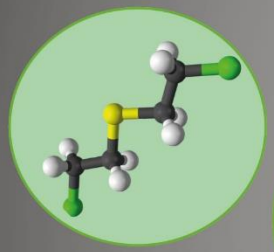
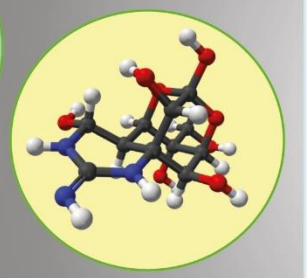
Science for Diplomats at EC-87

Science, Technology and the Chemical Weapons Convention:
A Preview of the Scientific Advisory Board's Report
to the Fourth Review Conference





And Don't Forget Your Smart phone!

Tuesday 13 March 2018
Ooms Room
13:30-14:45
Light lunch served at 13:00

Scan the QR code

to download the

"Science for Diplomats"

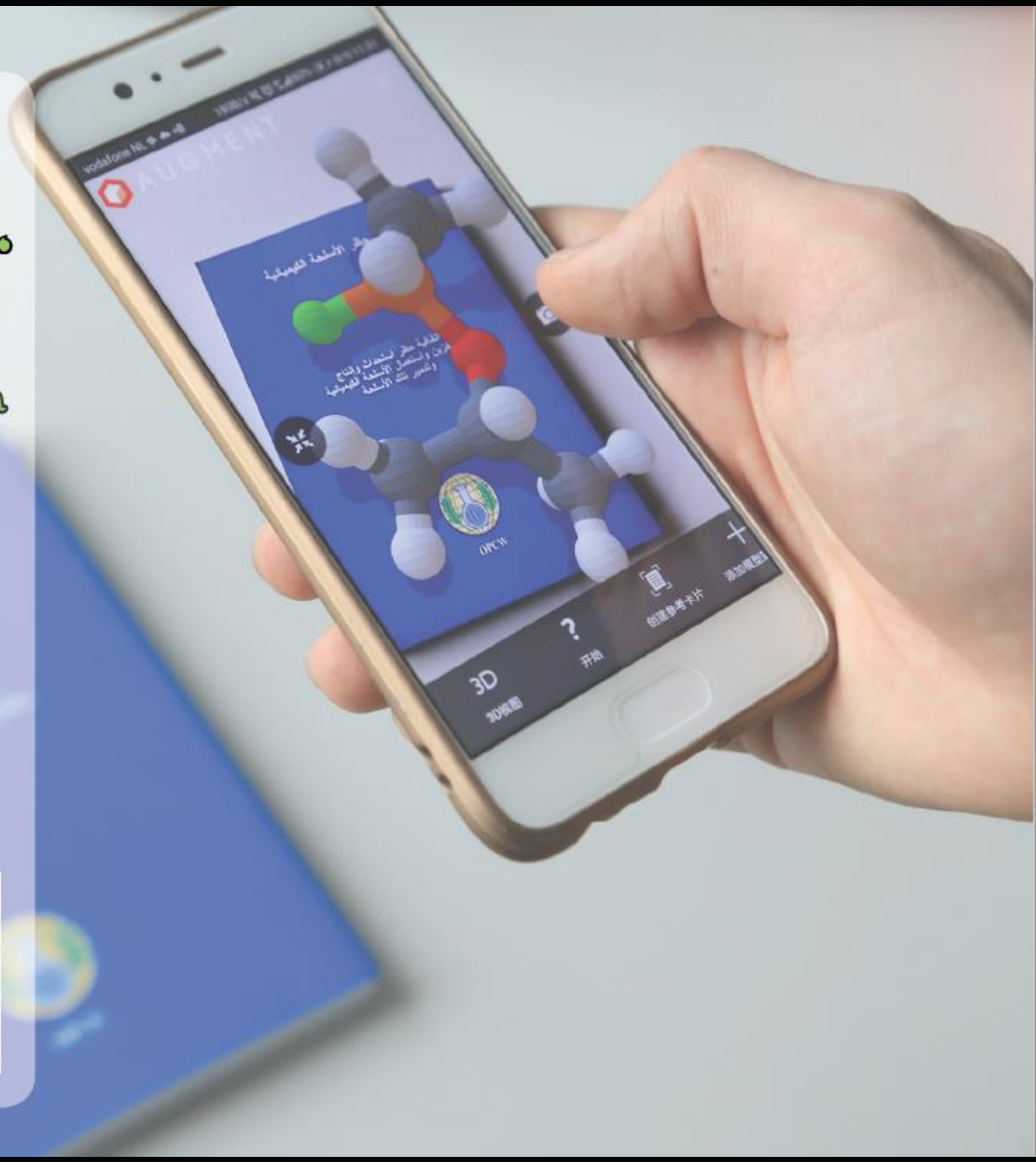
App

Now bring the Convention to life!

AUGMENT

android

iOS



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21-30 November 2018: A Time to Review

Scientific Advisory Board Report:

Overview of scientific and technological changes during review period

Advice on relevant and emerging areas of science and technology

Recommendations for moving forward

The OPCW Scientific Advisory Board in 2017

Report of the Scientific Advisory Board at its Twenty-Fifth Session
(SAB-25/1*, dated 31 March 2017)
URL: http://q-r.to/bap1L1

The Impact of the Developments in Science and Technology in the Context of the Chemical Weapons Convention, Response from the Director-General to SAB-25
(EC-85/DG.8, dated 19 May 2017)
URL: https://q-r.to/bap1LO

Report of the Scientific Advisory Board at its Twenty-Sixth Session
(SAB-26/1, dated 20 October 2017)
URL: http://q-r.to/bap1La

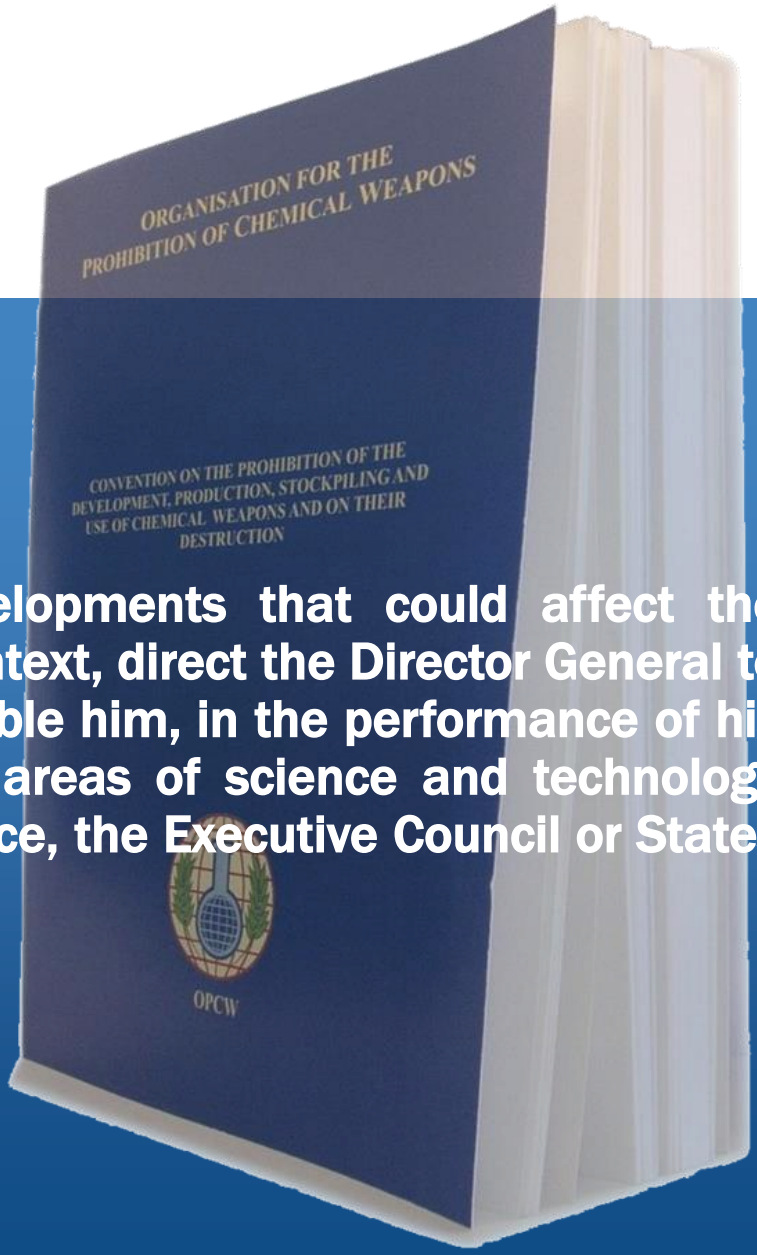
Response to the Report of the Twenty-Sixth Session of the Scientific Advisory Board
(EC-87/DG.11, dated 25 January 2018)
URL: http://l.ead.me/bar02E

Response to the Director-General's Request to the Scientific Advisory Board to Provide Consideration on which Riot Control Agents are Subject to Declaration under the Chemical Weapons Convention
(SAB-25/WP.1, dated 27 March 2017)
URL: https://q-r.to/bap1Li

Report of the Scientific Advisory Board's Workshop on Emerging Technologies
(SAB-26/WP.1, dated 21 July 2017)
URL: http://q-r.to/bap1Ln

Report of the Scientific Advisory Board's Workshop on Trends in Chemical Production
(SAB-26/WP.2, dated 19 October 2017)
URL: http://q-r.to/bap1Lr

Science and Technology in the Convention



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."

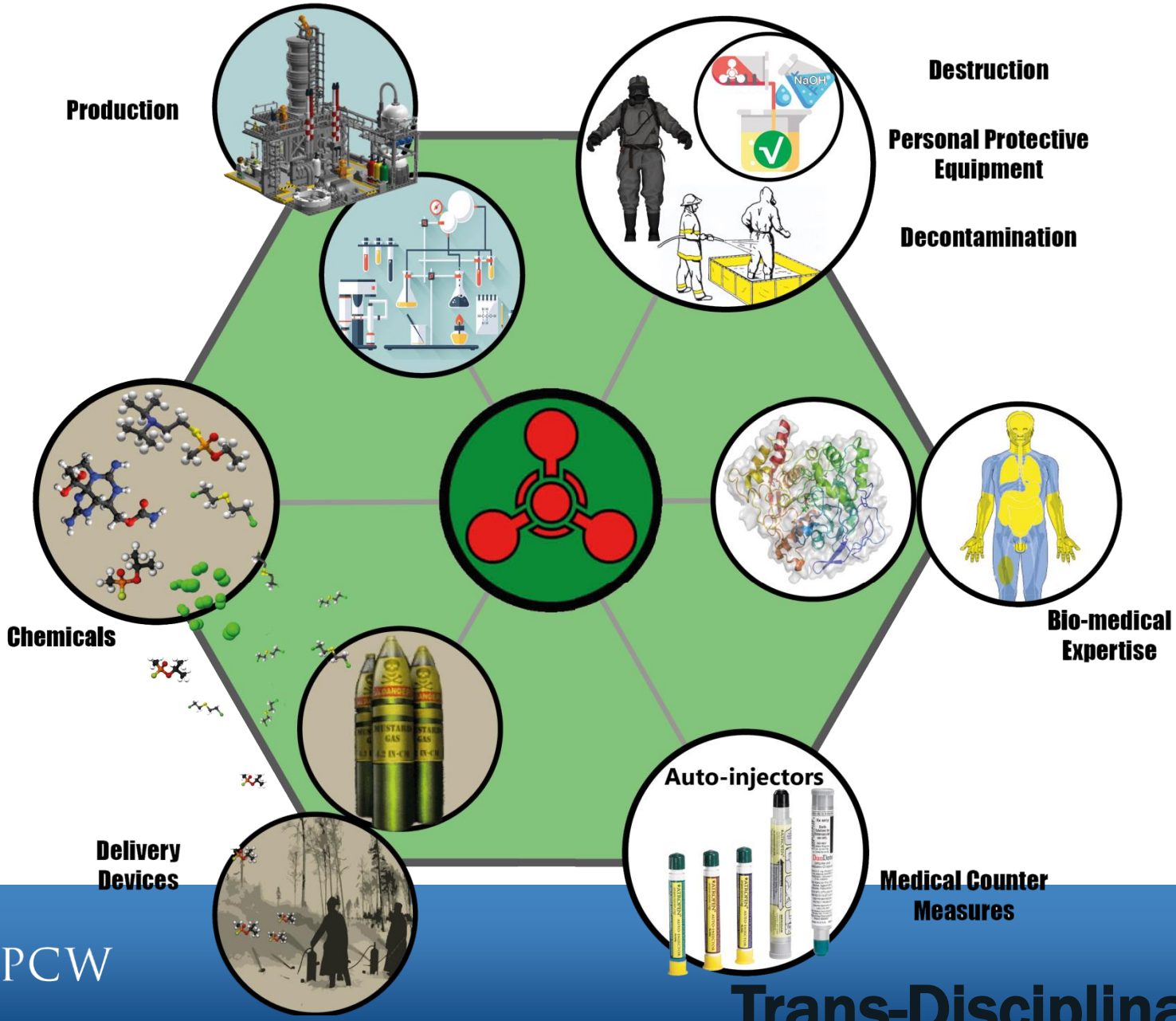
CWC Article VIII, Section B, paragraph 21(h)

OPCW

What does “Science and Technology” mean to you?

What does “Science and Technology” mean to you? (responses from audience)

What is the Science of Chemical Weapons?



OPCW

Trans-Disciplinary...

The Convention itself is "Convergent"

Chemical Weapon

Toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention as long as the types and quantities are consistent with such

Toxic Chemical

***Any chemical* which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals. This includes all such chemicals, regardless of their origin or of their method of production, and regardless of whether they are produced in facilities, in munitions or elsewhere.**

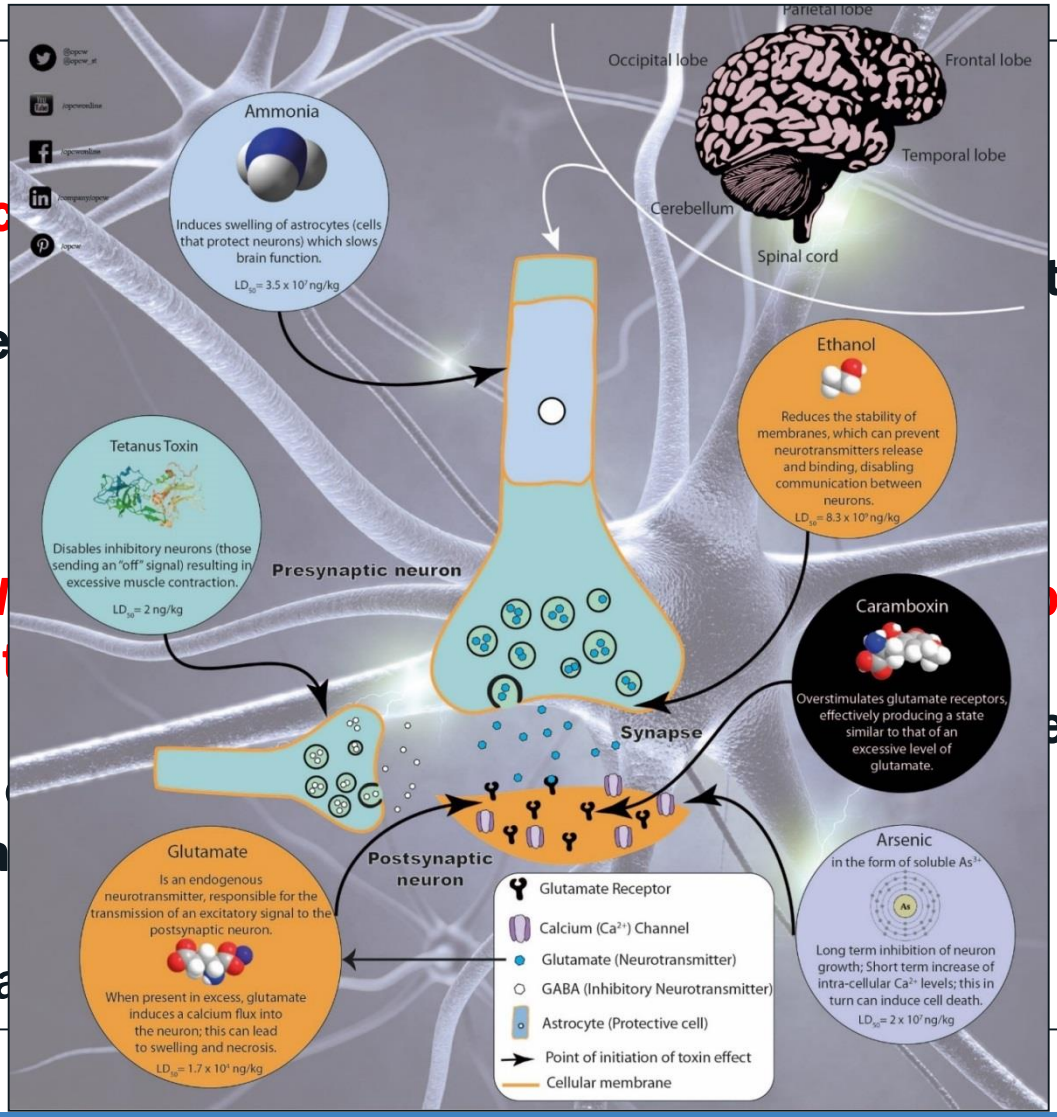
Chemical Weapons Convention Article II

The Convention itself is "Convergent"

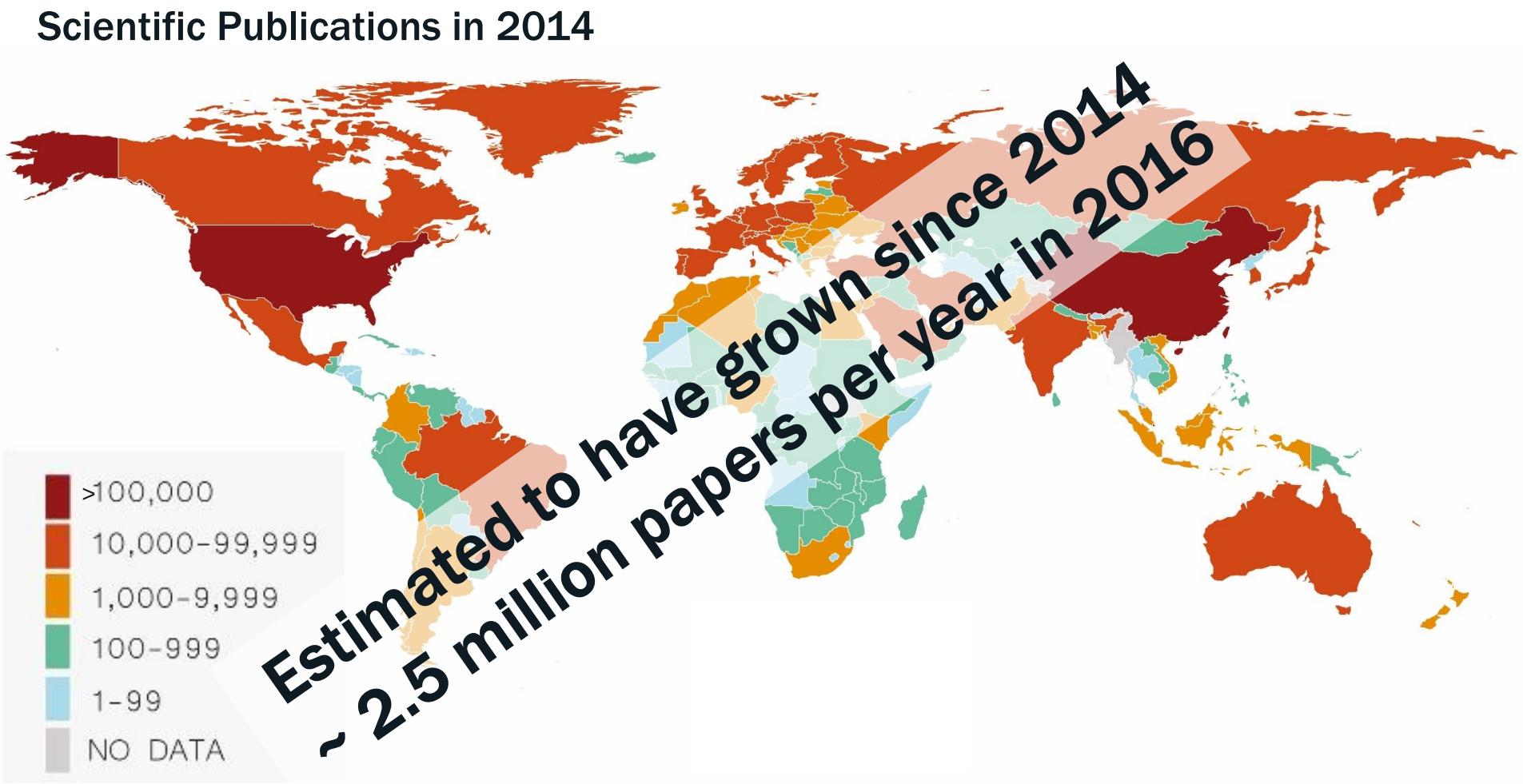
Toxic chemic **intended for purposes not** **the types and quantities are**

Any chemical **rocesses can cause death,** **to humans or animals. This** **eir origin or of their method** **are produced in facilities, in**

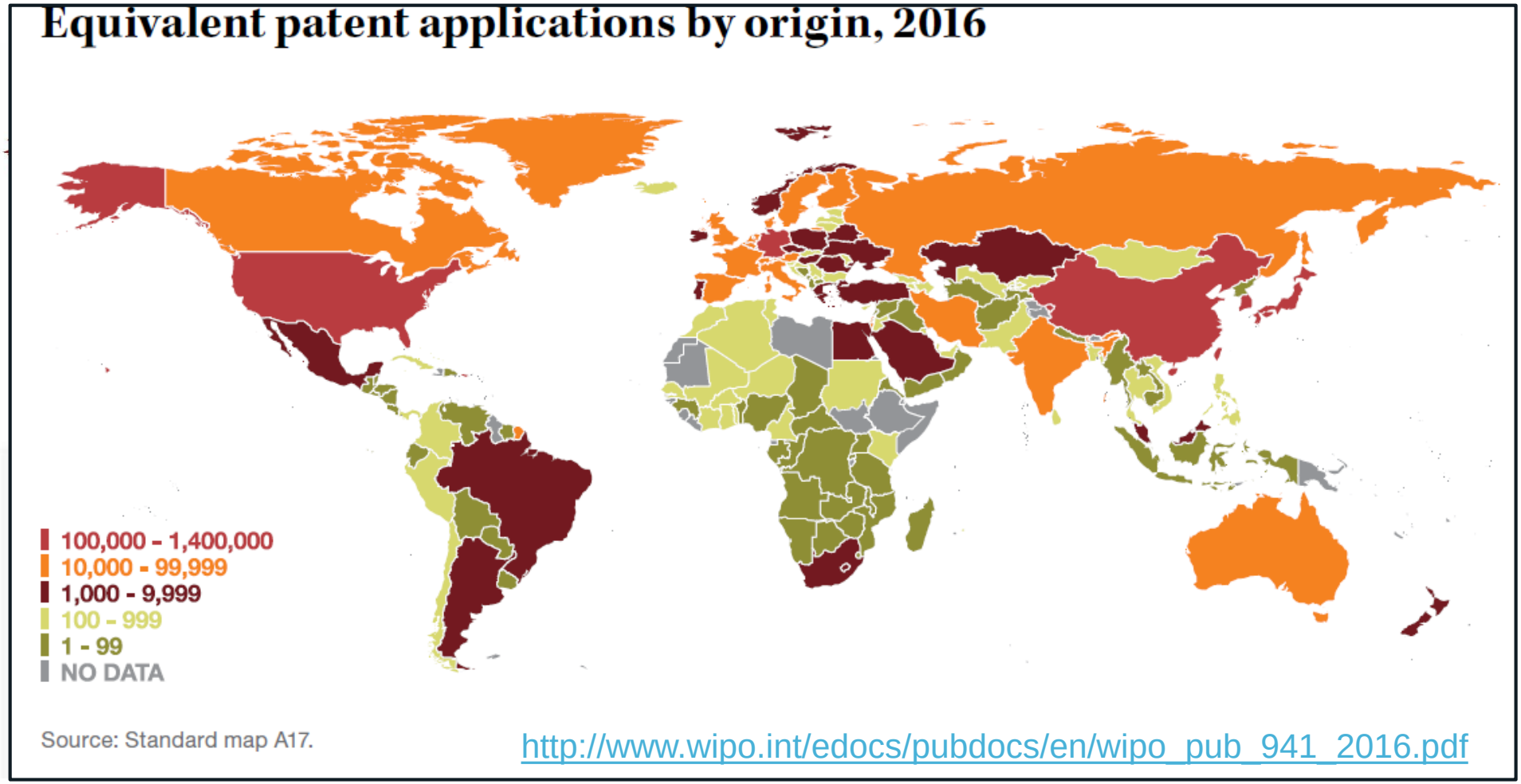
Chemical Wea



How Much Science is Out There?



