

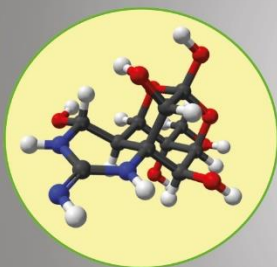
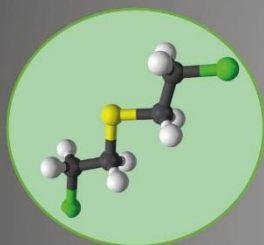


Science for Diplomats at EC-87

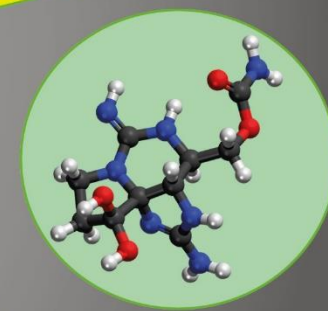
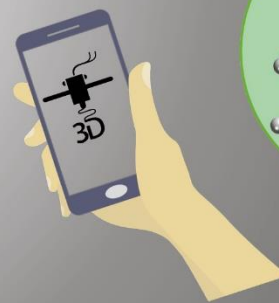
Science, Technology and the Chemical Weapons Convention:

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!*

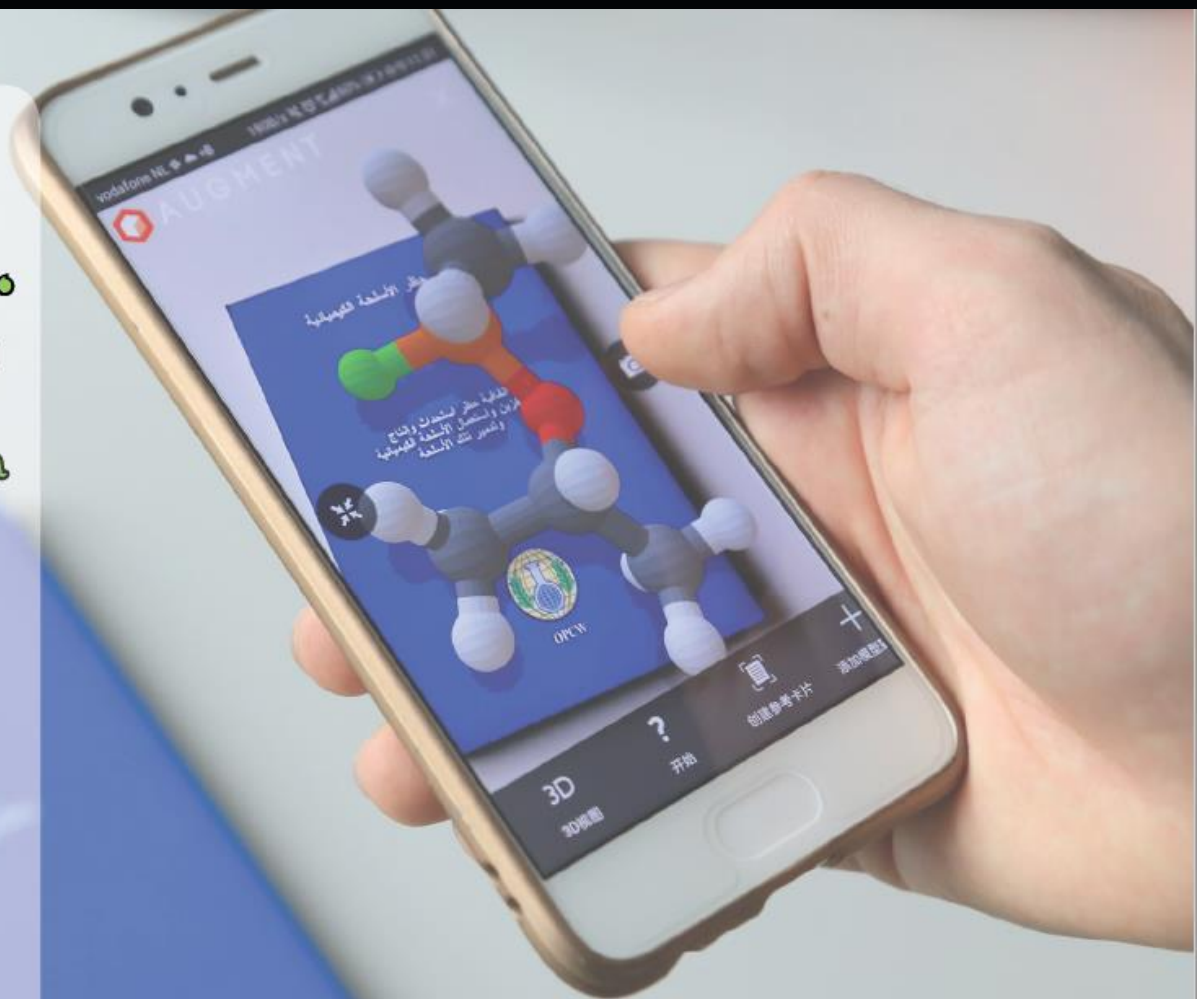
 **AUGMENT**



ANDROID



iOS



Scan the **QR** code
to download the
“**Science for Diplomats**”
App

Now bring the Convention
to life!

 **AUGMENT**



ANDROID



iOS



