 1 through 10. The text below the diagram discusses the importance of chemical reactions in the study of chemistry.
- Schedule 2:** This section is titled 'Schedule 2' and contains a large diagram of a chemical reaction network. The diagram shows a central molecule, CH3COOH, reacting with various other molecules to form a complex network of products. The reactions are labeled with numbers 1 through 10. The text below the diagram discusses the importance of chemical reactions in the study of chemistry.
- Schedule 3:** This section is titled 'Schedule 3' and contains a large diagram of a chemical reaction network. The diagram shows a central molecule, CH3COOH, reacting with various other molecules to form a complex network of products. The reactions are labeled with numbers 1 through 10. The text below the diagram discusses the importance of chemical reactions in the study of chemistry.
- The collage also includes several chemical structures and reaction schemes, such as the reaction of CH3COOH with CH3OH to form CH3COOCH3, and the reaction of CH3COOH with CH3NH2 to form CH3CONHCH3. There are also diagrams showing the reaction of CH3COOH with CH3I to form CH3COOCH3 and CH3I with CH3OH to form CH3OCH3.
- The collage is a valuable resource for students of chemistry, providing a comprehensive overview of chemical reactions and their applications. It is a must-have for anyone interested in the study of chemistry.





Advice on chemicals

- SAB advises against relying solely upon Chemical Abstracts Service (CAS) numbers to define chemicals covered by the schedules:
 - Although relevant as aids to declaration and verification, CAS numbers are not the only means to identify a chemical or to determine whether a chemical is included in or excluded from a schedule (consistent with previous SAB advice)
- The isotopically-labelled compound or stereoisomer related to the parent chemical specified in a schedule should be interpreted as belonging to the same schedule





Advice on chemicals

- Technical discussions of so-called “incapacitating chemicals” or central nervous system-acting (CNS) chemicals remain exhausted
- The SAB sees no value in revisiting this topic as scientific facts remain unchanged since the SAB first considered the issue
- In view of the increasing availability of such chemicals, the TS should be prepared to develop capabilities that could be required to conduct missions involving an alleged use of CNS-acting chemicals, including sample collection and addition of analytical data to OCAD