How Much Science is Out There?



http://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2016.pdf

- All this advanced science and...

- All this advanced science and…
- Allegations of use of Chlorine Gas, Sulphur Mustard and Nerve Agents

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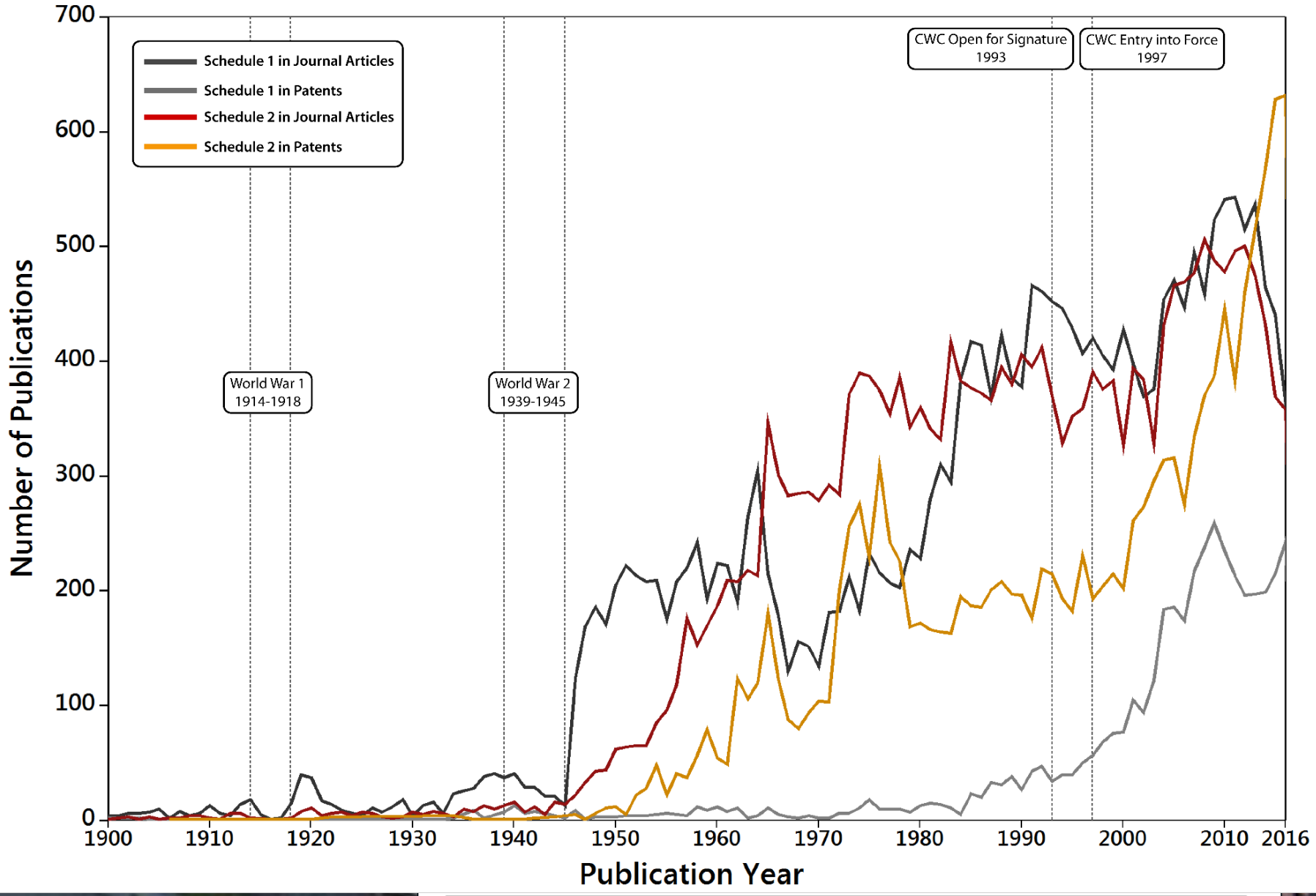


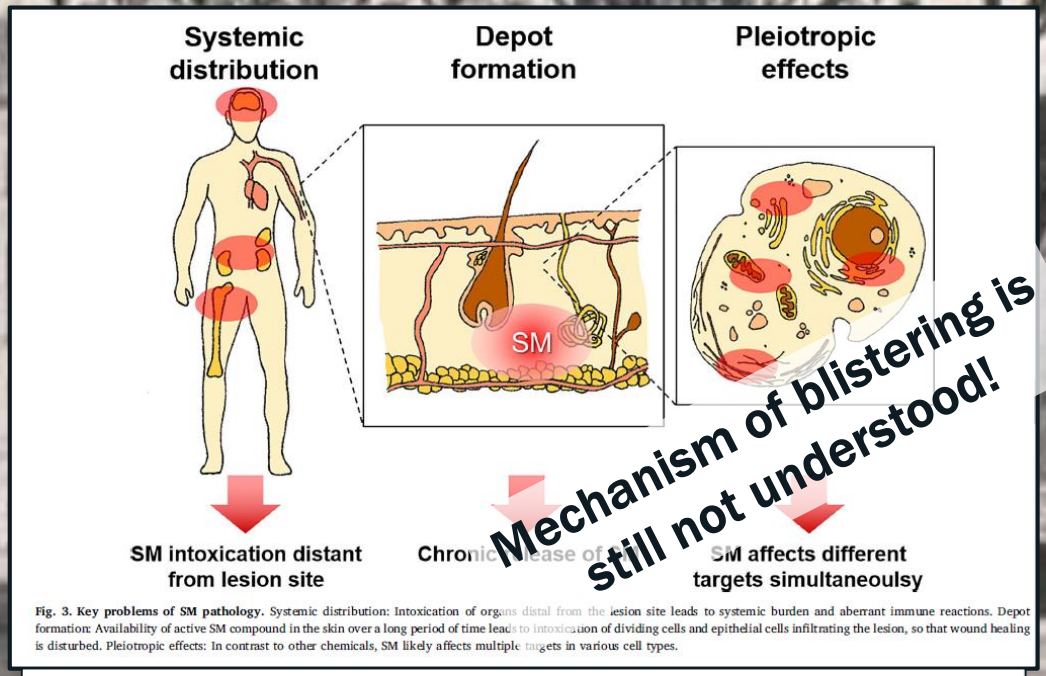


Fig. 3. **Key problems of SM pathology.** Systemic distribution: Intoxication of organs distal from the lesion site leads to systemic burden and aberrant immune reactions. Depot formation: Availability of active SM compound in the skin over a long period of time leads to intoxication of dividing cells and epithelial cells infiltrating the lesion, so that wound healing is disturbed. Pleiotropic effects: In contrast to other chemicals, SM likely affects multiple targets in various cell types.

Sulfur mustard skin lesions: A systematic review on pathomechanisms, treatment options and future research directions

Dorothee Rose[a], Annette Schmidt[b,*], Matthias Brandenburger[a], Tabea Sturmheit[a], Marietta Zille[a,c,1], Johannes Boltze[a,1]

[a] *Department of Translational Medicine and Cell Technology, Fraunhofer Research Institution for Marine Biotechnology and Cell Technology, Mönkhofer Weg 239a, 23562, Lübeck, Germany; Institute of Medical and Marine Biotechnology, University of Lübeck, Ratzeburger Allee 160, 23652, Lübeck, Germany*
[b] *Bundeswehr Institute of Pharmacology and Toxicology, Neuherbergstraße 11, 80937, Munich, Germany; Universität der Bundeswehr, Fakultät für Humanwissenschaften, Department für Sportwissenschaft, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany*
[c] *Institute for Experimental and Clinical Pharmacology and Toxicology, University of Lübeck, Ratzeburger Allee 160, 23562, Lübeck, Germany*

ARTICLE INFO

Keywords:
Mustard gas
CEES
Warfare toxicant
Vesicant
Oxidative stress
Cell death

ABSTRACT

Sulfur mustard (SM) is a chemical warfare, which has been used for one hundred years. However, its exact pathomechanisms are still incompletely understood and there is no specific therapy available so far. In this systematic review, studies published between January 2000 and July 2017 involving pathomechanisms and experimental treatments of SM-induced skin lesions were analyzed to summarize current knowledge on SM pathology, to provide an overview on novel treatment options, and to identify promising targets for future research to more effectively counter SM effects. We suggest that future studies should focus on (I) systemic effects of SM intoxication due to its distribution throughout the body, (II) removal of SM depots that continuously release active compound contributing to chronic skin damage, and (III) therapeutic options that counteract the pleiotropic effects of SM.

D. Rose, Toxicology Letters, 2017
DOI: 10.1016/j.toxlet.2017.11.039

266 *Guthrie, über einige Derivate*

an diesem Tage 9,4 CC. = 0,1 Grm. Eisen war. Diese 13,3 CC. geben aber 0,1425 Grm. Fe,
statt 0,1428 „ „ „ welche das Salz enthält.

Die Gründe zur Auswahl unter den drei vorgeschlagenen Methoden werden rein practische und öconomische sein, und werden sich bei häufiger Anwendung derselben Jedem nach seinen Bedürfnissen und Ansichten leicht ergeben.

Ueber einige Derivate der Kohlenwasserstoffe C_nH_{2n};

von *F. Guthrie.*

Erste Abhandlung*).

Die aus gleichviel Aequivalenten Wasserstoff und Kohlenstoff (H = 1, C =

geschichtliches Pro
Zeit die Aufmerks
sich gezogen. W
hunderts wurde di
durch solche Subs
Wasser haben, vor
dafs dieser Kohlenw
Und diese Ansich
man, wie schon fr
Zweifel gesetzt w
Alkohol wieder du
Die Isolirung
verbindungen der

*) Chem. Soc. Qu

288 *Niemann, über die Einwirkung*

dafs mir kein Zweifel über die Bildung des Productes $C_4H_8S_2Cl$ bleibt. Dann kann auch kein Zweifel darüber sein, dafs dieser Körper eine Reihe von Substanzen entstehen läfst, welche den oben beschriebenen, aus der entsprechenden Amylenverbindung entstehenden analog sind.

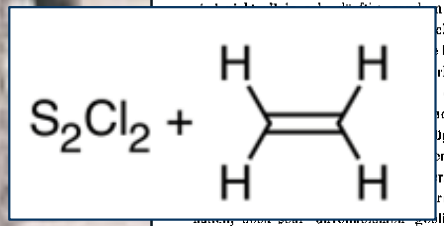
Ueber die Einwirkung des braunen Chlorschwefels auf Elaylgas;

von *A. Niemann.*

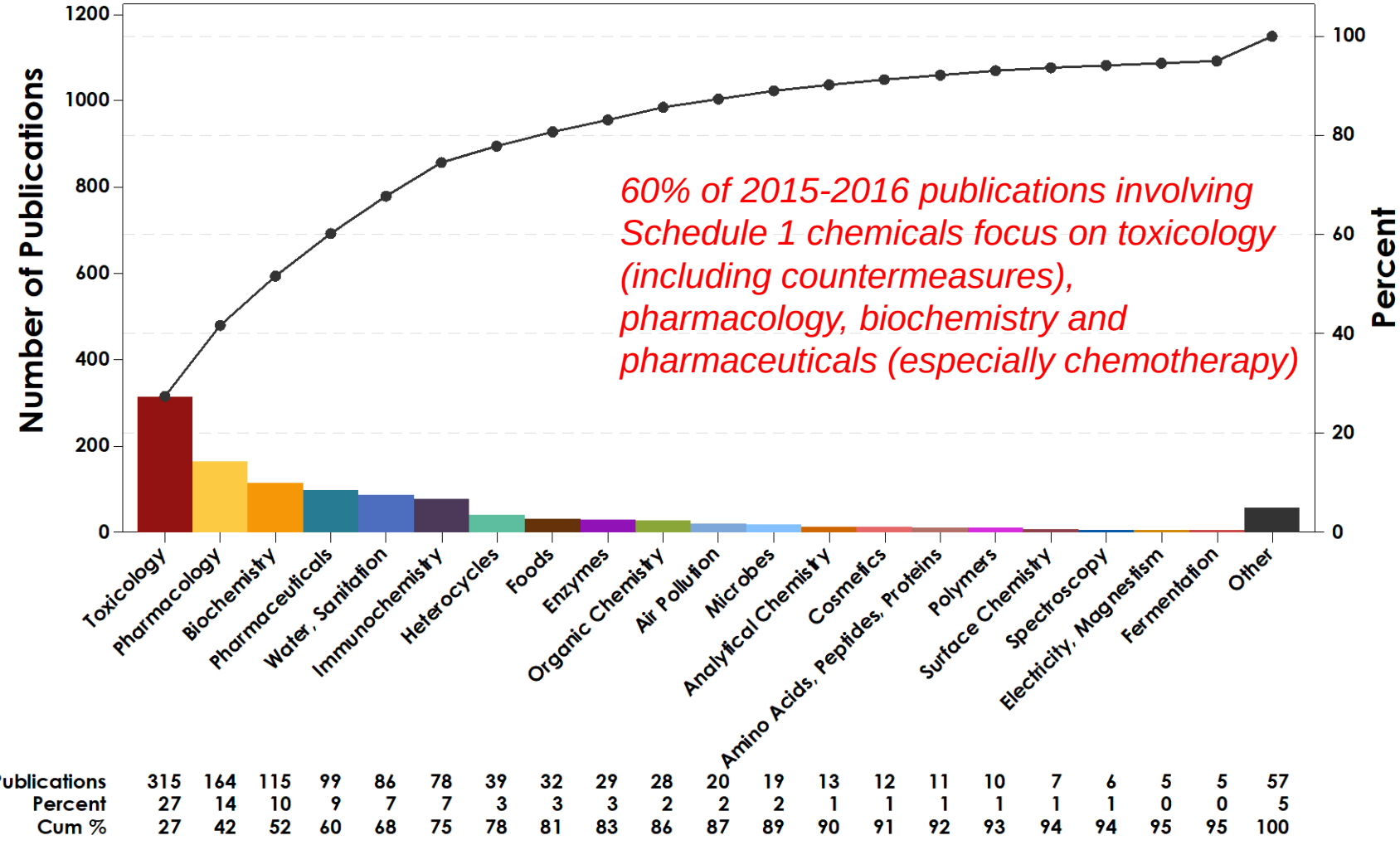
Die Angaben, welche man in den Lehrbüchern der Chemie über das Verhalten des Elaylgases zum Chlorschwefel findet, [illegible] auch widersprechend.
[illegible]chwefel verwandele sich
[illegible] Flüssigkeit, die weniger
[illegible]rbrennbar sei, während
[illegible] der Halbchlorschwefel
[illegible]e Veränderung erleidet.
[illegible]gliche Versuche ange-
[illegible]n kurz mittheile, obwohl
[illegible]rigkeit, gröfsere Mengen
[illegible]rdigen Productes zu er-
[illegible] geblieben sind. Ich hoffe indefs bald Zeit zu finden, diesen Gegenstand wieder aufnehmen und zum Abschlufs bringen zu können.

Der zu diesen Versuchen benutzte braune Chlorschwefel war das direct erhaltene Product der Einwirkung des Chlors

*) Ann. chim. phys. XXI, 438.
**) Poggendorff's Annalen XIII, 298.



Systemic distribution | Depot formation | Pleiotropic effects

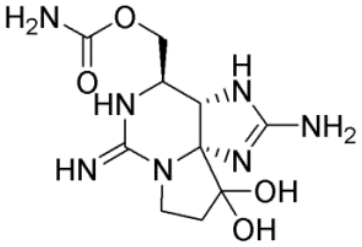


Number of Publications	315	164	115	99	86	78	39	32	29	28	20	19	13	12	11	10	7	6	5	5	57
Percent	27	14	10	9	7	7	3	3	3	2	2	2	1	1	1	1	1	1	0	0	5
Cum %	27	42	52	60	68	75	78	81	83	86	87	89	90	91	92	93	94	94	95	95	100

*) Ann. chim. phys. XXI, 433.
**) Poggendorff's Annalen XIII, 233.

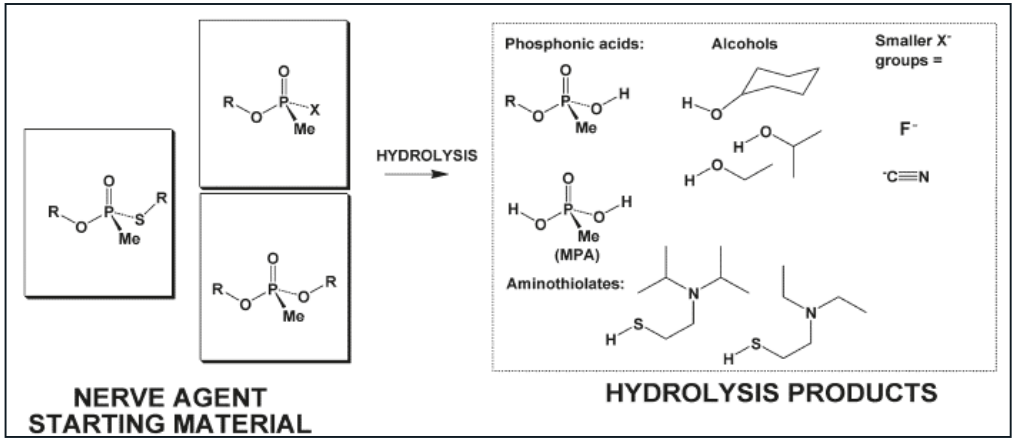
D. Rose, Toxicology Letters, 2017
DOI: 10.1016/j.toxlet.2017.11.039

Implementation Requires Science and Technology!



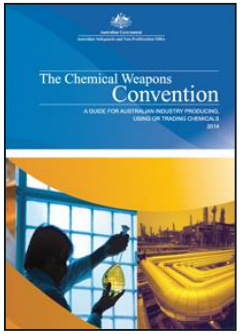
Article II

Article III



Articles IV and V

Article VI



Article VII

Article VIII

Articles IX and X

Article XI

Science and Convention Quiz

Rules:

Open Note

Talking allowed

Passing notes allowed

Smart phones allowed

How Many Chemicals Do You Know About?

Schedule 1

Guidelines for Schedule 1

The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article II;

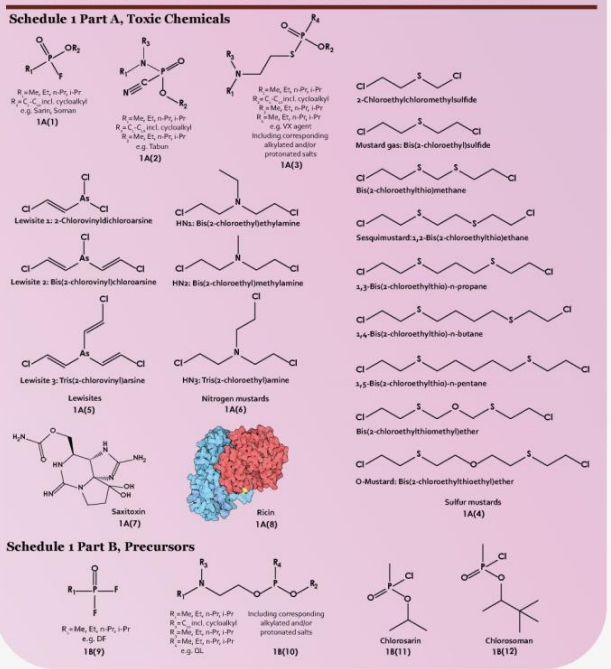
(b) It poses otherwise a high risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention because one or more of the following conditions are met:

(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparableproperties;

(ii) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;

(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;

(c) It has little or no use for purposes not prohibited under this Convention.



Schedule 2

Guidelines for Schedule 2

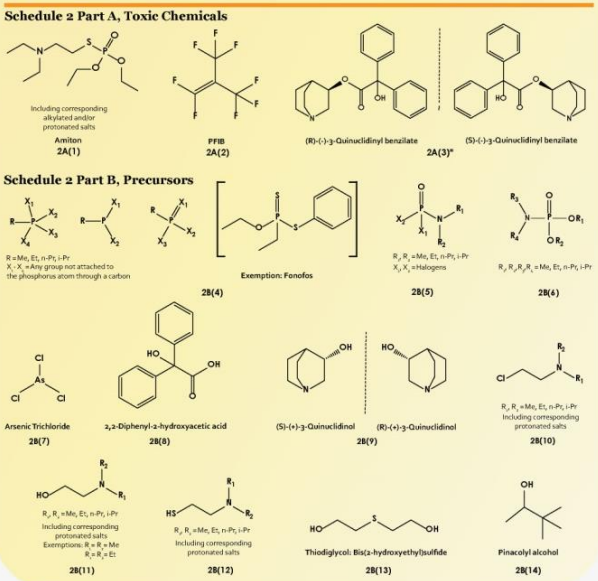
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:

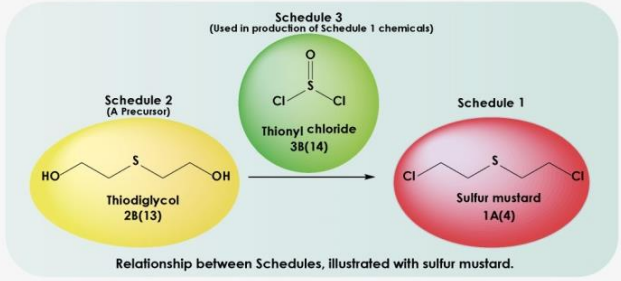
(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;

(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2, part A;

(d) It is not produced in large commercial quantities for purposes not prohibited under this Convention.