21-30 November 2018: A Time to Review

Third Special Session of the
Conference of the States
Parties to Review the
Operation of the Chemical
Weapons Convention

8 - 19 April 2013

Organisation for the Prohibition of Chemical Weapons

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/bap1L0>



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>

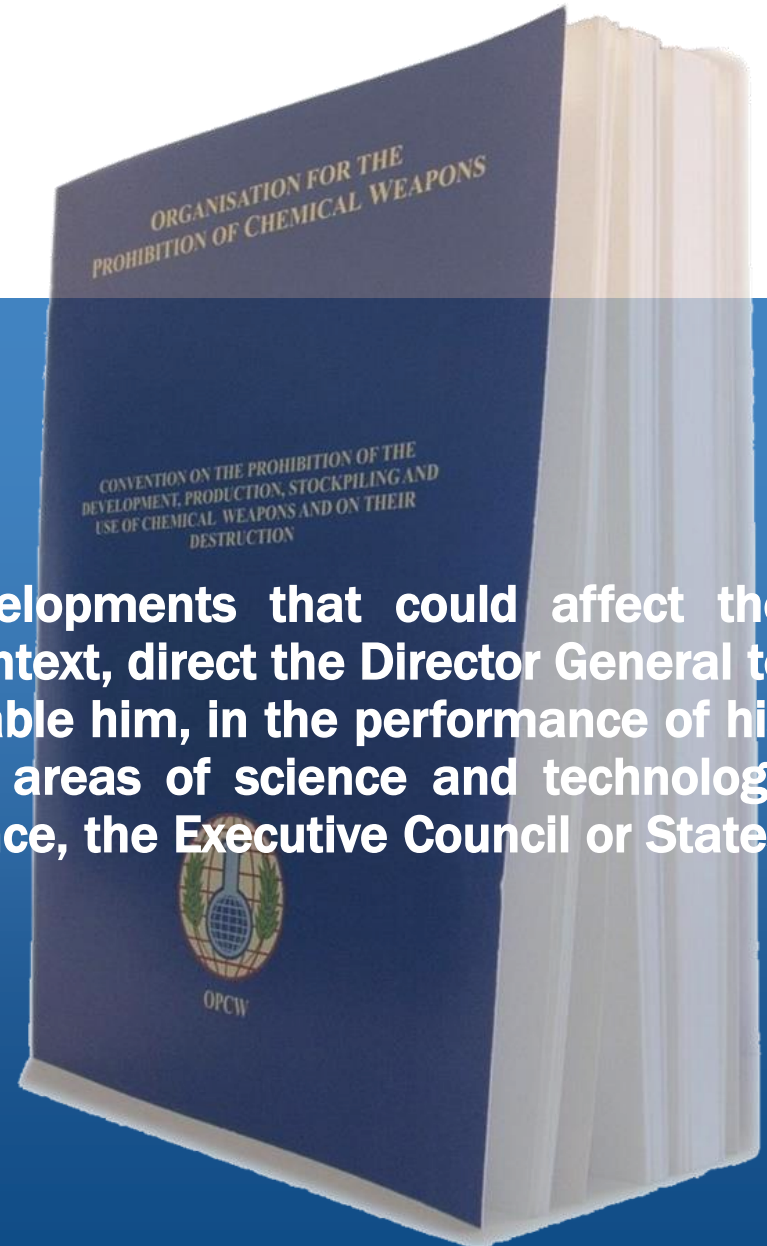


Science and Technology in the Convention

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)



What does “Science and Technology” mean to you?