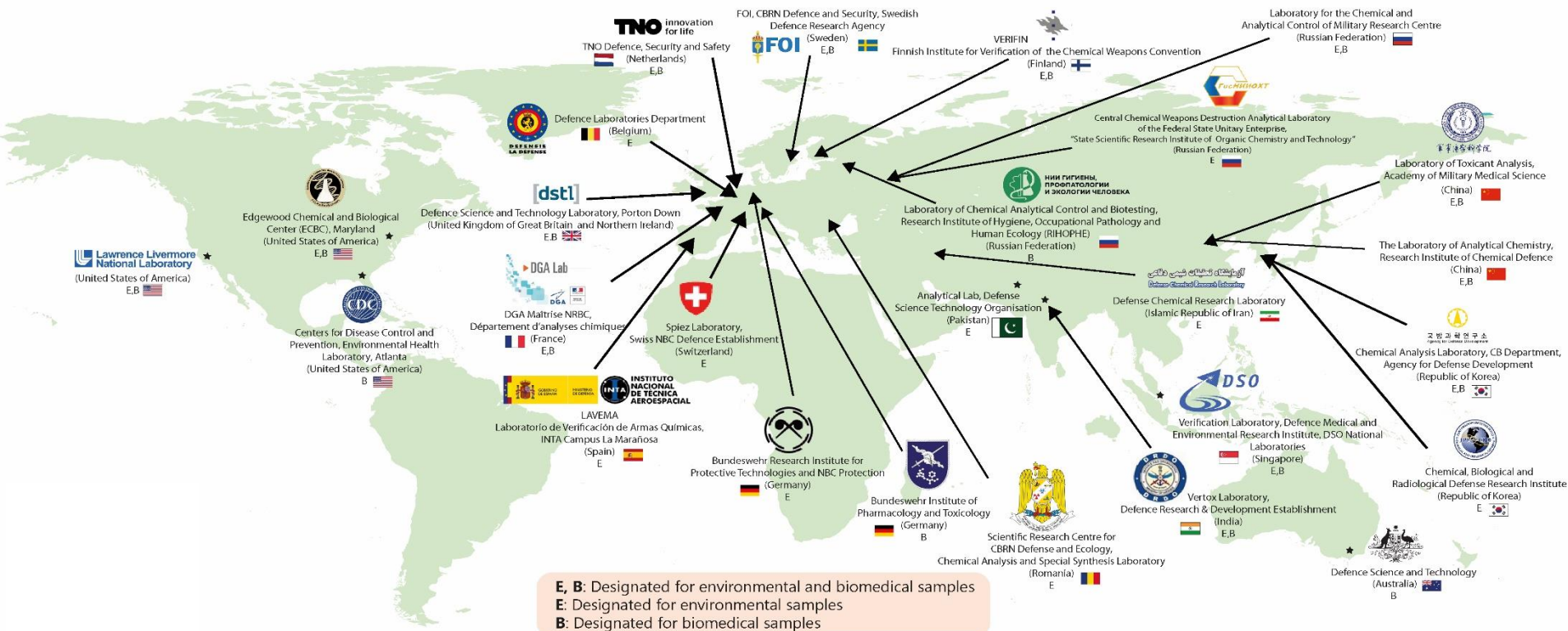
Advice on chemicals

- In view of use of toxic industrial chemicals (TICs) as chemical weapons, TS should seek to identify markers that may be formed through reactions of TICs with living tissue or materials present in environment and assess utility of such markers in investigations



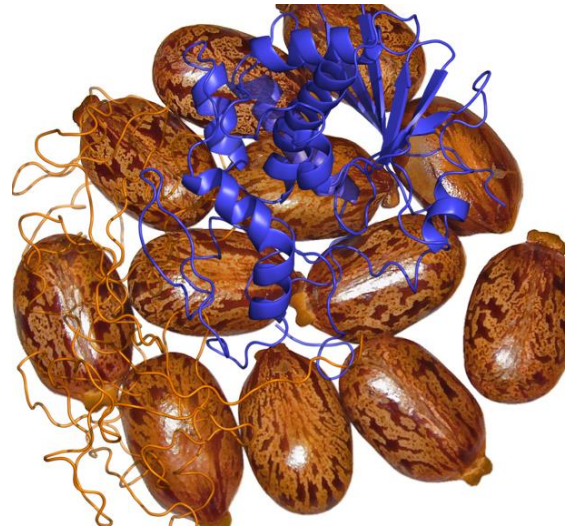
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Designated Laboratory network



Advice on chemicals

- TS should enhance efforts to strengthen capabilities of labs to identify the hostile use of toxins and analyse samples for toxins:
 - updating existing ricin and saxitoxin fact sheets
 - preparing factsheets on other toxins that have been weaponised (e.g. staph. enterotoxin B) or pose a high risk of potential use as weapons
 - identifying a priority set of toxins for development of analytical methods
 - collaborating with other networks of laboratories seeking to build capabilities for toxin analysis



Science and technology relevant to verification

- Effective verification requires assessment of all relevant information pertaining to a site and SP, not simply the evaluation of a single inspection: TS should move toward an integrated approach where all separate elements of information are combined and analysed
- TS should review the Verification Information System (VIS), develop new templates for Article VI inspection reports that would make it possible to upload the entire report to the VIS as a searchable document, and explore possibilities for the secure transmission of documents and data between inspection sites and OPCW HQ

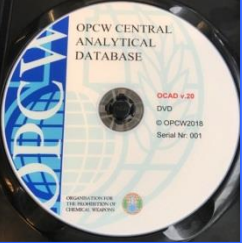




Science and technology relevant to verification

- SAB notes that satellite imagery has proven useful in planning contingency operations and recommends TS considers cooperating with other international organisations and experts to enhance its capability to interpret and apply satellite information to non-routine operations (e.g. use of hyperspectral, thermal, and near-IR imagery)
- To enable inspection teams to operate in dangerous/remote areas, TS should review remote and automated monitoring technologies to identify where their capabilities could be beneficial (new equipment should be added to the list of approved inspection equipment)