Relationship between Schedules, illustrated with sulfur mustard.

Schedule 3

Guidelines for Schedule 3

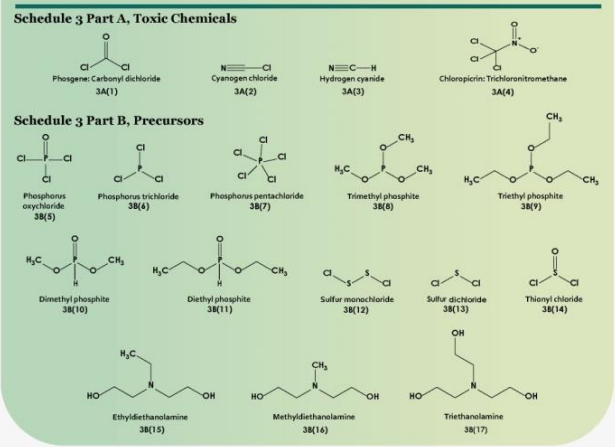
The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

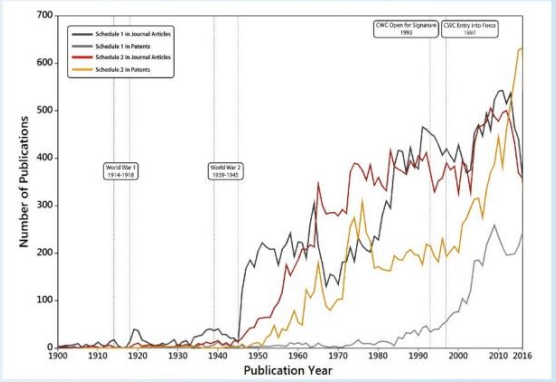
(a) It has been produced, stockpiled or used as a chemical weapon;

(b) It poses otherwise a risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that might enable it to be used as a chemical weapon;

(c) It poses a risk to the object and purpose of this Convention by virtue of its importance in the production of one or more chemicals listed in Schedule 1 or Schedule 2, part B;

(d) It may be produced in large commercial quantities for purposes not prohibited under this Convention.





Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

@opcw @opcw_st /opcwonline /opcwonline /company/opcw /opcw

How Many Chemicals Do You Know About? (response from audience)

Schedule 1 | Schedule 2 | Schedule 3

30

Sarin

82

Chlorine

VX

9

2000000

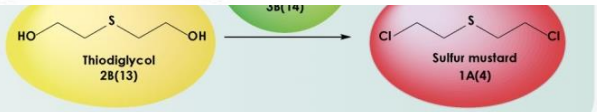
Show image

5

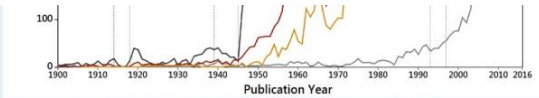
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

@opcw @opcw_st /opcwonline /opcwonline /company/opcw /opcw



Relationship between Schedules, illustrated with sulfur mustard.



Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.

How Many Chemicals Do You Know About?

More possible chemicals with drug like properties than atoms in the universe! (and don't look for them on the Schedules)

Schedule 1

Guidelines for Schedule 1

The following criteria chemical or precursor

(a) It has been dev defined in Artic

(b) It poses otherw virtue of its Convention be

(i) It posse

(ii) posse

(iii)

Schedule 1 Part A, Toxic

Lewisite 1: 2-Chlorovinyldichloroarsine

Lewisite 2: Bis(2-chlorovinyl)chloroarsine

Lewisite 3: Tris(2-chlorovinyl)arsine

Lewisites 1A(5)

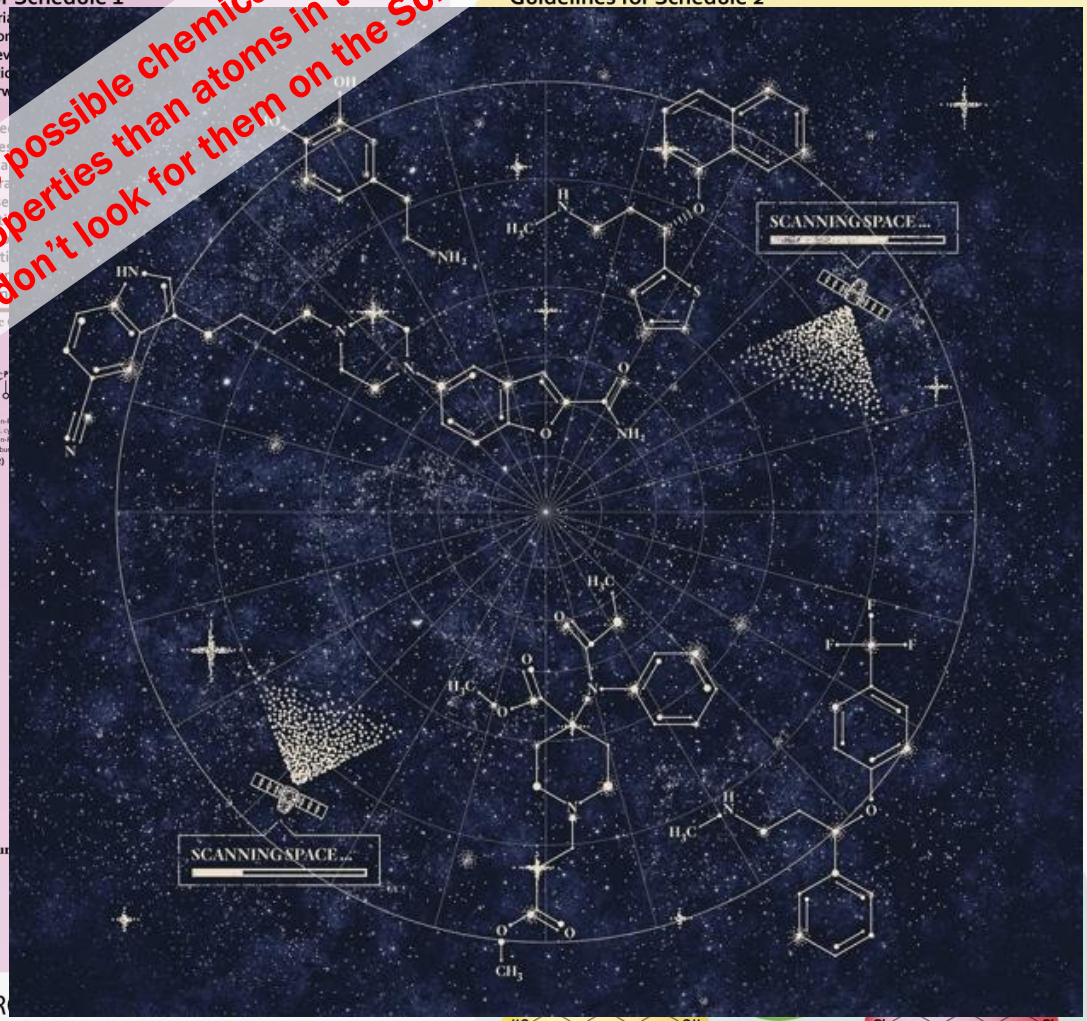
Saxitoxin 1A(7)

Schedule 1 Part B, Precur

1B(9)

Schedule 2

Guidelines for Schedule 2



Thiodiglycol 2B(13)

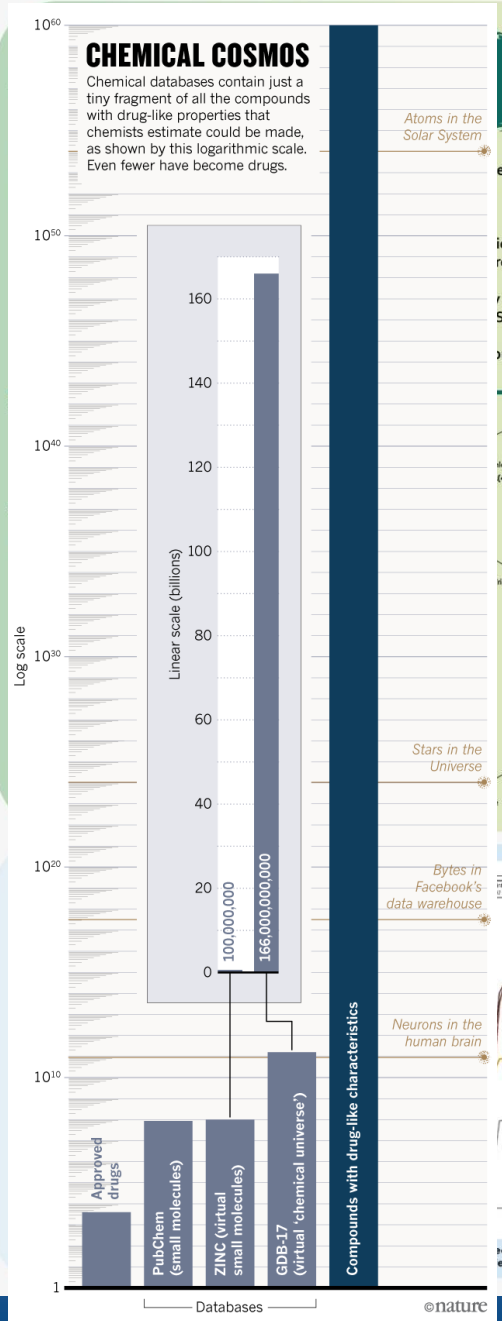
Sulfur mustard 1A(4)

Relationship between Schedules, illustrated with sulfur mustard.

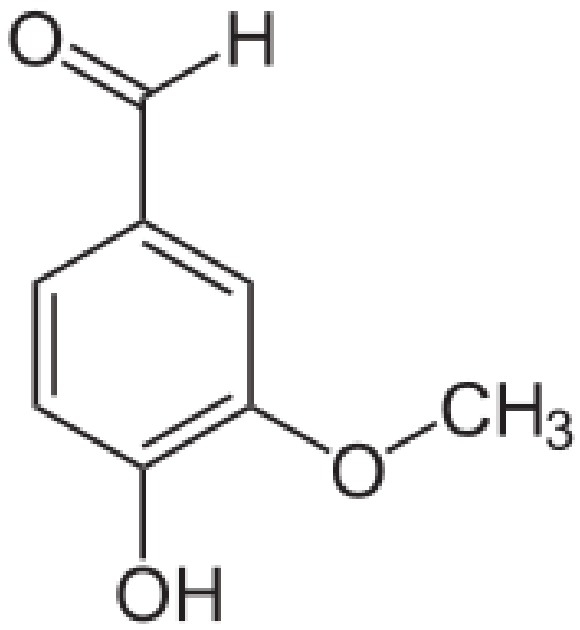
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

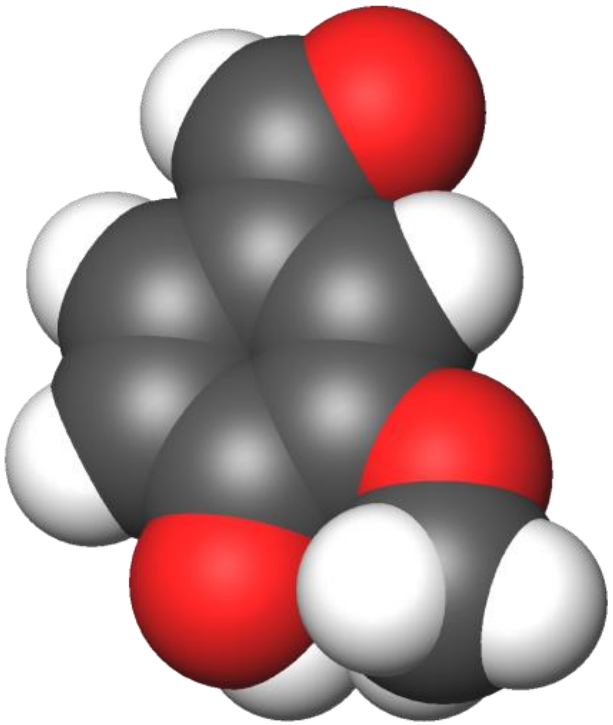
Working Together for a World Free of Chemical Weapons

@opcw @opcw_st /opcwonline /opcwonline /company/opcw /opcw



“Good” Chemical or “Bad” Chemical?





“Good” Chemical or “Bad” Chemical? (response from audience)

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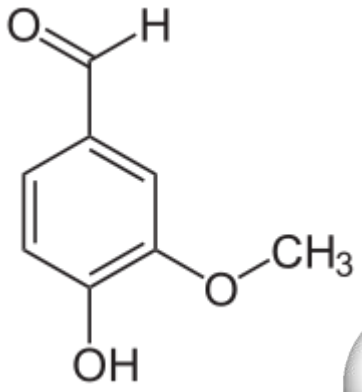
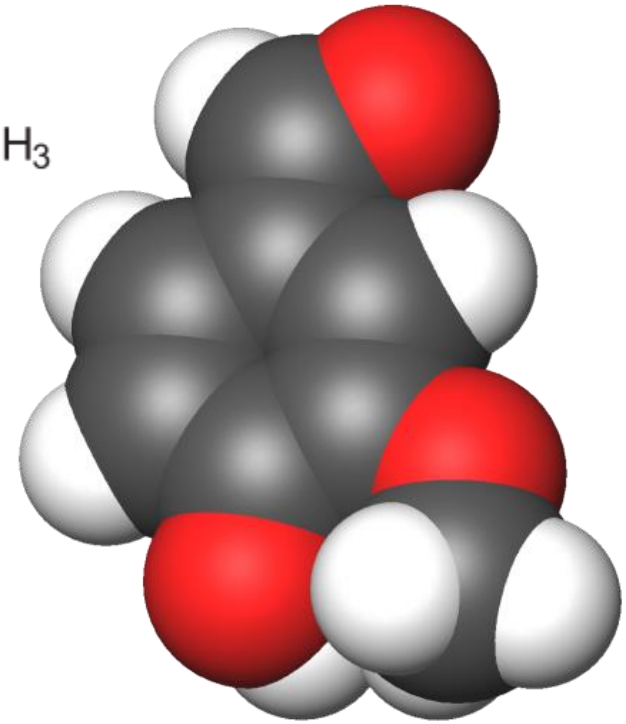
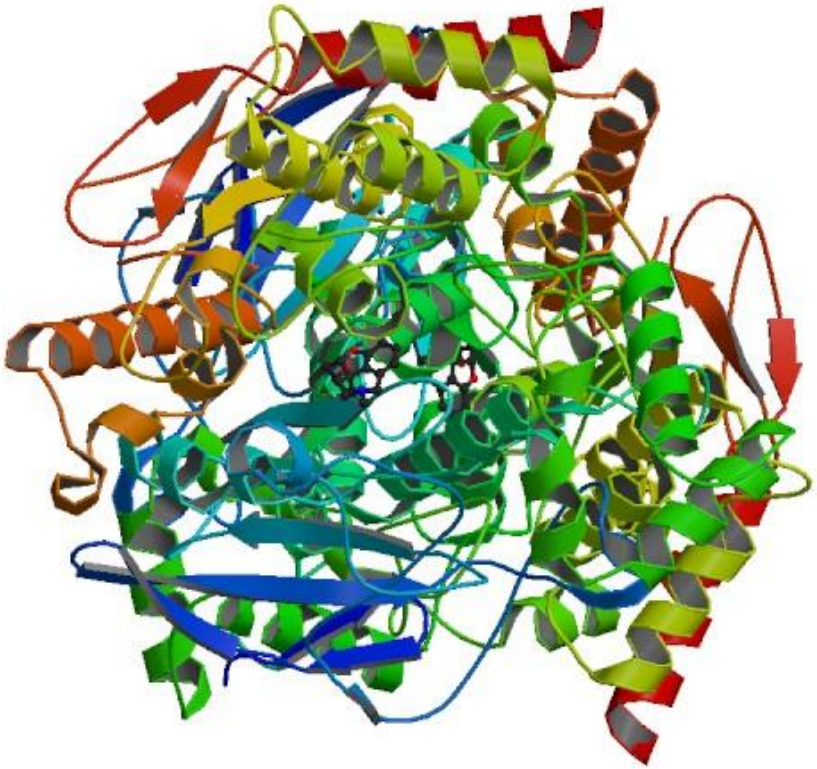




“Good” Biological or “Bad” Biological?



“Good” Biological or “Bad” Biological? (response from audience)

“Good” Biological or “Bad” Biological?

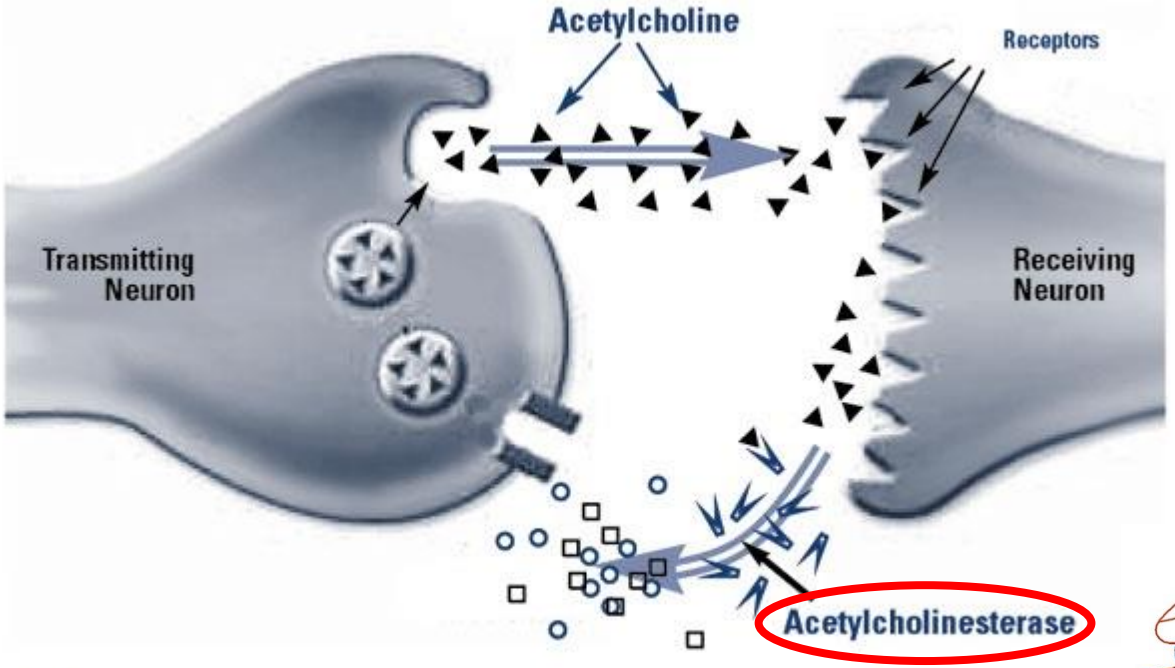
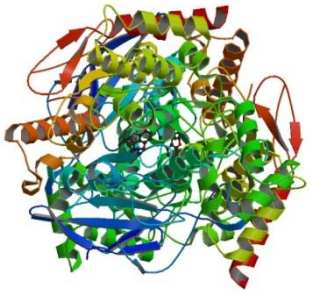
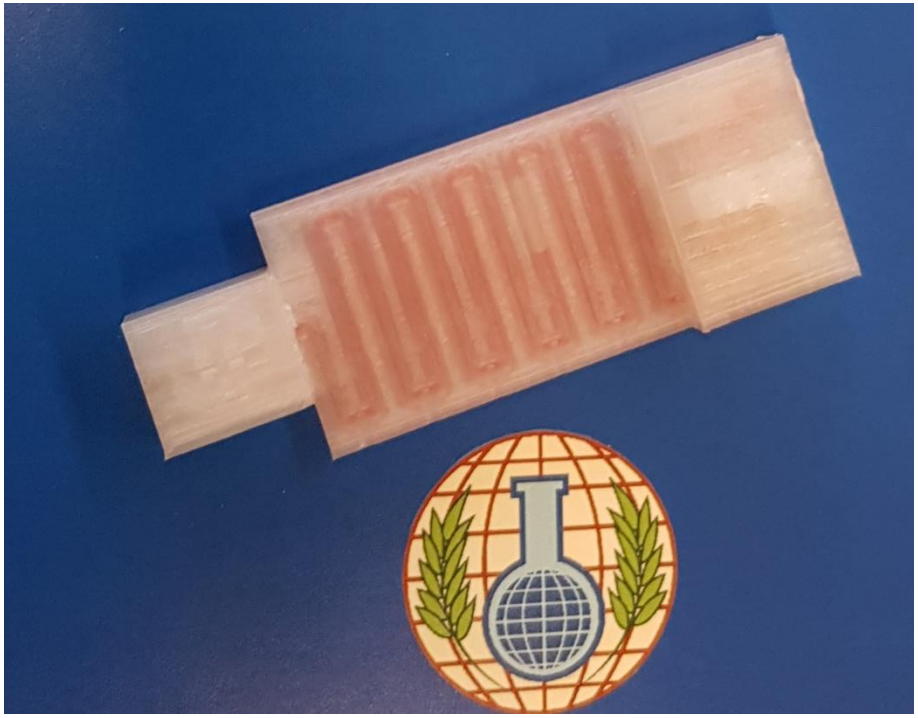


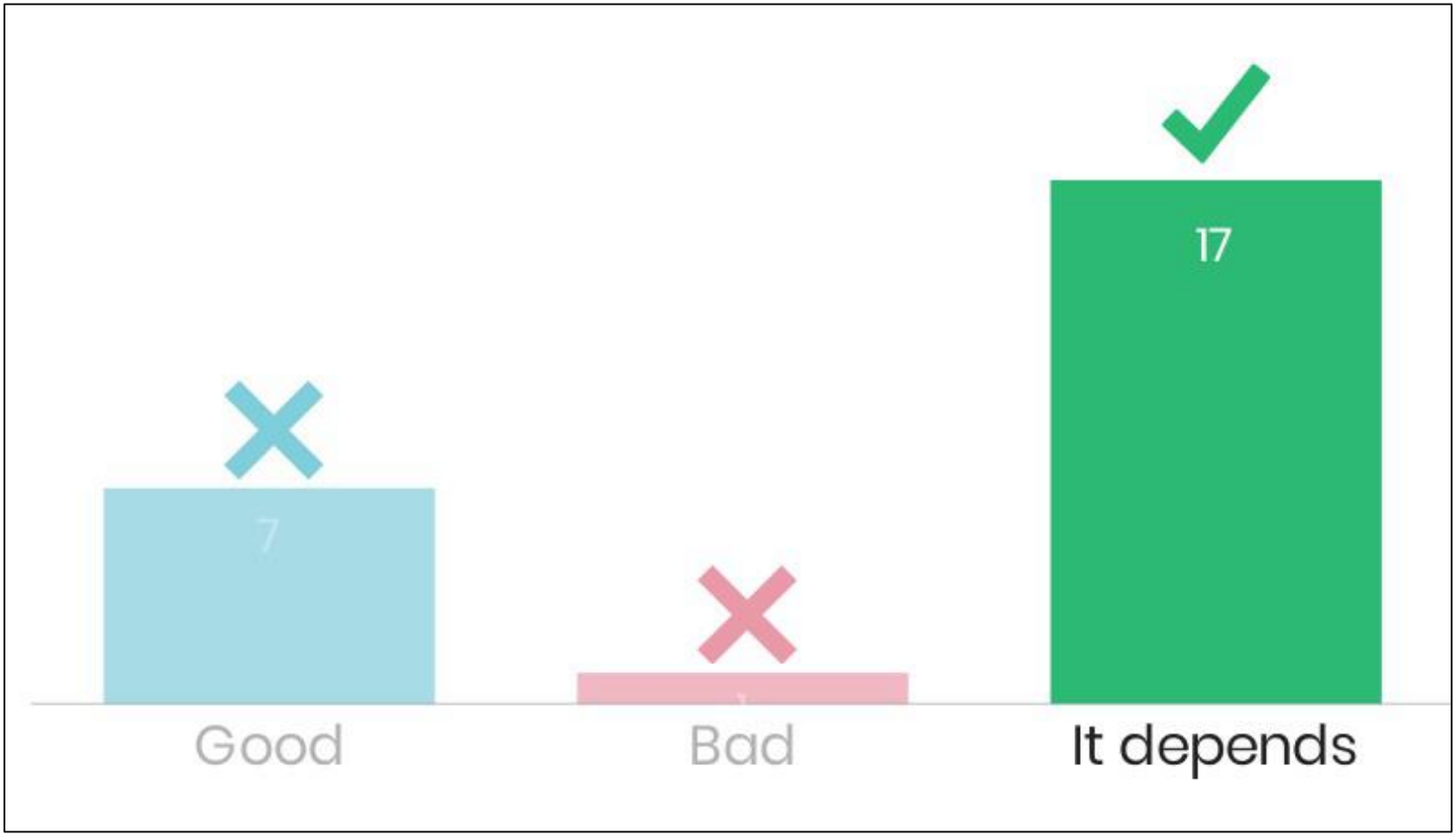
Fig. 1. After signalling, acetylcholine is released from receptors and broken down by acetylcholinesterase to be recycled in a continuous process.