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

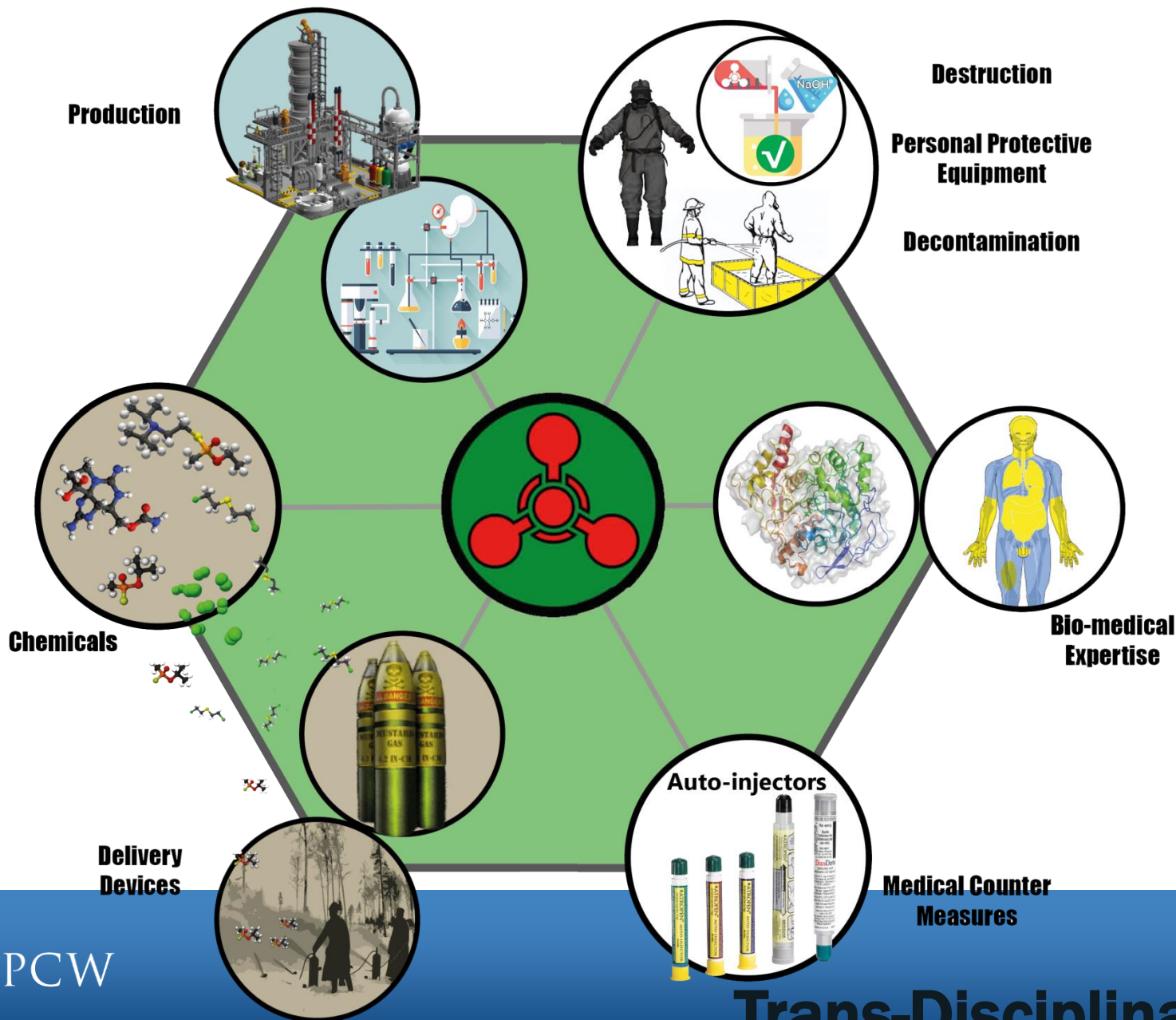
A word cloud visualization of audience responses to the question 'What does Science and Technology mean to you?'. The words are arranged in a circular pattern around a central globe graphic. The most prominent word is 'Progress' in large blue letters. Other significant words include 'Peace' in red, 'Innovation' in red, 'Security' in purple, 'Ice cream' in green, 'Safety' in red, 'Chemistry and biology' in orange, 'Convergence' in orange, 'FUTURE' in blue, 'Modernization' in red, 'notpolitical' in green, 'Forward looking' in purple, 'Chemical' in orange, 'Sustainability' in blue, 'Convetygence' in purple, 'Good' in green, 'Innovative' in blue, and 'Bad' in orange. The words are of various sizes and colors, indicating their relative frequency or importance in the responses.