Science and technology relevant to verification

- **Appropriate analytical data for chemicals that may pose a risk to the CWC or are needed to help differentiate permitted activities from prohibited activities should be added to the OCAD**
 - **Could include isotopically labelled relatives and stereoisomers of scheduled compounds, salts of scheduled chemicals, TICs, CNS-acting chemicals, riot control chemicals, bioregulators, toxins, and unscheduled chemicals that have been identified as posing a risk to the Convention**



Science and technology relevant to verification

- SAB recommends that technical data related to sample analyses conducted for the OPCW be shared among laboratories in the network and published in peer-reviewed scientific journals, enabling all laboratories to benefit from proven methods and technologies
- Given the requirement for OPCW to be able to investigate alleged use of non-scheduled toxic chemicals, the capability to detect and identify traces of such chemicals and associated degradation and reaction products should be strengthened, by suitable exercises





Science and technology relevant to verification

- In view of the critical role of biomedical samples in investigations of alleged use of toxic chemicals, TS should actively encourage further research on potential markers of exposure: TS should engage with experts from broad range of fields to identify promising approaches
- To facilitate investigations of alleged prohibited activities, TS should maintain a curated collection of reference samples and chemical data, including compiled data on abandoned chemical weapons, environmental fate of toxic chemicals, and impurities associated with synthetic routes to nerve and blister agents





Science and technology relevant to verification

- TS could develop a repository of technical information on environmental impact of old, abandoned, and/or sea dumped CW to facilitate knowledge sharing through TS. (Information contains useful data for understanding environmental fate/transport of CW agents that is valuable for investigative and retrospective analysis)
- Investigative techniques required for verification of use of toxic chemicals include approaches used by the forensic community. TS, in consultation with relevant experts, should identify commonly used forensic techniques to assess applicability for its own activities



Science and technology relevant to verification

- **SAB supports the project to upgrade the OPCW Laboratory to a Centre for Chemistry and Technology : this would enable the Laboratory to increase capabilities to meet its expanded mandate**
- **An upgraded facility would be better able to facilitate proficiency testing and confidence building exercises, contingency operations, the handling and storage of authentic samples, provide training, and bring higher scientific visibility to the OPCW**



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Technologies for the delivery of toxic chemicals

- Continued development of unmanned aerial vehicles (UAVs) to deliver payloads for permitted purposes should be monitored to assess risks of development for chemical weapon delivery purposes



Developments in chemical production and discovery

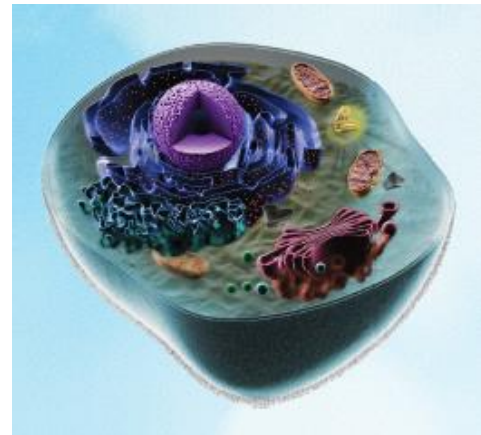
- OPCW verification could benefit from risk assessment tools and practices employed in chemical industry, specifically those that have been developed to facilitate safer process and product design, and for regulatory compliance
- Aspects of good practices employed in the chemical industry for knowledge management could enable more efficient use of information in OPCW operations



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Developments in chemical production and discovery

- Efforts to ensure that the verification regime remains effective would benefit from more extensive engagement with technical experts from industry, and review of industry focused R&D, including the driving forces for adoption of new technologies into industrial processes



Developments in chemical production and discovery

- Many facilities worldwide produce toxic chemicals that may be relevant to the CWC in quantities below current declaration thresholds (e.g. highly active pharmaceutical ingredients or toxins for cosmetic purposes or cancer therapy)
- Corresponding verification thresholds for facilities producing such chemicals should be addressed by SAB and its recommendations should be considered