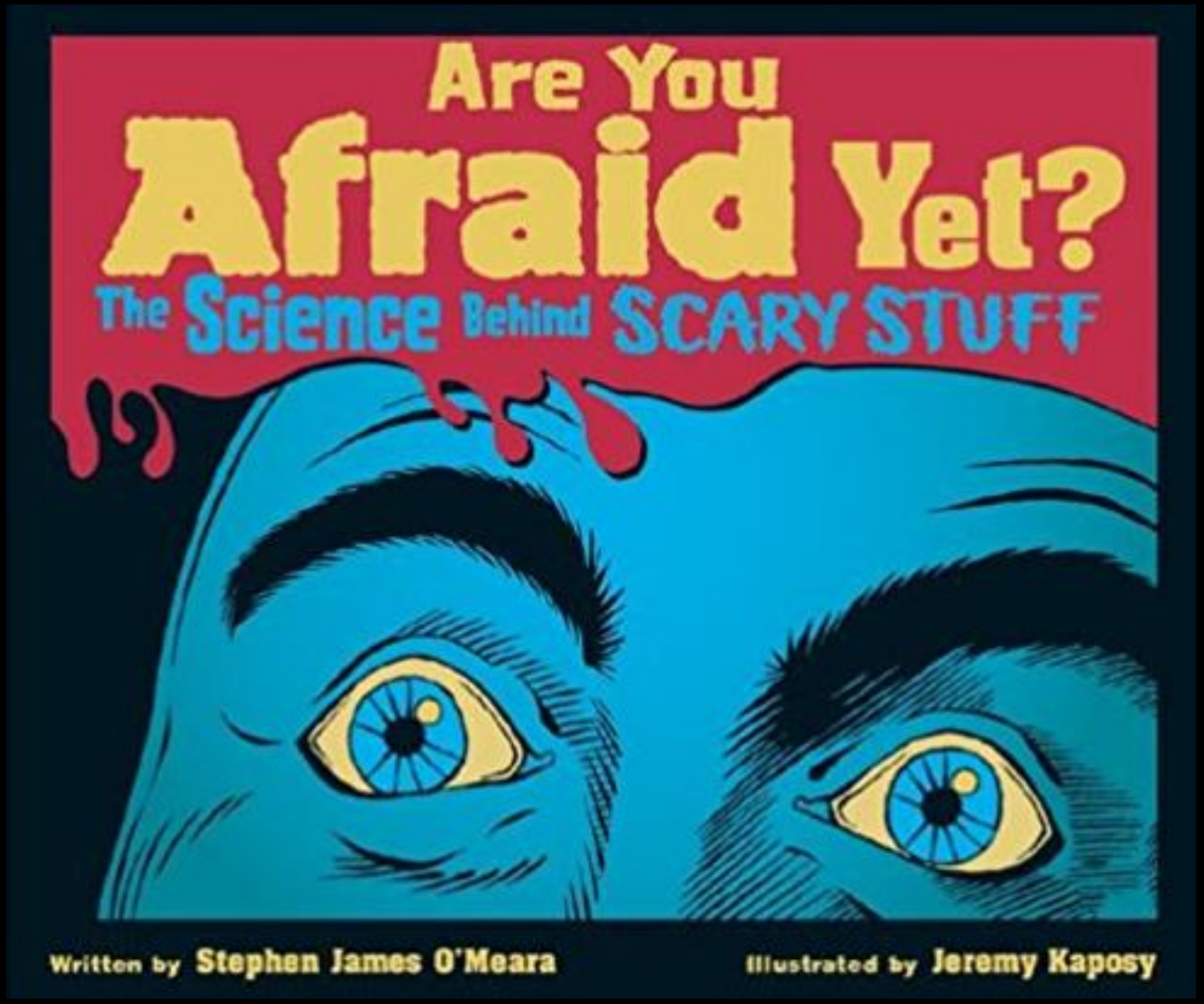


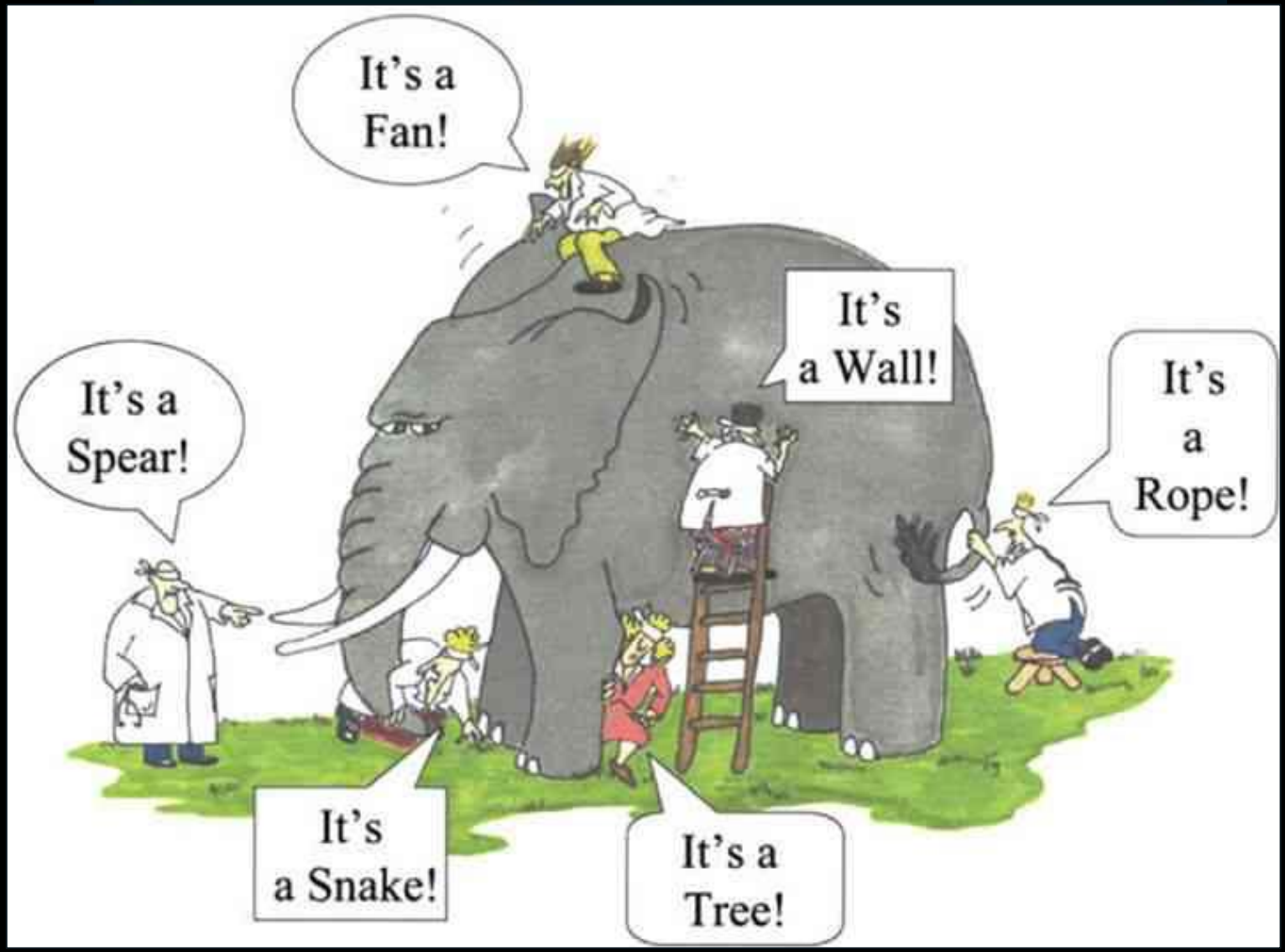
“Good” Device or “Bad” Device?



“Good” Device or “Bad” Device?
(response from audience)




Are You
Afraid Yet?
The Science Behind SCARY STUFF
Written by Stephen James O'Meara
Illustrated by Jeremy Kaposy


It's a Fan!
It's a Wall!
It's a Spear!
It's a Rope!
It's a Snake!
It's a Tree!

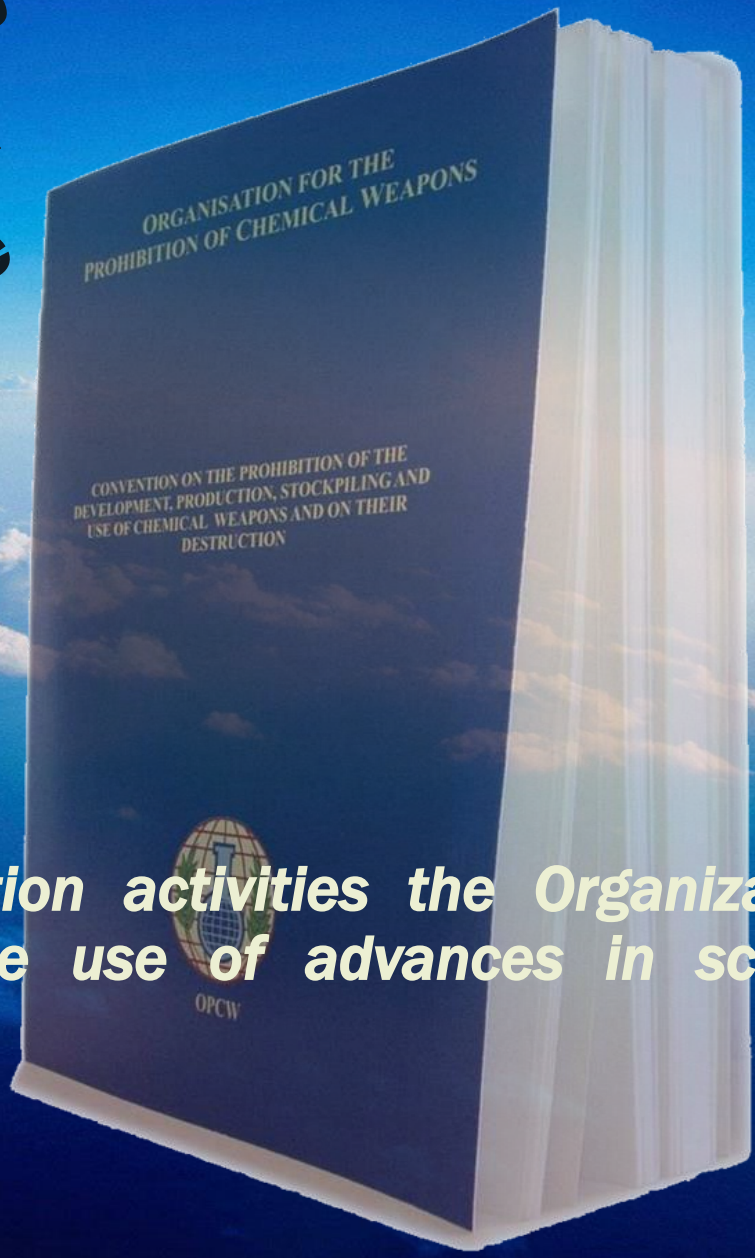
Innovation

and

the Chemical Weapons Convention

Scientific Review for an International Disarmament Treaty

Too much science!
Need science that can help recognize unusual and unexpected change



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

- *CWC Article VIII, paragraph 6*

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"In undertal *nization shall consider m* *science and technology"*

- *CWC Article VIII, paragraph 3*

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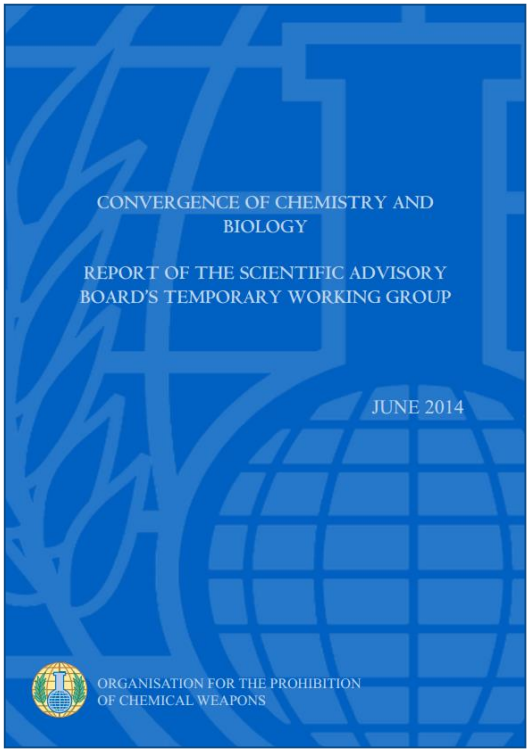
- CWC Ar

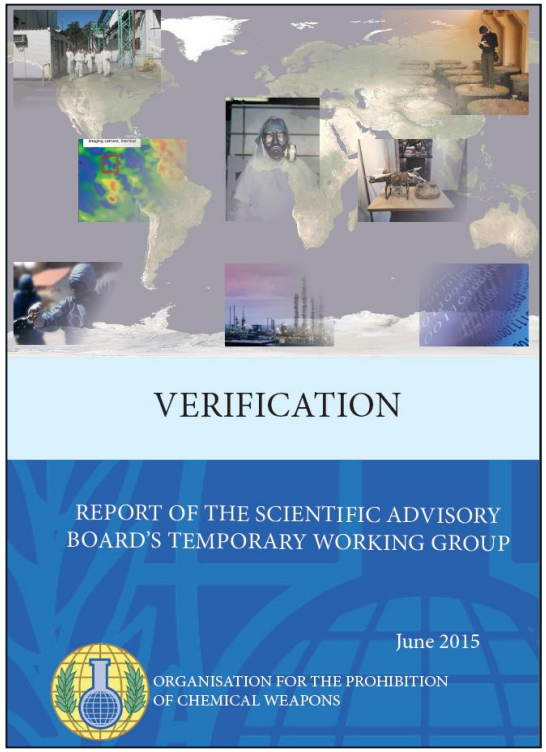
In the Lead Up To Previous Review Conferences

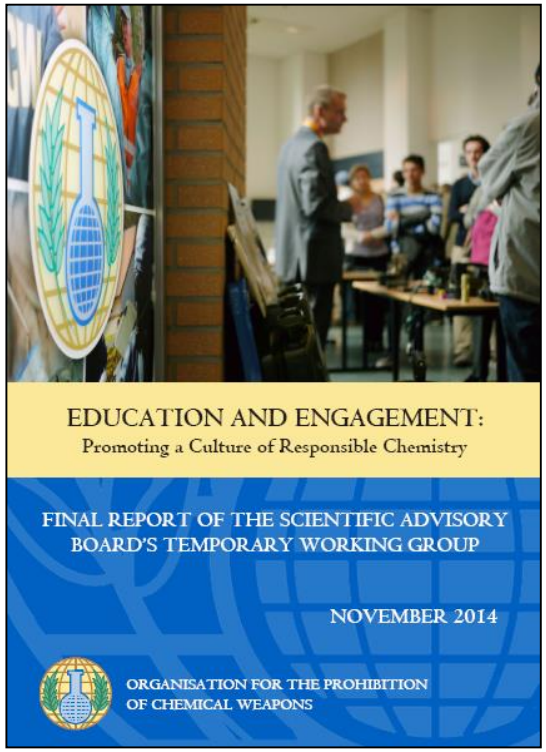
INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

OPCW

Toward The Fourth Review Conference: Find a Tricorder!







Toward The Fourth Review Conference: Find a Tricorder!

Toward The Fourth Review Conference: Find a Tricorder!

OPCW

Toward The Fourth Review Conference: Find a Tricorder!

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/bap1gy

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:

SGDSN

Innovative Technologies for Chemical Security

Rio de Janeiro, Brazil. 3 to 5 July 2017

SAB-26/WP.1, dated 21 July 2017, URL: http://q-r.to/bap1hC

Coorganizers:

IUPAC

The National Academies 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

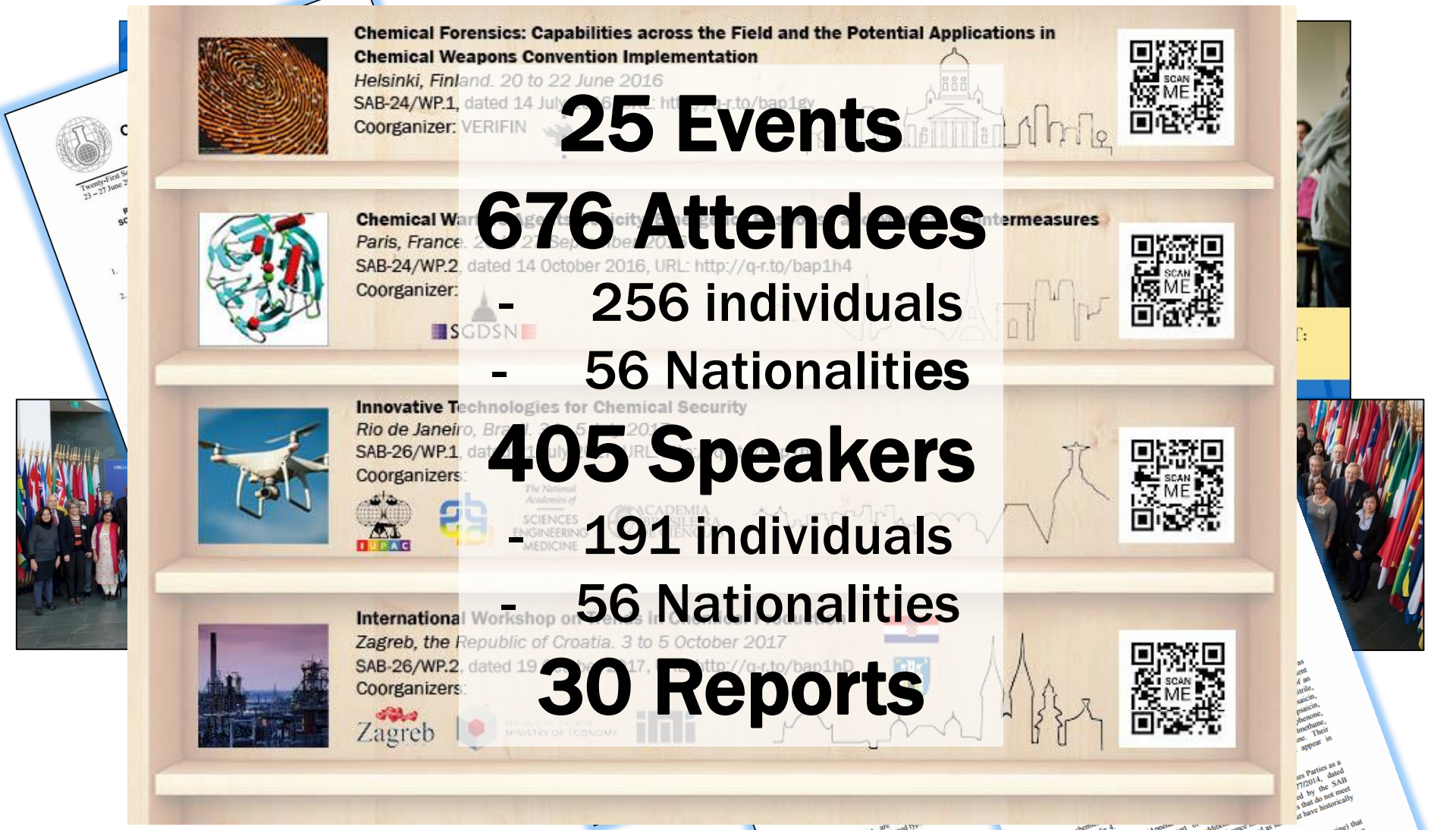
Coorganizers:

Zagreb

MINISTRY OF ECONOMY

OPCW

Toward The Fourth Review Conference: Find a Tricorder!



25 Events

676 Attendees

- 256 individuals
- 56 Nationalities

405 Speakers

- 191 individuals
- 56 Nationalities

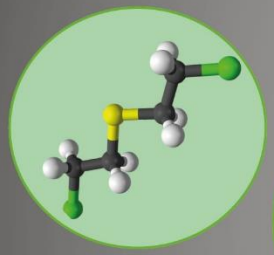
30 Reports

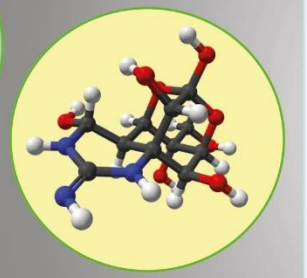
OPCW

Presentation by Dr Christopher Timperley

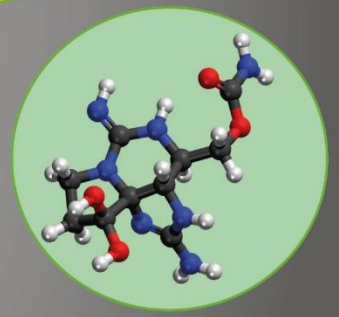
Science for Diplomats at EC-87

Science, Technology and the Chemical Weapons Convention: A Preview of the Scientific Advisory Board's Report to the Fourth Review Conference





And Don't Forget Your Smart phone!



Tuesday 13 March 2018
Ooms Room
13:30-14:45
Light lunch served at 13:00

Dr Christopher M. Timperley (SAB Chairperson)

Successes of the Chemical Weapon Convention

192

NATIONS COMMITTED TO THE CHEMICAL WEAPONS CONVENTION

98

PERCENT OF WORLD POPULATION LIVING UNDER THE PROTECTION OF THE CHEMICAL WEAPONS CONVENTION

95

PERCENT OF WORLD'S DECLARED CHEMICAL WEAPON STOCKPILES VERIFIABLY DESTROYED

(APPROXIMATE)

Challenges

Starting with the 2013 UN-led mission to the Syrian Arab Republic, the TS has undertaken non-routine inspection, verification and technical assistance activities in Syria, Libya and Iraq

Contingency operations have required:

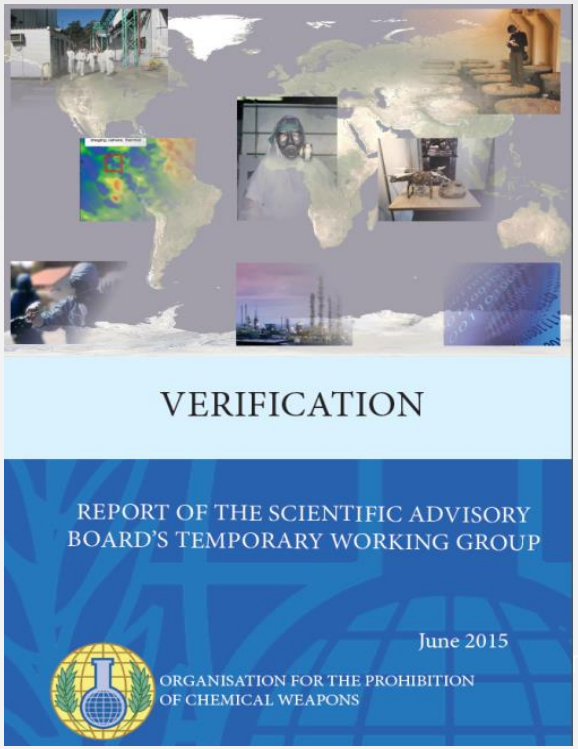
- Investigations
- Analysis, and fact-finding
- Evaluation of oral, material, and digital evidence

Contingency operations

Non-routine situations have been insightful for considering new technologies with potential to enhance capabilities available to inspectors

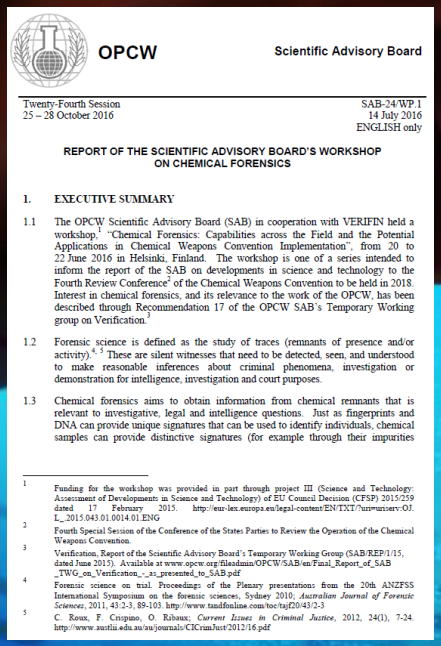
Operational challenges:

- Access to sites is time-limited
- Harsh environmental conditions
- Chain-of-custody (taking & shipping samples)
- Evidence needs to be authenticated
- Required expertise beyond chemical analysis



OPCW Scientific Advisory Board

Chemical forensics



OPCW — **Scientific Advisory Board**

Twenty-Fourth Session
25 – 28 October 2016

SAB-24/WP.1
14 July 2016
ENGLISH only

REPORT OF THE SCIENTIFIC ADVISORY BOARD'S WORKSHOP ON CHEMICAL FORENSICS

1. EXECUTIVE SUMMARY

1.1 The OPCW Scientific Advisory Board (SAB) in cooperation with VERIFIN held a workshop,[1] "Chemical Forensics: Capabilities across the Field and the Potential Applications in Chemical Weapons Convention Implementation", from 20 to 22 June 2016 in Helsinki, Finland. The workshop is one of a series intended to inform the report of the SAB on developments in science and technology to the Fourth Review Conference[2] of the Chemical Weapons Convention to be held in 2018. Interest in chemical forensics, and its relevance to the work of the OPCW, has been described through Recommendation 17 of the OPCW SAB's Temporary Working group on Verification.[3]

1.2 Forensic science is defined as the study of traces (remnants of presence and/or activity).[4, 5] These are silent witnesses that need to be detected, seen, and understood to make reasonable inferences about criminal phenomena, investigation or demonstration for intelligence, investigation and court purposes.

1.3 Chemical forensics aims to obtain information from chemical remnants that is relevant to investigative, legal and intelligence questions. Just as fingerprints and DNA can provide unique signatures that can be used to identify individuals, chemical samples can provide distinctive signatures (for example through their impurities

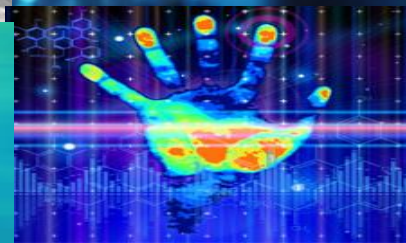
1 Funding for the workshop was provided in part through project III (Science and Technology: Assessment of Developments in Science and Technology) of EU Council Decision (CFSP) 2015/259 dated 17 February 2015. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2015.043.01.0014.01.ENG

2 Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention.

3 Verification, Report of the Scientific Advisory Board's Temporary Working Group (SAB/REP/1/15, dated June 2015). Available at www.opcw.org/fileadmin/OPCW/SAB/en/Final_Report_of_SAB_TWG_on_Verification_-_as_presented_to_SAB.pdf

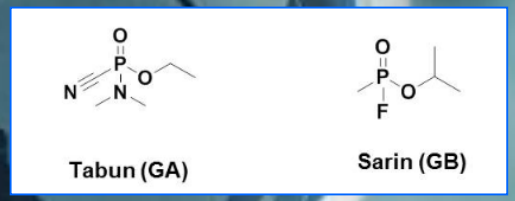
4 Forensic science on trial. Proceedings of the Plenary presentations from the 20th ANZFSS International Symposium on the forensic sciences, Sydney 2010; *Australian Journal of Forensic Sciences*, 2011, 43:2-3, 89-103. http://www.tandfonline.com/toc/tajf20/43/2-3

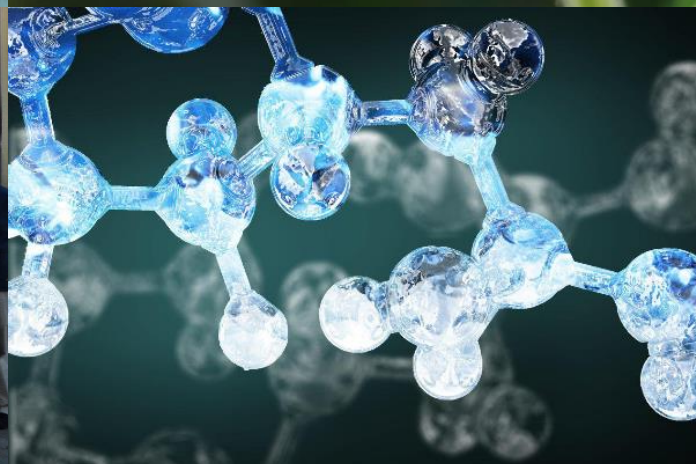
5 C. Roux, F. Crispino, O. Ribaux; *Current Issues in Criminal Justice*, 2012, 24(1), 7-24. http://www.austlii.edu.au/au/journals/CICrimJust/2012/16.pdf



Medical countermeasures and emergency response

SGDSN
SECRÉTARIAT GÉNÉRAL DE LA DÉFENSE ET DE LA SÉCURITÉ NATIONALE





Innovative technologies for chemical security

OPCW | 1997-2017

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The National Academies of SCIENCES ENGINEERING MEDICINE

ACADEMIA BRASILEIRA DE CIÊNCIAS

03-05 | **JULY - 2017**
RIO DE JANEIRO - BRAZIL

INTERNATIONAL WORKSHOP ON INNOVATIVE TECHNOLOGIES FOR CHEMICAL SECURITY

Science for Peace
#ScienceforPeace

OPCW | 1997-2017
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS
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abciencias
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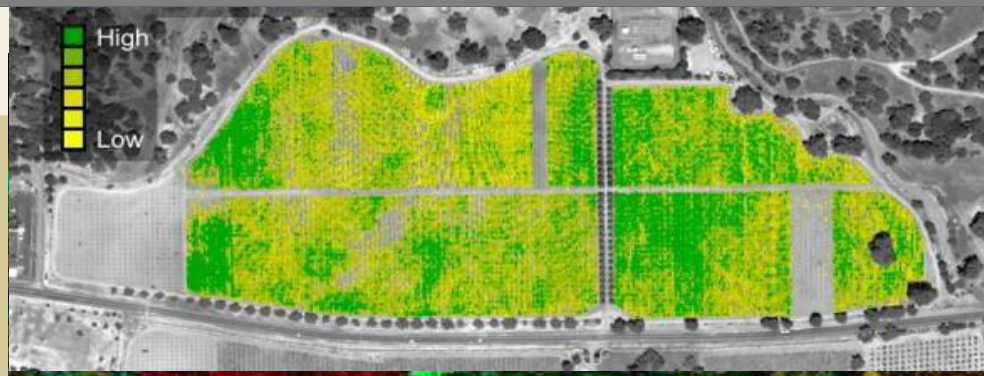
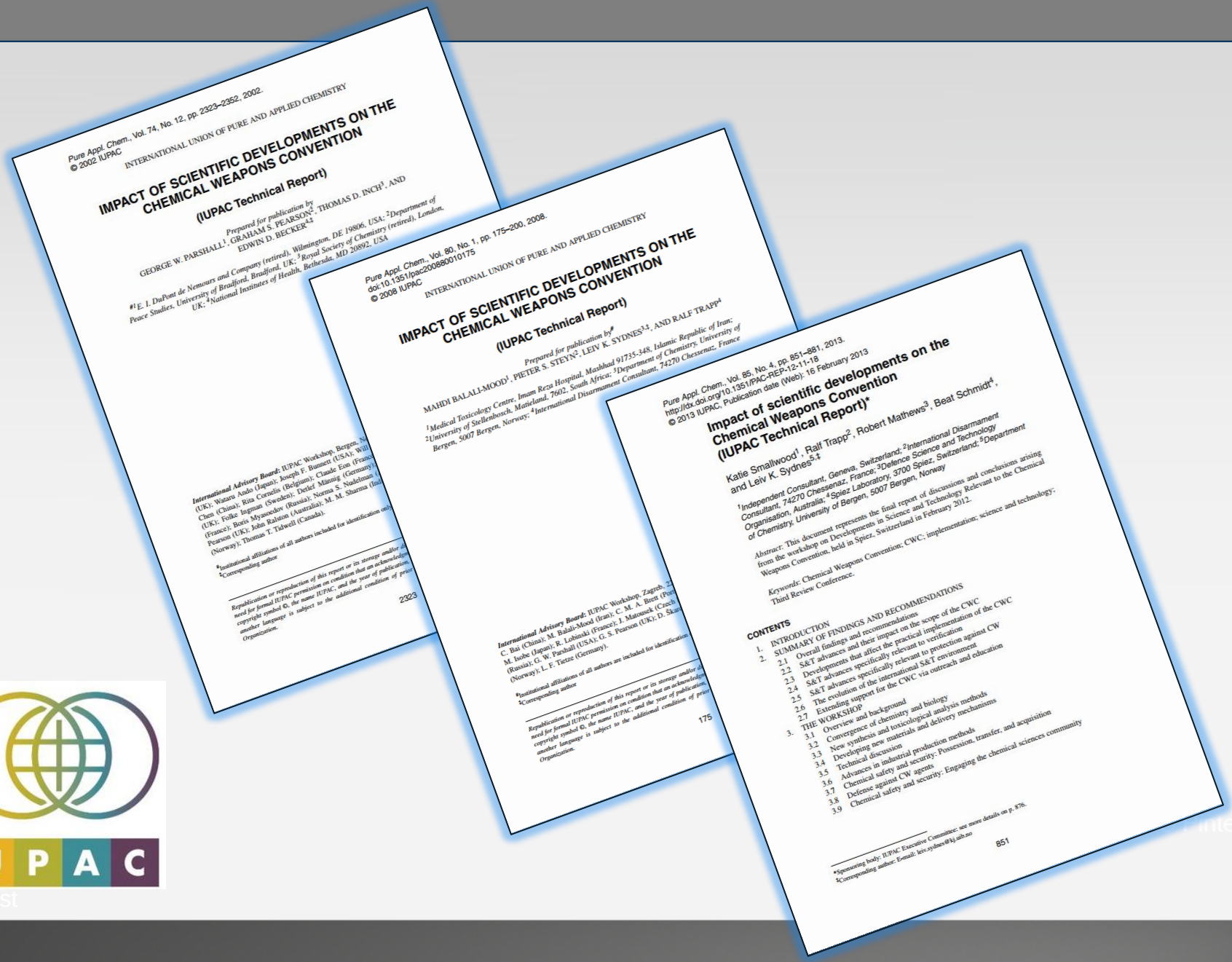


IUPAC and OPCW



Pure Appl. Chem., Vol. 74, No. 12, pp. 2323–2352, 2002.
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INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

IMPACT OF SCIENTIFIC DEVELOPMENTS ON THE CHEMICAL WEAPONS CONVENTION

(IUPAC Technical Report)

Prepared for publication by

GEORGE W. PARSHALL[1], GRAHAM S. PEARSON[2], THOMAS D. INCH[3], AND EDWIN D. BECKER[4,‡]

[1]E. I. DuPont de Nemours and Company (retired), Wilmington, DE 19806, USA; [2]Department of Peace Studies, University of Bradford, Bradford, UK; [3]Royal Society of Chemistry (retired), London, UK; [4]National Institutes of Health, Bethesda, MD 20892, USA

Pure Appl. Chem., Vol. 80, No. 1, pp. 175–200, 2008.
doi:10.1351/pac200880010175
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INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

IMPACT OF SCIENTIFIC DEVELOPMENTS ON THE CHEMICAL WEAPONS CONVENTION

(IUPAC Technical Report)

Prepared for publication by

MAHDI BALALI-MOOD[1], PIETER S. STEYN[2], LEIV K. SYDNES[3,‡], AND RALF TRAPP[4]

[1]Medical Toxicology Centre, Imam Reza Hospital, Mashhad 91735-348, Islamic Republic of Iran; [2]University of Stellenbosch, Matieland, 7602, South Africa; [3]Department of Chemistry, University of Bergen, 5007 Bergen, Norway; [4]International Disarmament Consultant, 74270 Chessenaz, France

Pure Appl. Chem., Vol. 85, No. 4, pp. 851–881, 2013.
http://dx.doi.org/10.1351/PAC-REP-12-11-18
© 2013 IUPAC; Publication date (Web): 16 February 2013

Impact of scientific developments on the Chemical Weapons Convention (IUPAC Technical Report)*

Katie Smallwood[1], Ralf Trapp[2], Robert Mathews[3], Beat Schmidt[4], and Leiv K. Sydnes[5,‡]

[1]Independent Consultant, Geneva, Switzerland; [2]International Disarmament Consultant, 74270 Chessenaz, France; [3]Defence Science and Technology Organisation, Australia; [4]Spiez Laboratory, 3700 Spiez, Switzerland; [5]Department of Chemistry, University of Bergen, 5007 Bergen, Norway

Abstract: This document represents the final report of discussions and conclusions arising from the workshop on Developments in Science and Technology Relevant to the Chemical Weapons Convention, held in Spiez, Switzerland in February 2012.

Keywords: Chemical Weapons Convention; CWC; implementation; science and technology; Third Review Conference.

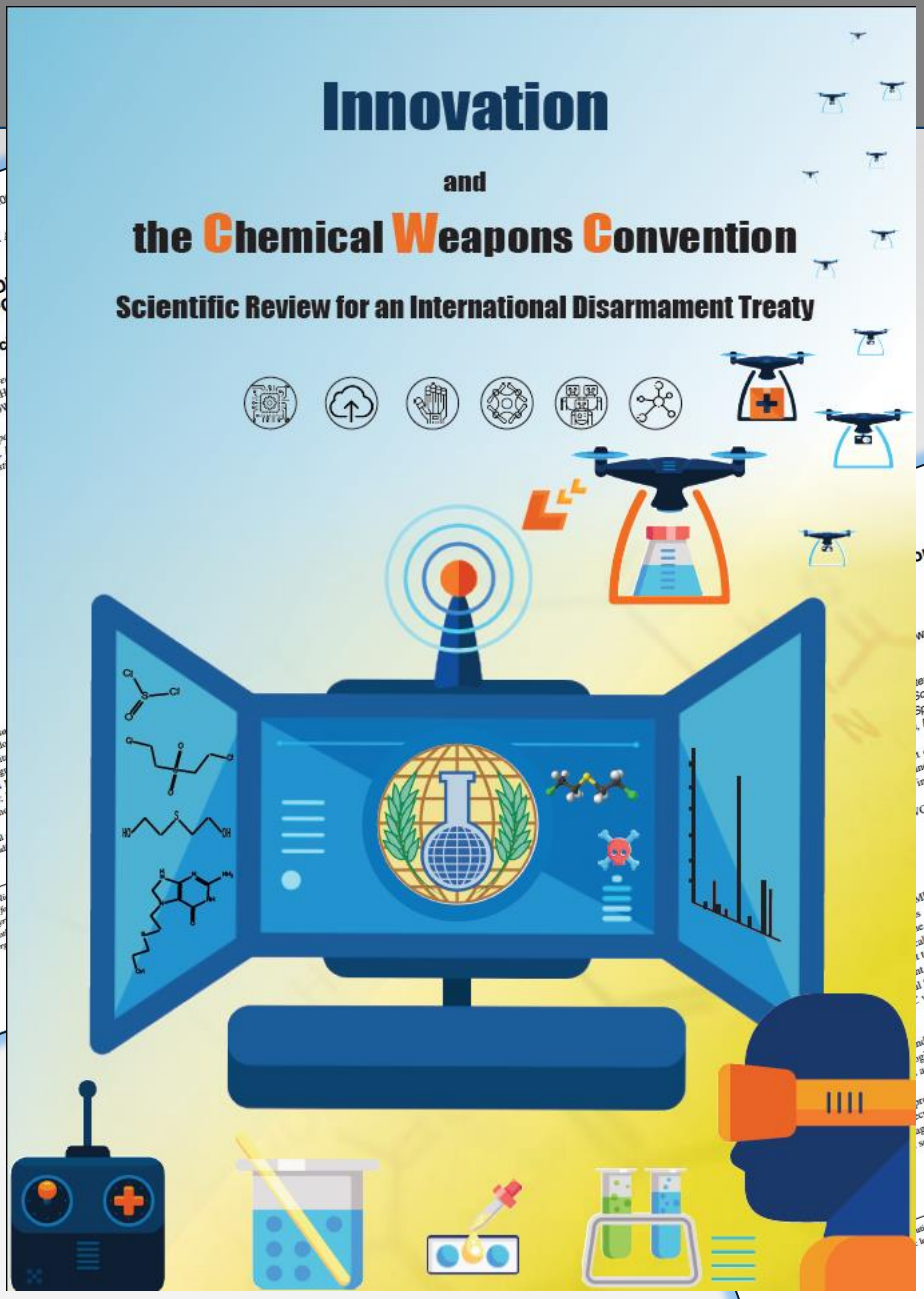
CONTENTS

Innovation

and

the Chemical Weapons Convention

Scientific Review for an International Disarmament Treaty



Trends in chemical production

Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1

The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article II;

(b) It poses otherwise a high risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention because one or more of the following conditions are met:

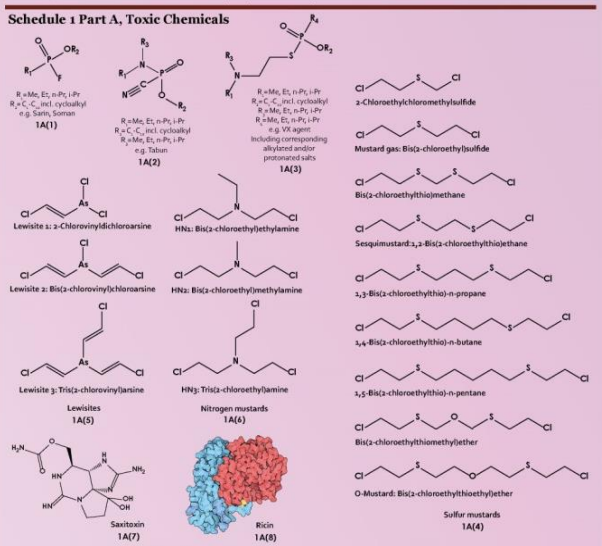
(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparableproperties;

(ii) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;

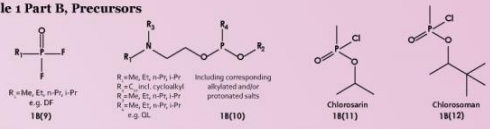
(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;

(c) It has little or no use for purposes not prohibited under this Convention.