Assistance and protection

- To enhance OPCW's capability to assist SPs in response to a chemical weapon attack or incident involving toxic chemicals, the TS should strengthen its preparedness and monitor advances in
 - medical countermeasures
 - detection and decontamination
 - physical protection



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Chemical safety and security

- **SAB encourages TS to engage with technical experts to ensure that its efforts to assist SPs with chemical safety and security have a sound scientific and technological foundation**
- **SAB recommends that TS encourage research in chemical security to prevent toxic chemicals from being acquired by non-State actors with intent to use them as chemical weapons; the research support programme under Article XI provides a possible mechanism**



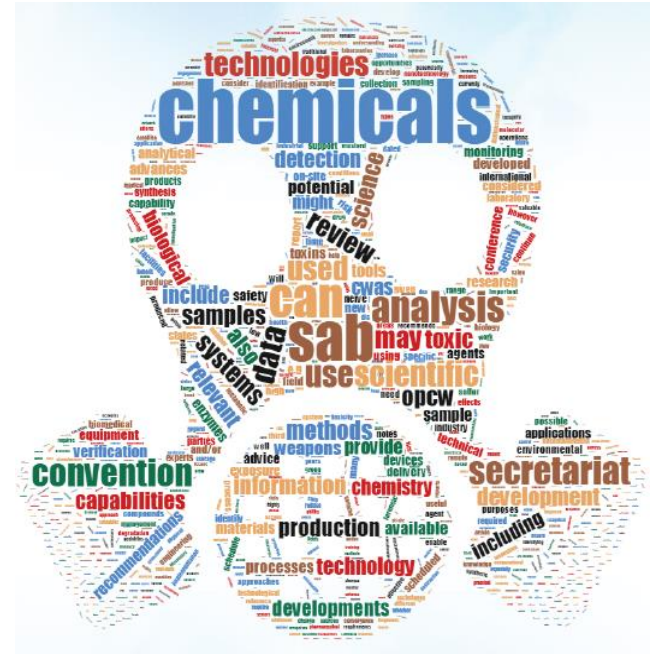
Chemical safety and security

- SAB has been informed that some SPs, where the economies are developing or in transition, have expressed an interest in improving chemical safety and security capabilities, specifically with regard to monitoring transfer of chemicals into and out of their territories
- SAB recommends TS strengthen its partnerships with international organisations engaged in R&D of technologies for this purpose, and that the TS pursues collaborative projects with such organisations to develop additional internal expertise to assist SPs



Scientific literacy and science advice

- Greater interaction between SAB and TS staff who perform operational roles would strengthen SAB's ability to identify S&T-related issues facing OPCW and augment the SAB's ability to provide practical advice
- Given the increasing degree to which S&T impacts effective implementation of the CWC, the TS should continue to strengthen its capability to monitor and forecast developments and their implications



Scientific literacy and science advice

- SAB and TS should maintain a “watching brief ” in areas most likely to have greatest impact on CWC’s verification regime : these include
 - chemicals and technologies that markedly increase potential for hostile use of chemicals
 - technologies that provide substantially enhanced capabilities for verification purposes
- In view of interdisciplinary nature of advances in S&T relevant to the CWC, the SAB should continue to build close working relationships with relevant professional societies and science advisory bodies of other relevant international organisations to enable it to identify and assess developments that may impact the CWC or OPCW. (Should also be used to raise awareness of the Convention.)



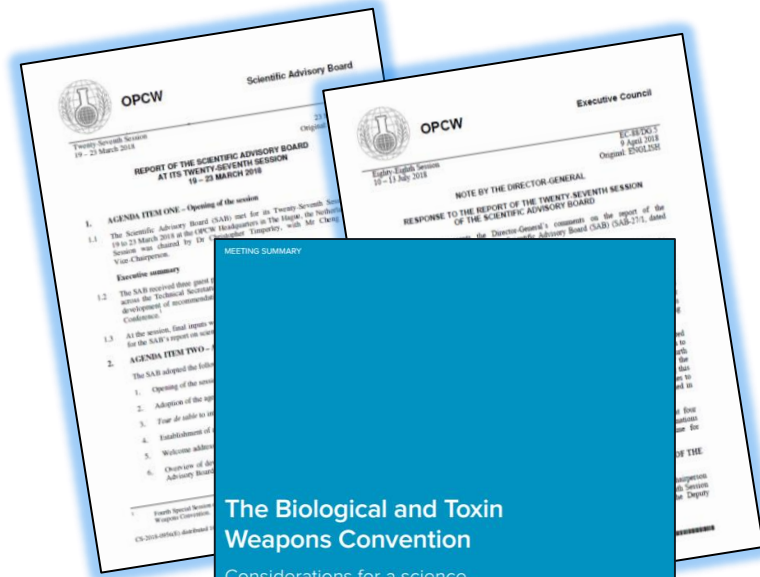
Dialogue between scientists and policymakers should continue