Schedule 1 Part A, Toxic Chemicals



Schedule 1 Part B, Precursors



Schedule 2

Guidelines for Schedule 2

The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:

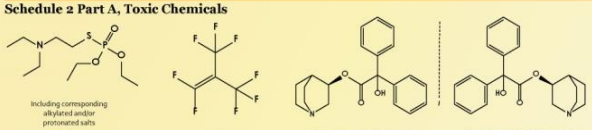
(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;

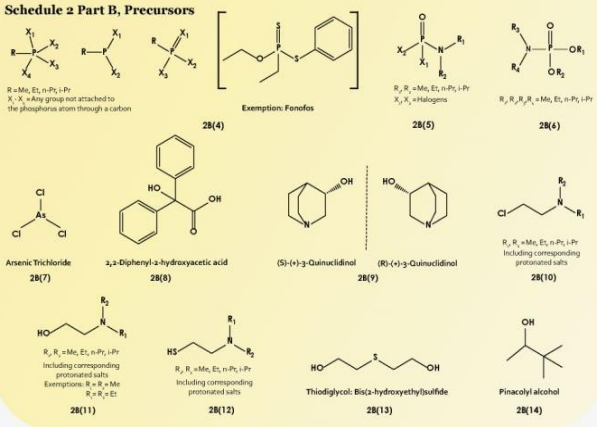
(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2, part A;

(d) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 2 Part A, Toxic Chemicals



Schedule 2 Part B, Precursors



Schedule 3

Guidelines for Schedule 3

The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

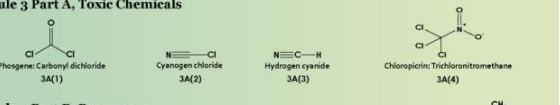
(a) It has been produced, stockpiled or used as a chemical weapon;

(b) It poses otherwise a risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that might enable it to be used as a chemical weapon;

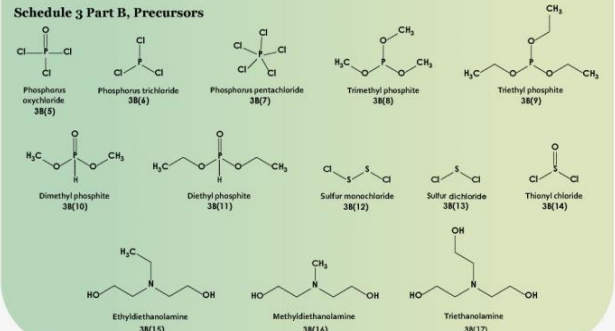
(c) It poses a risk to the object and purpose of this Convention by virtue of its importance in the production of one or more chemicals listed in Schedule 1 or Schedule 2, part B;

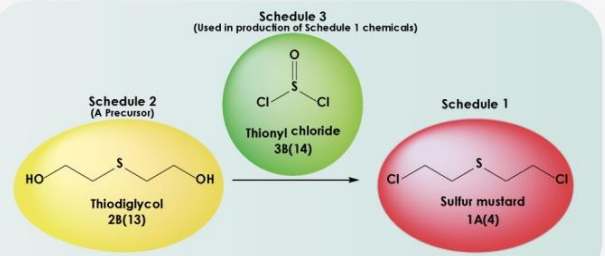
(d) It may be produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 3 Part A, Toxic Chemicals

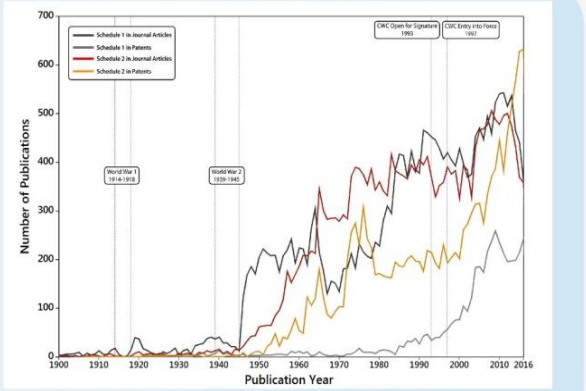


Schedule 3 Part B, Precursors





Relationship between Schedules, illustrated with sulfur mustard.



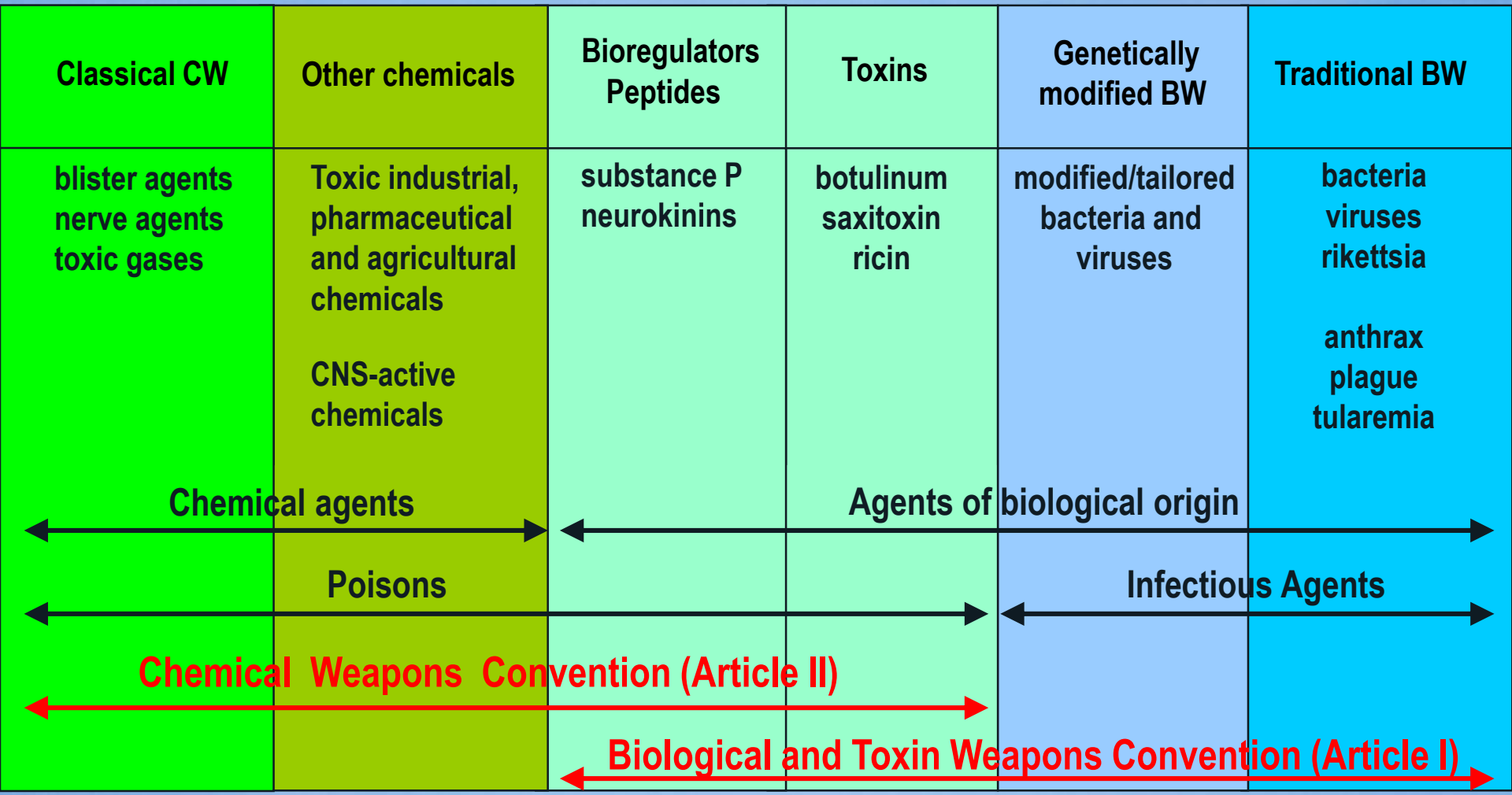
Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

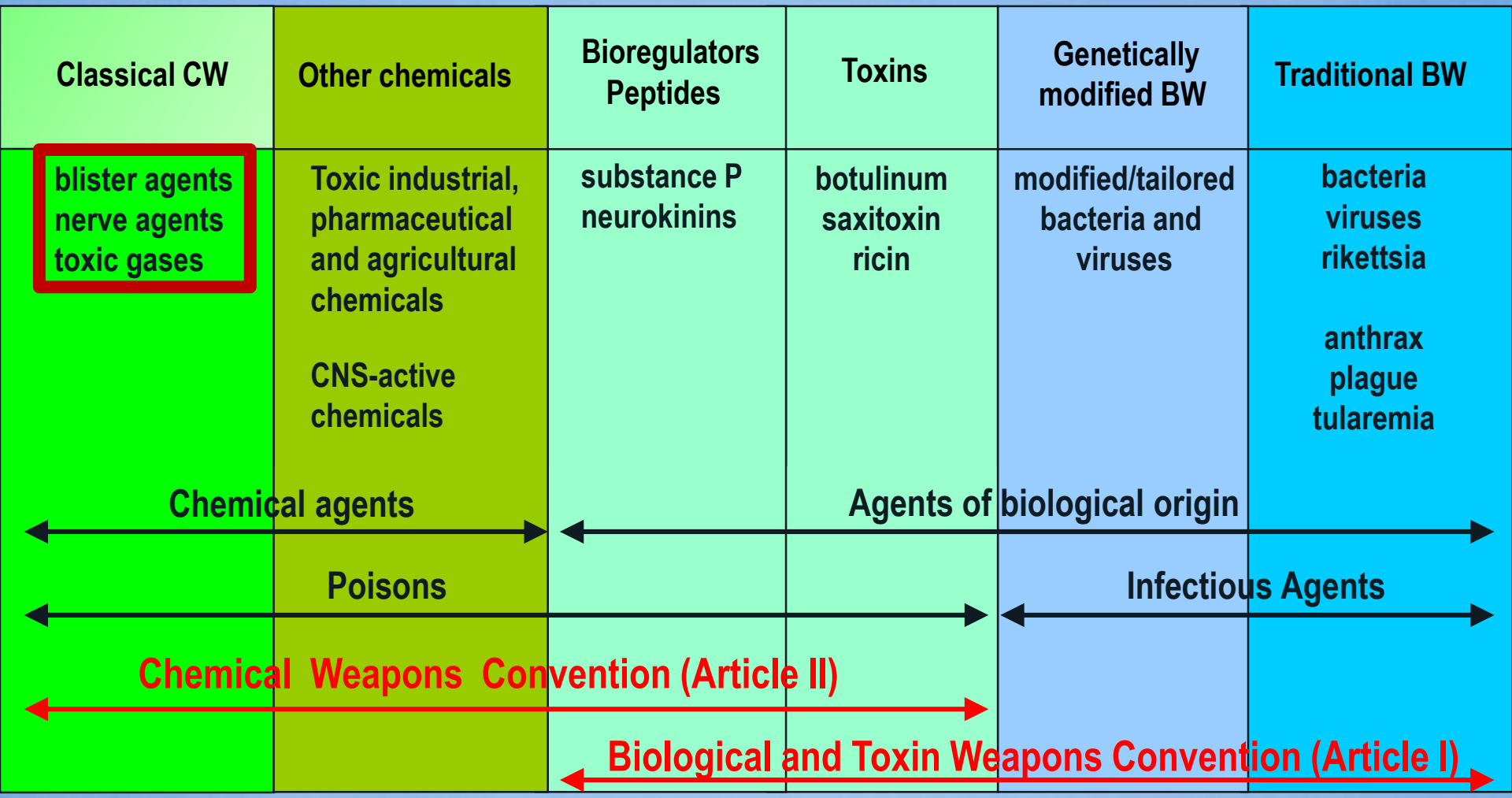
@opcw @opcw_st /opcwonline /opcwonline /company/opcw /opcw

Threat spectrum



Adopted from Graham S Pearson, ASA Newsletter, 90-1, February 1990 and Robert Mathews at TWG on Convergence, 1st Meeting 2011.

Threat spectrum



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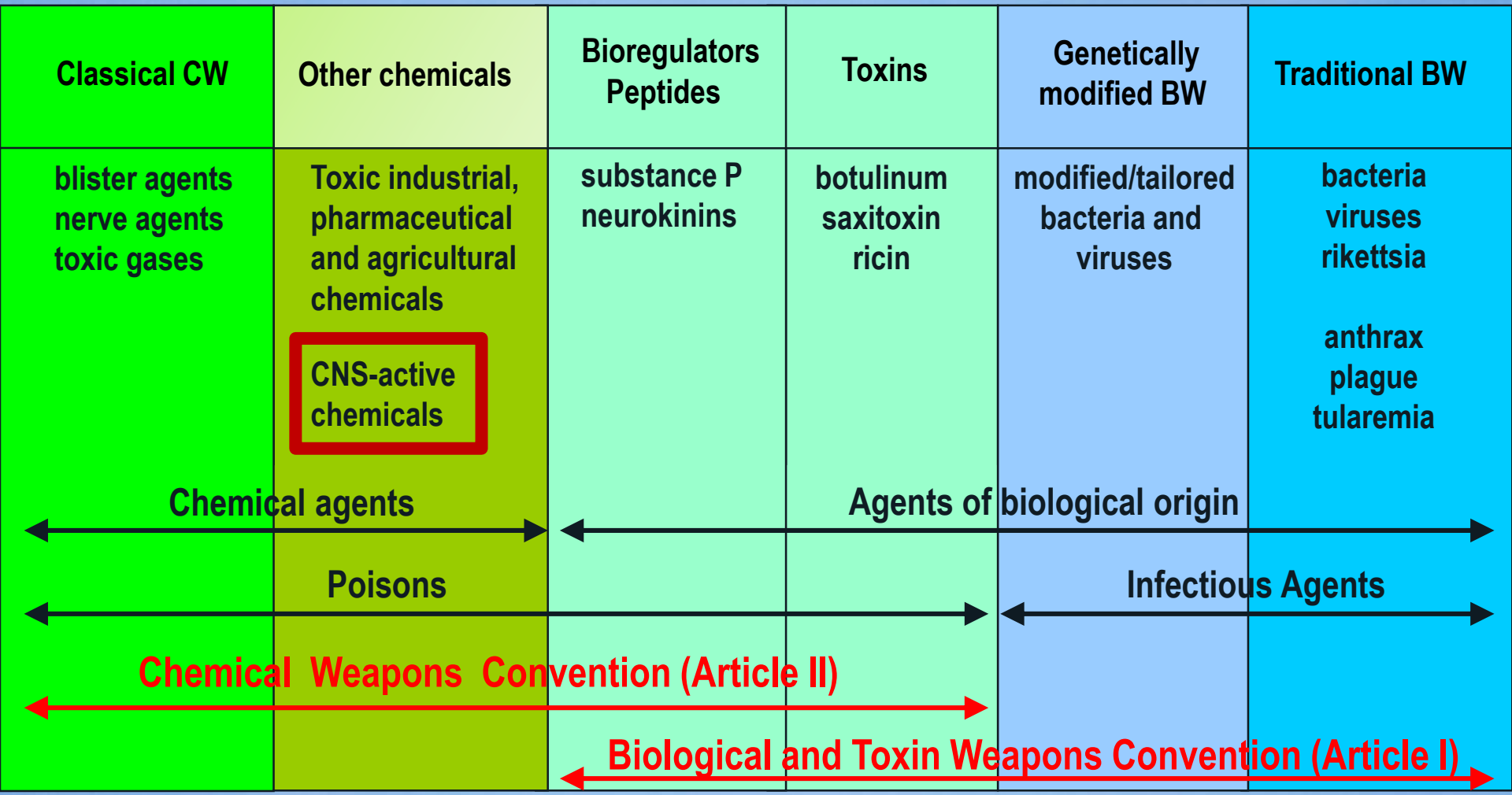
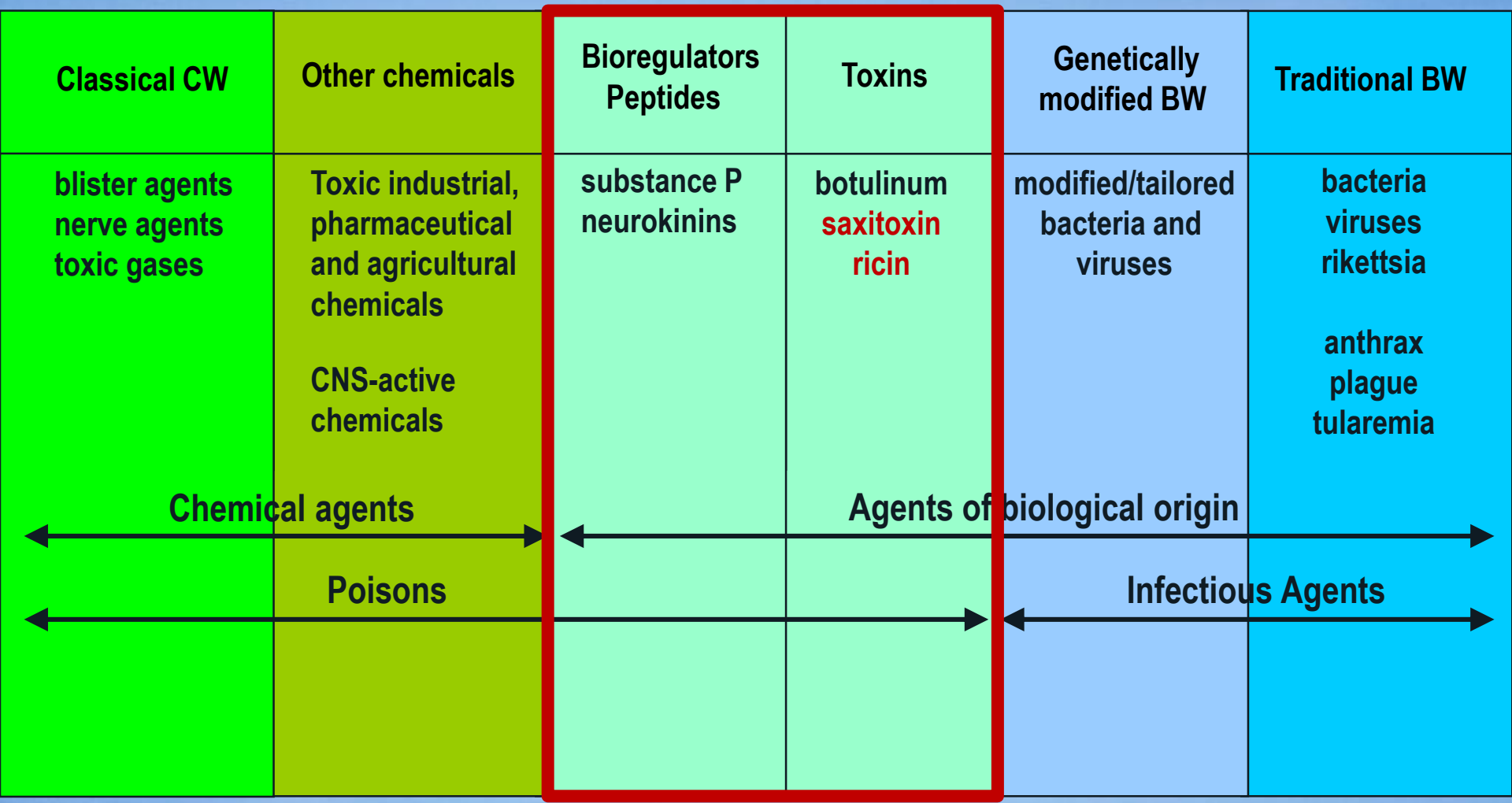
Threat spectrum



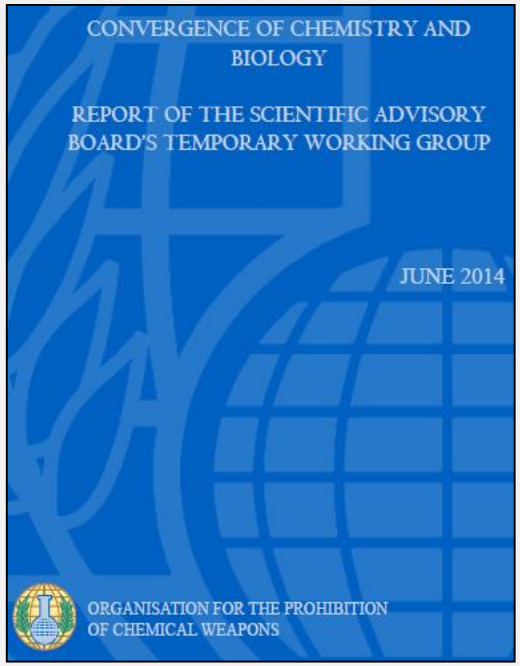
Threat spectrum



Convergence

Practical applications of new technologies for anticipated novel applications are advancing by trans-disciplinary problem solving

Technological change should be viewed from a practical perspective focusing on developments relevant to the Convention rather than focusing on single disciplines



Production of chemicals using biological processes

SAB recommended “production by synthesis" covers <u>any</u> process for the formation of a chemical

Technological advances : metabolic engineering, synthetic biology, gene editing

No advantage to producing classical CW agents by biological means

Toxins might be produced genetically rather than isolated from organisms

TS should continue to assess the possibility of conversion of biological facilities to the production of scheduled chemicals; the outcome of such a review would inform the degree of relevance these facilities have to the object and purpose of the Convention

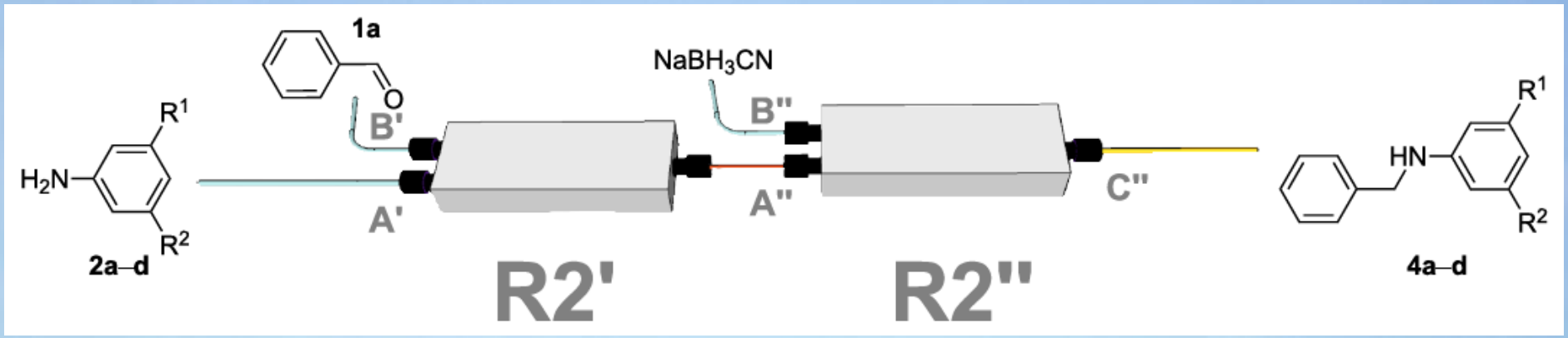
3D printing

Beilstein J. Org. Chem. **2013,** *9,* 951–959

3D-printed devices for continuous-flow organic chemistry

Vincenza Dragone, Victor Sans, Mali H. Rosnes, Philip J. Kitson and Leroy Cronin*

We present a study in which the versatility of 3D-printing is combined with the processing advantages of flow chemistry for the synthesis of organic compounds. Robust and inexpensive 3D-printed reactionware devices are easily connected using standard fittings resulting in complex, custom-made flow systems, including multiple reactors in a series with in-line, real-time analysis using an ATR-IR flow cell. As a proof of concept, we utilized two types of organic reactions, imine syntheses and imine reductions, to show how different reactor configurations and substrates give different products.

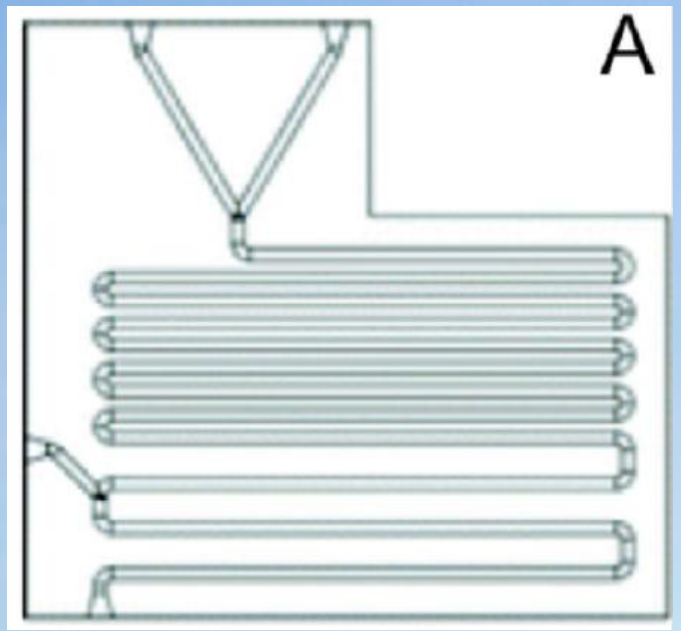


3D printing

Evaluation of 3D Printing and Its Potential Impact on Biotechnology and the Chemical Sciences

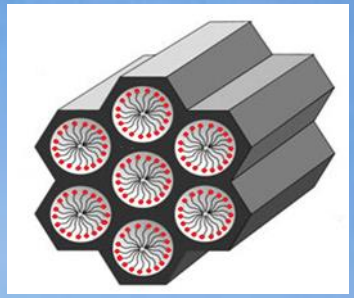
Nearing 30 years since its introduction, 3D printing technology is set to revolutionize research and teaching laboratories. This feature encompasses the history of 3D printing, reviews various printing methods, and presents current applications. The authors offer an appraisal of the future direction and impact this technology will have on laboratory settings as 3D printers become more accessible.

Bethany C. Gross, Jayda L. Erkal, Sarah Y. Lockwood, Chengpeng Chen, and Dana M. Spence*

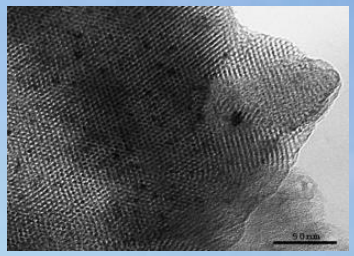


Nanotechnology

Nanotechnology has enabled advances in detection technology by incorporation of antibody or enzyme sensing elements that might be used for on-site inspections

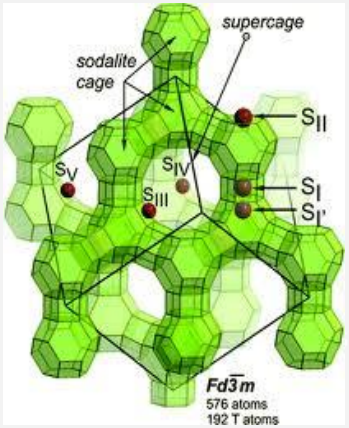


Publications on nanotechnology for chemical analysis, detection, protection, decontamination, and medical countermeasures reveal that few commercial products have come onto the market



Nanotechnologies that impact life processes through chemical action, used for purposes prohibited by the Convention, are covered by the general purpose criterion of Article II

Nanotechnologies to deliver chemical or biological agents would constitute a delivery system and contravene the CWC and BWC



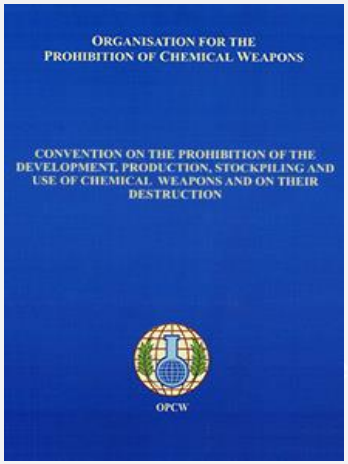
Schedules

Up-to-date knowledge of chemistry related to the Schedules and industrial processes are key for inspectors

Adequate levels of scientific understanding will remain critical in making any assessments of an industrial capability or facility – unusual practices cannot be recognised without good knowledge

A review of the schedules may be of value regarding chemicals previously not considered that are determined to pose a risk to non-proliferation, and could include :

- toxic industrial chemicals
- CNS-acting chemicals
- bioregulators and/or toxins



Isotopically-labelled compounds and stereoisomers

SAB-23/WP.1

OPCW — **Scientific Advisory Board**

Twenty - Third Session
18 – 22 April 2016

SAB-23/WP.1
28 April 2016
ENGLISH only

1.1 The Scientific Advisory Board (SAB) has considered isotopically labelled scheduled chemicals and stereoisomers of scheduled compounds relating to the Convention according to the Director-General's requests (see Appendixes 1 and 2).

1.2 **Recommendation 1**. The SAB recommends that the molecular parent structure of a chemical should determine whether it is covered by a schedule entry. This is because:

(a) it is inappropriate to rely solely upon Chemical Abstracts Service (CAS) numbers to define chemicals covered by the schedules. Although relevant as aids to declaration and verification, CAS numbers should not be used as the means to identify a chemical, or to determine whether a chemical is included in, or excluded from, a schedule;

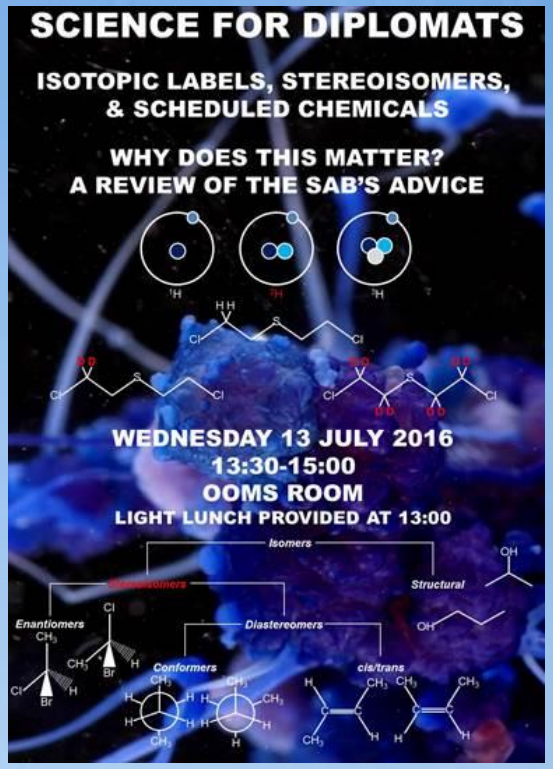
(b) thus, if a chemical is included within a schedule, then all possible isotopically-labelled forms and stereoisomers of that chemical should be included, irrespective of whether or not they have been assigned a CAS number or have CAS numbers different to those shown in the Annex on Chemicals to the Convention. The isotopically labelled compound or stereoisomer related to the parent chemical specified in the schedule should be interpreted as belonging to the same schedule; and

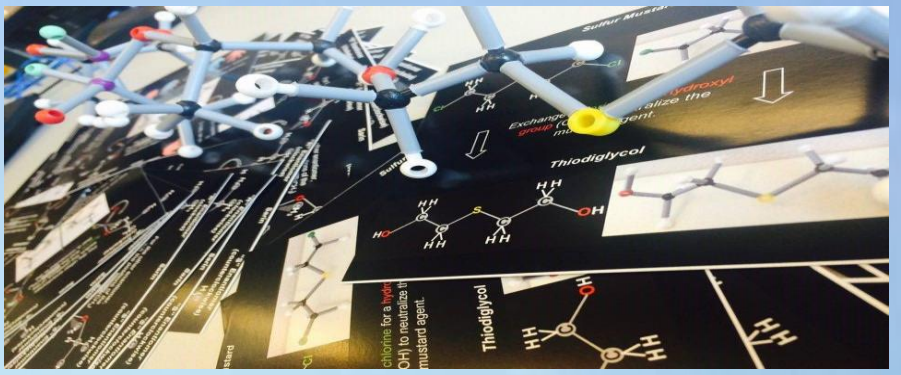
(c) this advice is consistent with previous SAB views on this topic.[1]

1.3 **Recommendation 2.** Inclusion of appropriate analytical data in the OPCW Central Agent Database (OCAD) for isotopically labelled relatives of scheduled compounds where available is recommended.

2. OBJECTIVE

2.1 At the Twenty-Second Session of the SAB in June 2015 [1][2], the Technical Secretariat introduced a request from the Director-General (Appendixes 1 and 2) to make technical recommendations on how chemicals relevant to Schedules 1, 2 and 3 should be considered in relation to the Convention if they contain isotopic labels or can exist in distinguishable stereoisomeric forms; taking into account the SAB's previous views on CAS registry numbers [2].





Emerging technologies

SAB encourages Technical Secretariat to consider scenarios where new technologies may enhance capabilities of inspectors

Satellite imaging (including hyperspectral and non-visible light methods) should be considered for contingency operations and routine inspections where access to a site is difficult due to security concerns

The utility of UAVs to support investigations should be further explored - emphasis on area reconnaissance, visual confirmation, live entry support, and scene documentation

Unmanned systems for monitoring chemical change and/or collecting samples should be assessed

Detection

Remote and automated monitoring technologies should be added to the list of approved inspection equipment (including those that could be incorporated into unmanned vehicles)

Handheld devices that provide chemical information, including through spectroscopic capabilities, mass spectrometry, and non-destructive techniques should be assessed

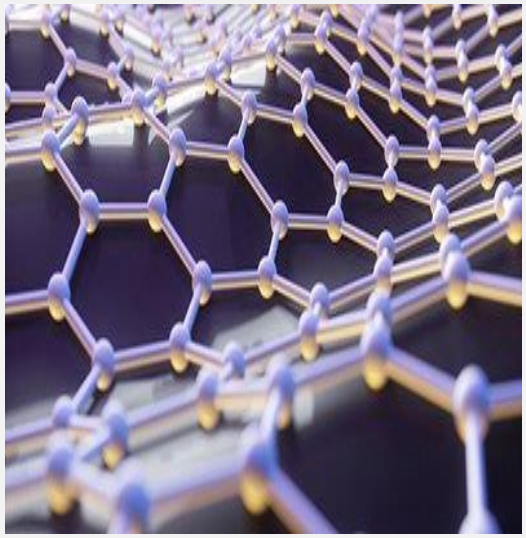
Use of multiple and complementary detectors will provide higher confidence in results

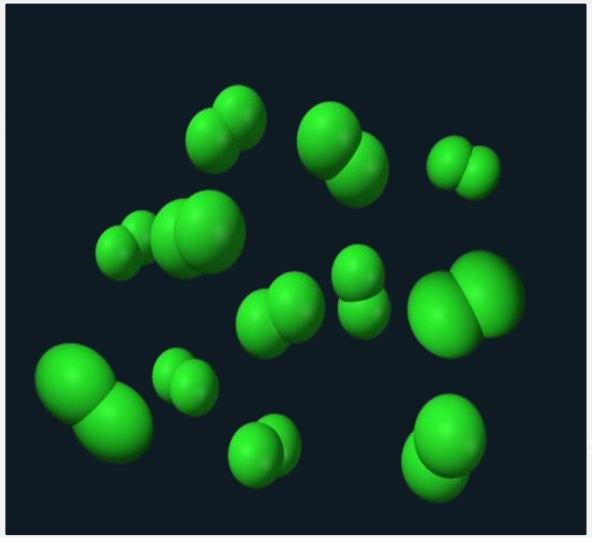
Protection

Research directed at enhancing protection while reducing the physiological burden of respirators and clothing

Incorporation of enzymes/catalysts to give self-decontaminating clothing, and evaluation of new materials in filters and clothing

E.g. metal organic frameworks (MOFs)





The OPCW inspector today

The OPCW inspector tomorrow

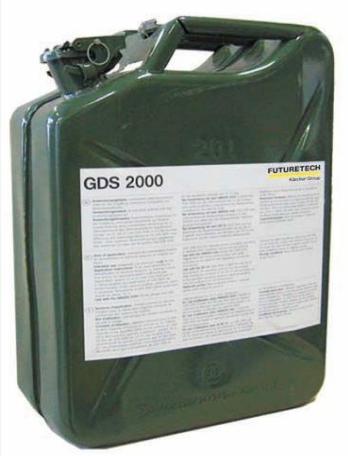
Decontamination

Enzymes might offer non-corrosive, safe and catalytic means of decontaminating CW agents

Directed evolution of enzymes may provide ‘green catalysts’ for degrading CW agents

New decontamination formulations will continue to be sought

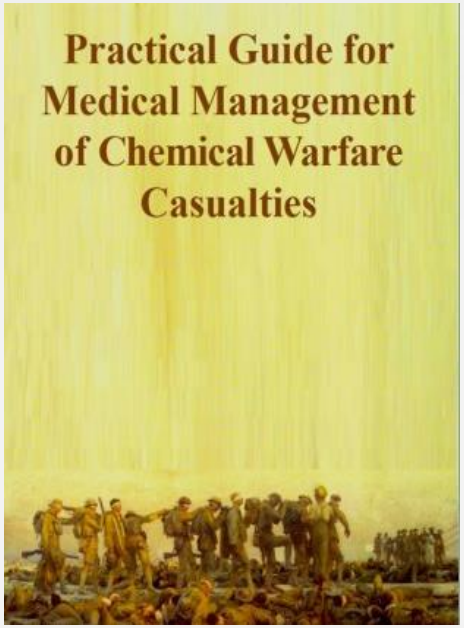
Microorganisms that digest chemicals may allow CW remediation



Medical countermeasures

There is a continuing need to identify early biochemical events to understand better mechanisms leading to vesicant injury

Requirement for fast and efficient means to diagnose and treat people exposed to toxic chemicals and for improved MedCMs



OPCW

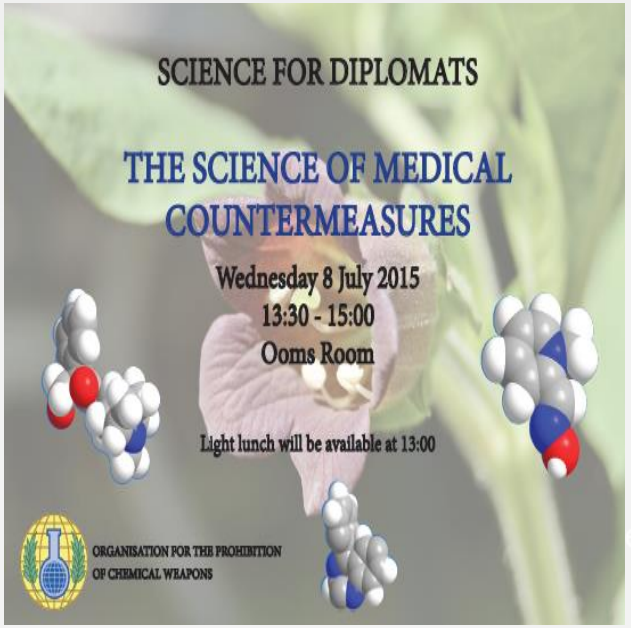
Scientific Advisory Board

Twenty-Second Session
8 – 12 June 2015

SAB-22/WP.2
8 April 2015
ENGLISH only

RESPONSE TO THE DIRECTOR-GENERAL'S REQUEST TO THE SCIENTIFIC ADVISORY BOARD TO PROVIDE FURTHER ADVICE ON ASSISTANCE AND PROTECTION

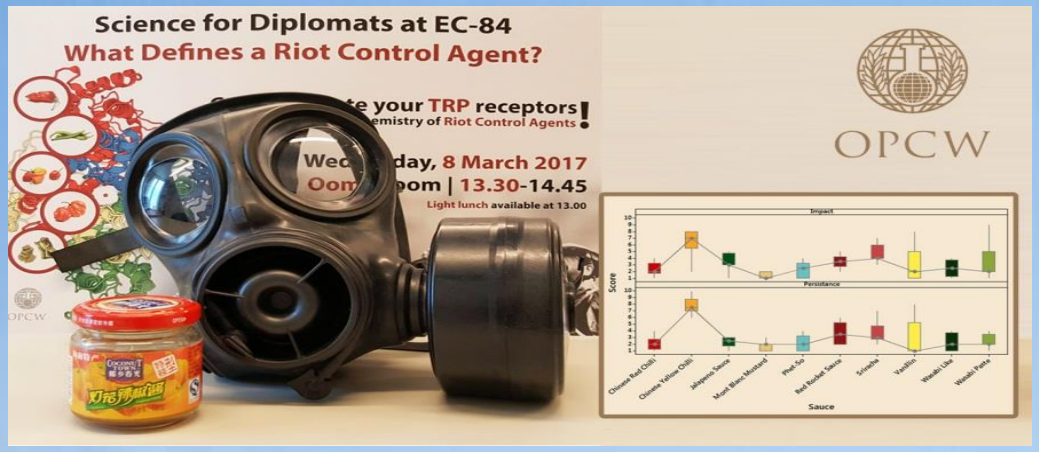
TOXI TRIAGE

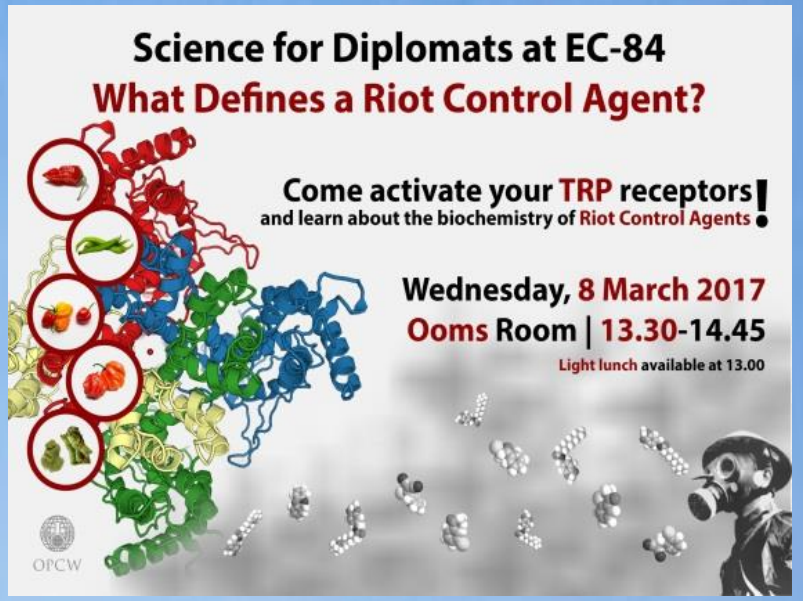


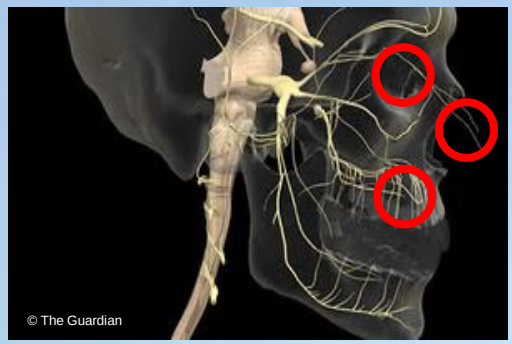
Riot control agents (RCAs)

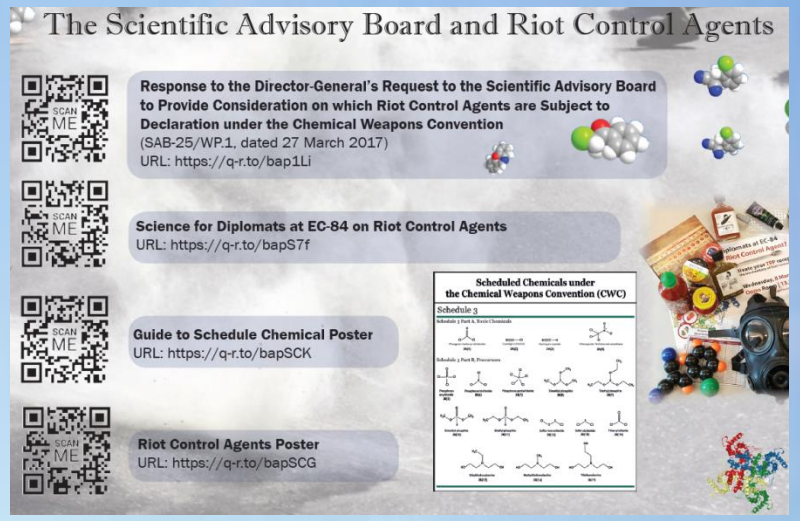
Reviewed list of 60 chemicals that had been discussed in a RCA context

Only 17 met CWC-definition of RCA

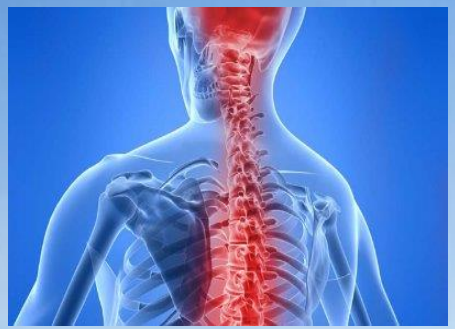








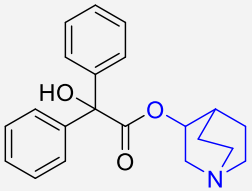
Central nervous system (CNS) acting chemicals



SAB reviewed 25 years of its advice on CNS-acting chemicals and concluded aerosolisation of these materials for law enforcement poses a significant health risk to humans

Technical discussions remain exhausted: issue now in the policy domain

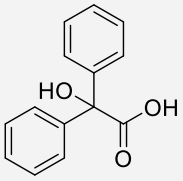
OPCW should start preparations for verification activities to prepare for any future IAU



3-quinuclidinyl benzilate (BZ)

Schedule 2.A.3

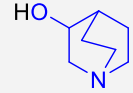
made from



2,2-diphenyl-2-hydroxyacetic acid

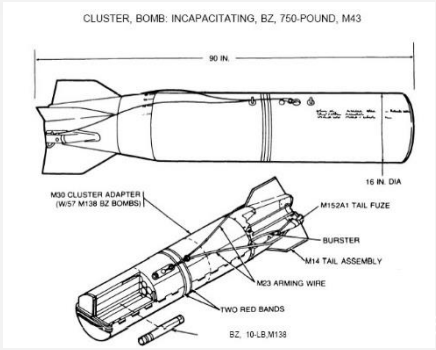
Schedule 2.B.8

and



quinuclidin-3-ol

Schedule 2.B.9



Toxins

Standardised methods for identification and analysis of saxitoxin and ricin should continue to be developed, and an international capability built to analyse samples for these two Sch. 1 chemicals

- Methods for detecting and analysing other toxins/chemicals that have been weaponised, or pose a high risk of use as chemical weapons, should be addressed

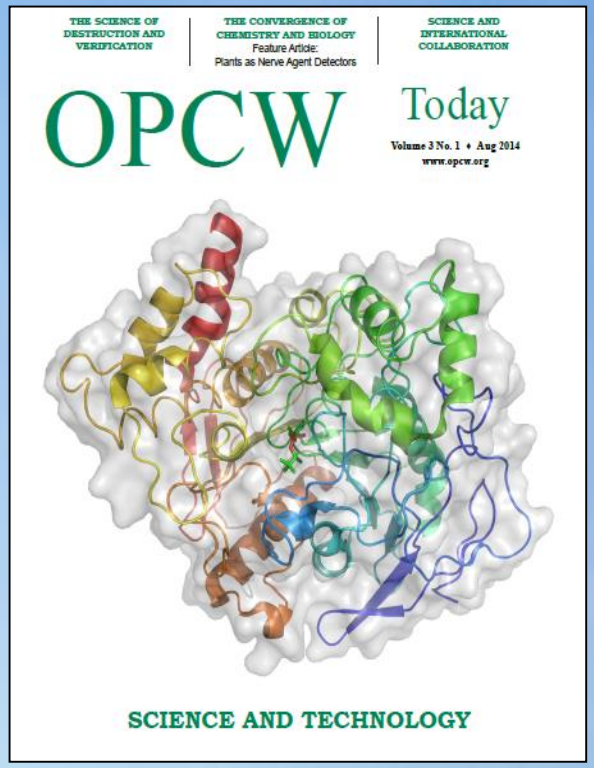
- Development of analysis of specific biomarkers related to toxins in biomedical samples would be advantageous

OPCW Laboratory and designated laboratory network should engage with other networks of laboratories to share best practice in toxin identification and analysis

Monitoring chemical change

Plants offer a means to detect and monitor chemical exposure (physical, chemical, and microbiological changes occur)

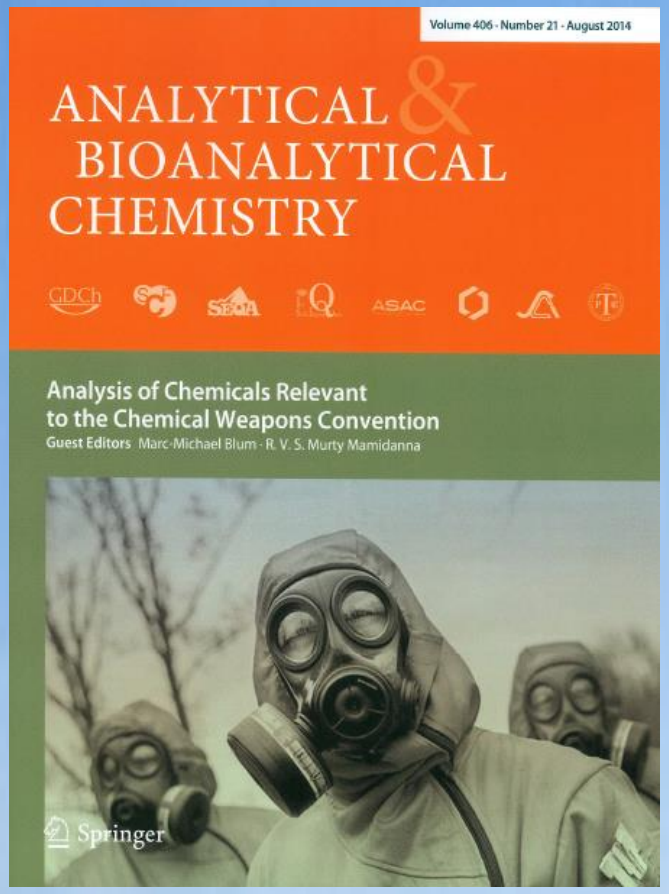
Might be able to read such changes using handheld devices etc.