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Science – Policymaker Engagement

- **Feedback and dialogue**
 - Responses from Director-General
- **Sharing experiences with other science advisory mechanisms**
 - BWC and CTBTO
 - Common technology needs and concerns
 - Setting up science boards



The Biological and Toxin Weapons Convention

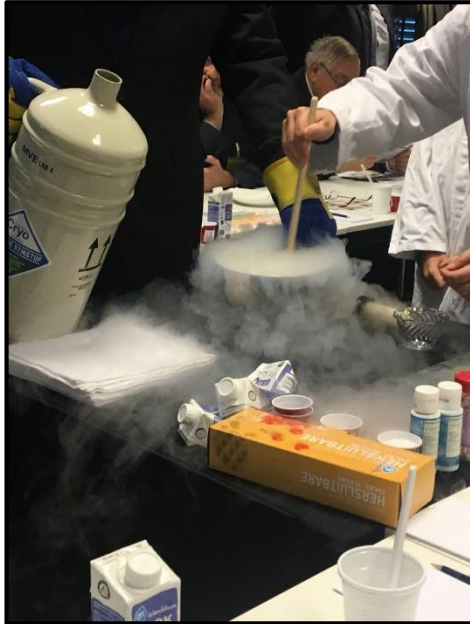
Considerations for a science advisory mechanism



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Interactive Engagement: Science for Diplomats

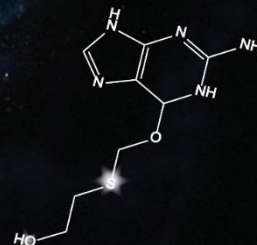
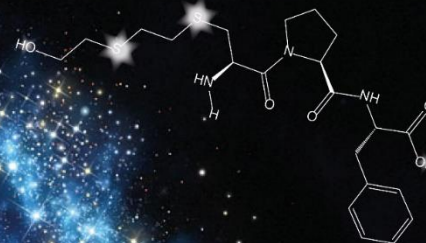
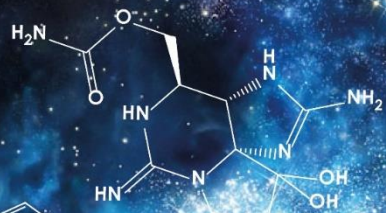
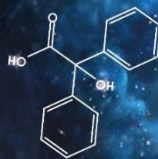
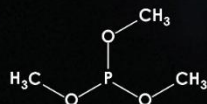
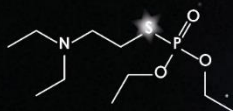
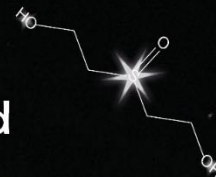
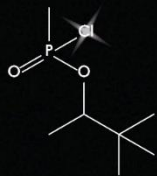
- Overcome technical discomfort – promote scientific literacy



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Science for Diplomats at EC-88

The Chemical Universe: Scheduled and Unscheduled



Tuesday, 10 July 2018

Ooms Room, OPCW

13:30 - 14:45

Light lunch served at 13:00

Questions?



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منظمة حظر الأسلحة الكيميائية

禁止化学武器组织

Organisation for the Prohibition of Chemical Weapons

Organisation pour l'Interdiction des Armes Chimiques

Организация по запрещению химического оружия

Organización para la Prohibición de las Armas Químicas