Designated laboratories (DLs)

- SAB supports expansion of the network which is a model of international cooperation
- IAU technical data should be shared among DLs and published in peer-reviewed scientific papers to build capacity worldwide that OPCW may draw upon in future

Important to share analytical methods



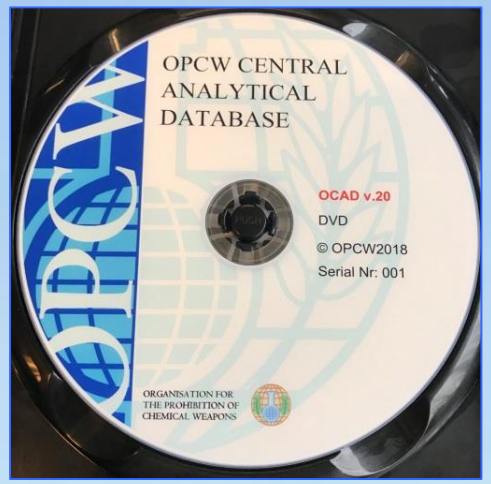
Proficiency Tests do not address identification of poisoning by non-sch. chemicals

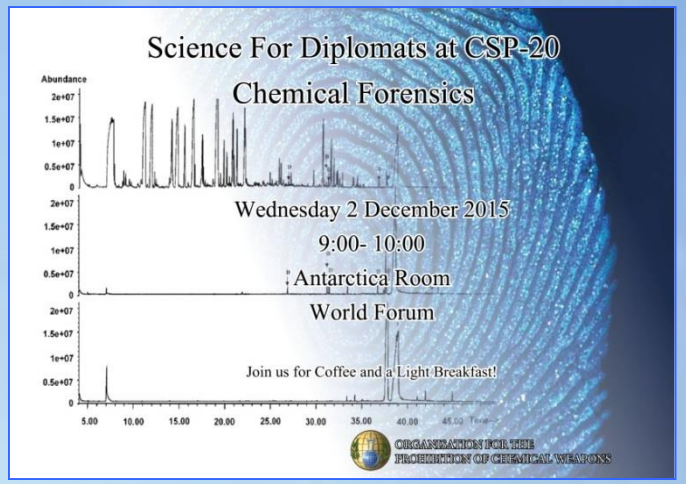
The SAB recommends that a possible approach for such a scenario is evaluated

OPCW Central Analytical Database (OCAD)

Analytical data for chemicals that pose a risk of use for purposes prohibited by the CWC should be included in the OCAD, including:

- Isotopically labeled relatives
- Stereoisomers of scheduled compounds
- Riot control agents
- CNS-acting chemicals
- Bioregulators and/or toxins
- Relevant biomarkers





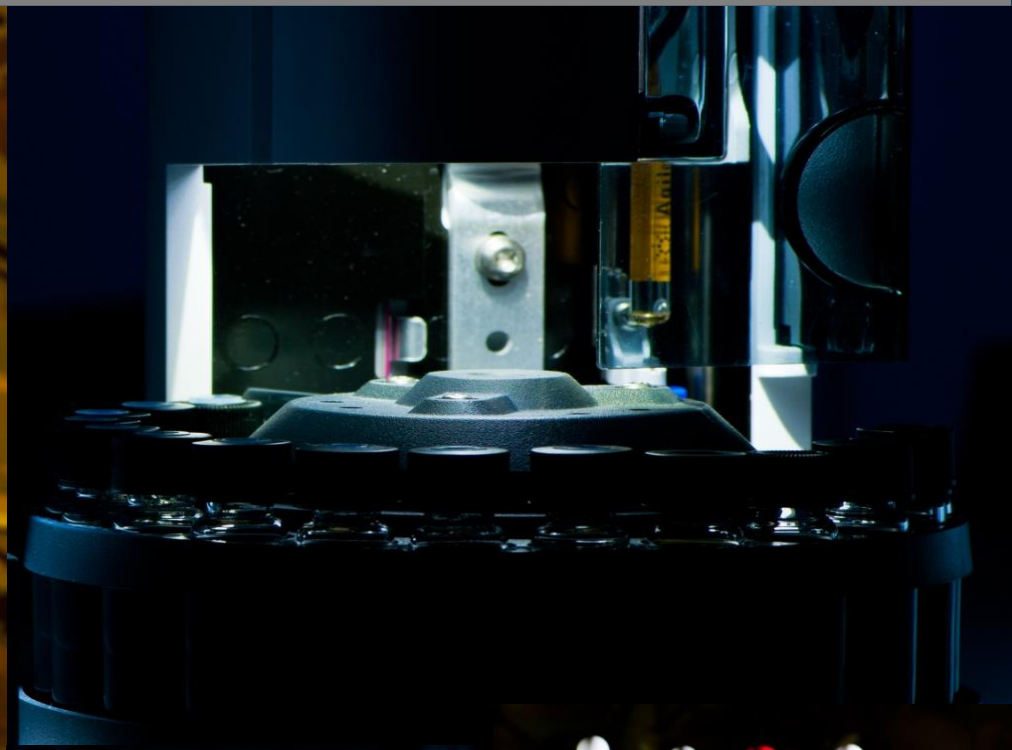
Sample handling and storage

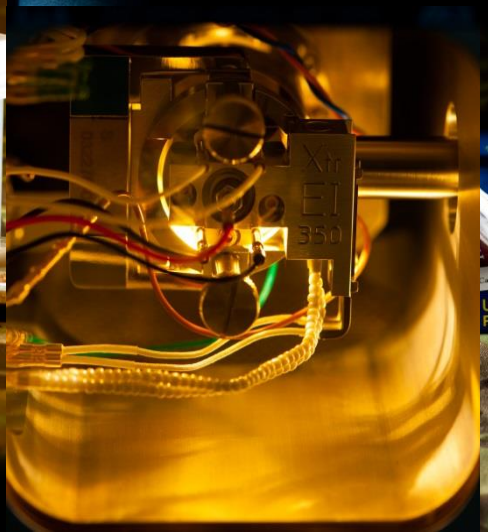
Further documentation on the stability of samples just after sampling and during transport to the OPCW Laboratory; sample handling during splitting, handling, storage and disposal of samples at the OPCW Laboratory; should be pursued and shared with relevant stakeholder laboratories

Solid phase micro-extraction fibres, blood spot papers and related technologies may be promising for long-term storage of blood and other biological matrices – opportunities to test these should be sought

Collaborative opportunities to develop sample preparation methodologies for relevant non-scheduled chemicals (e.g. TICS, CNS acting chemicals, RCAs) should be sought

TWG on Investigative Science and Technology





TWG on Investigative Science and Technology

Contingency operations have increasingly involved investigations, analysis, and fact-finding, with collection and evaluation of oral, material, and digital evidence of the use of chemical agents

- Review science and technology relevant to investigations mandated under the CWC
- Include science and technology for the validation and provenancing (determining the chronology of ownership, custody and/or location) of evidence, and integration of multiple and diverse inputs to reconstruct a past event
- Identify capabilities, skill sets, and equipment that will augment and strengthen the investigative capabilities of OPCW





Temporary Working Group on Investigative Science and Technology

Reporting to the Scientific Advisory Board (SAB), the Temporary Working Group (TWG) will in particular consider the following questions:

Question 1:

Which methods and capabilities used in the forensic sciences could usefully be developed and/or adopted for Chemical Weapons Convention-based investigations?

Question 2:

What are the best practices and analysis tools used in the forensic sciences for effectively cross-referencing, validating, and linking together information related to investigation sites, materials collected/analysed, and individuals interviewed?

Question 3:

What are the best practices for management of data collected in investigations, including compilation, curation, and analytics?

Question 4:

What are the best practices for the collection, handling, curation and storage, and annotation of evidence?

Question 5:

Which technologies and methodologies (whether established or new) allow point-of-care and non-destructive measurements at an investigation site to help guide evidence collection?

Question 6:

Which technologies and methodologies (whether established or new) can be used in the provenancing of chemical and/or material samples collected in an investigation?

Question 7:

Which methods are available (or are being developed) for the sampling and analysis of environmental and biomedical materials and can be used in the detection of toxic industrial chemicals relevant to the Chemical Weapons Convention?

Question 8:

Which technologies and methodologies (whether established or new) can be used in ensuring chain of custody and verifying authenticity (especially in regard to digital images and video recordings)?

Question 9:

Which technologies and methodologies (whether established or new) can be used to ensure the integrity of an investigation site?

Question 10:

Do collections of physical objects, samples, and other information for chemical weapons-related analysis exist and can they be made available to investigators for retrospective review? How might these collections be used to support investigations?

Question 11:

Are there stakeholders that the Technical Secretariat could usefully engage with to leverage their capabilities on investigative matters?

In addition, the TWG will provide advice on Technical Secretariat proposals for methodologies, procedures, technologies, and equipment for investigative purposes.

Initial findings

Any site of alleged use of toxic chemicals should be viewed as a crime scene with interagency cooperation important for OPCW

Impurity profiling is an important developing area of science

Biomedical samples should be exploited as much as possible

Forensic techniques including analysis of open source videos and documents to establish authenticity should aid investigations

Important to consider best practice adopted by first responders

OPCW should keep reference samples of investigation samples

Closing statement

The SAB's report to the Fourth Review Conference will be delivered to the Director-General in April 2018

The SAB condemns any use of chemicals as weapons and stands ready to provide relevant scientific advice in support of verification and the prevention of re-emergence of chemical weapons in response to any allegations

Thank you for your attention

Non-Invasive Disease Diagnosis (could include chemical agent exposure)

http://www.basilleaftech.com/

Qualcomm TRICORDER X PRIZE

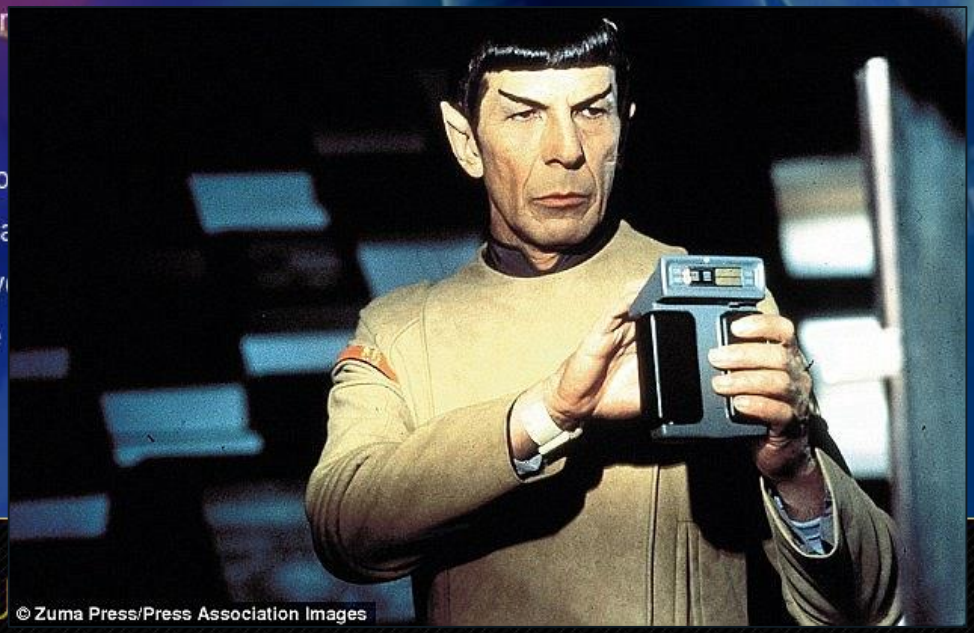
Active / $10 Million

Launched in 2012, this competition is designed to put healthcare in the palm of your hand, giving individuals far greater choices in when, where and how they receive medical care the world over.

The dire need for improvements in healthcare has captured the attention of government, industry, and private citizens for
But a viable solution still evades us.

Inspired by the technology of Star Trek, we imagined a po
wireless device that could monitor and diagnose your hea
conditions and collect data that could be transmitted to y
physician. Already, some 200 teams in 32 countries have
their intent to compete.

Photos & Video →



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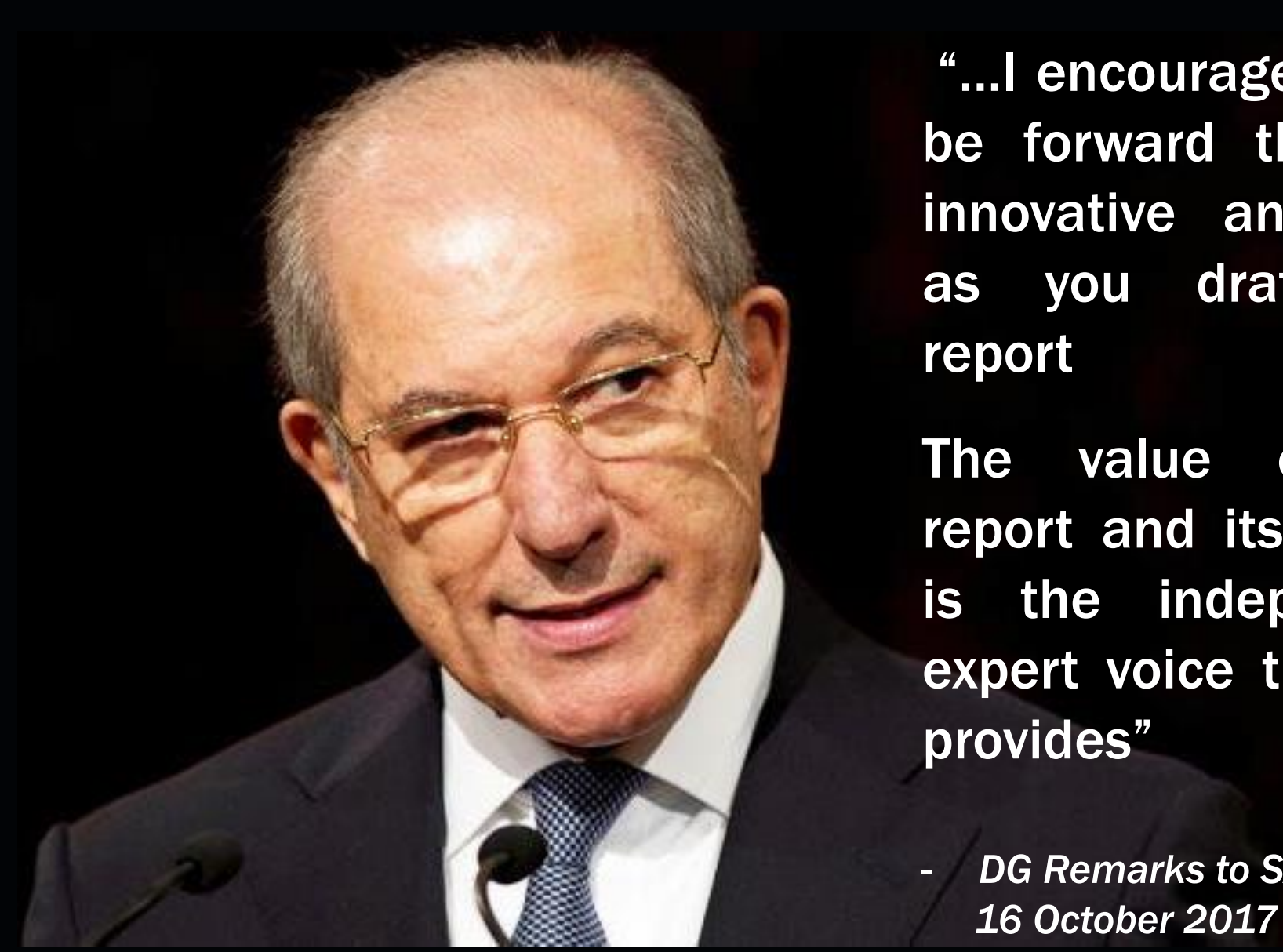
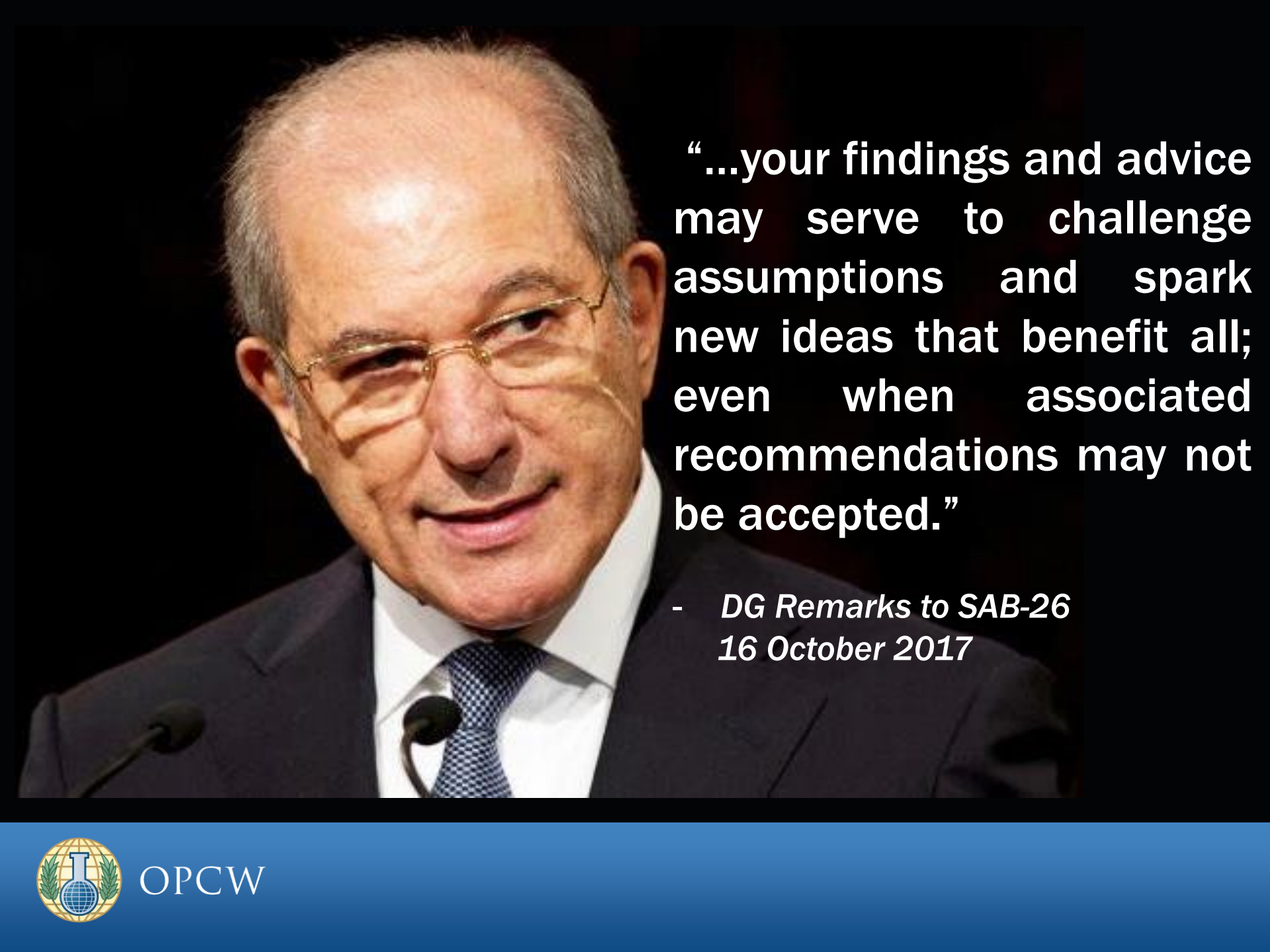


"...I encourage you to be forward thinking, innovative and bold as you draft this report

The value of the report and its advice is the independent expert voice the SAB provides"

- *DG Remarks to SAB-26*
  16 October 2017


"...your findings and advice may serve to challenge assumptions and spark new ideas that benefit all; even when associated recommendations may not be accepted."
- DG Remarks to SAB-26
16 October 2017

SAB Meets 19-23 March
Report submitted to Director-General in April
Response from Director-General in May
SAB Chair Addresses OEWG-RC in June

OPCW

OPCW Scientific Advisory Board

Briefing to States Parties

Thursday 22 March 2018

Ieper Room | 13:30-15:00

Light lunch served at 13:00

OPCW

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