Convetygence
Sustainability
Chemical
Peace
Forward looking
notpolitical
Progress
Modernization
FUTURE
biomediated processes
Chemistry and biology
Convergence
Safety
Ice cream
Security
Innovation
Bad
Innovative
Good

Show image

17

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

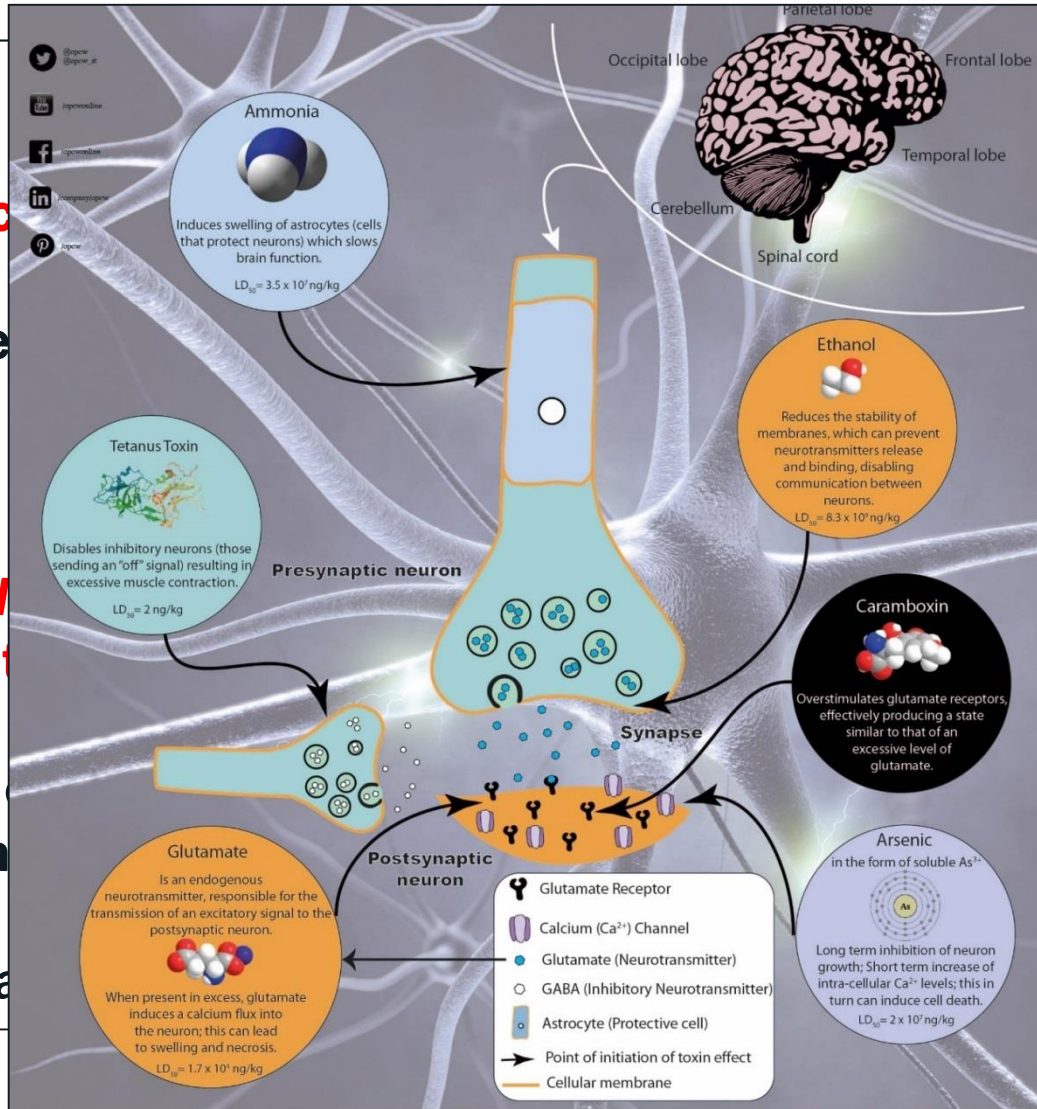


OPCW

The Convention itself is “Convergent”

Toxic chemical purposes not quantities are

Any chemical cause death, animals. This their method in facilities, in Chemical Wea



intended for the types and

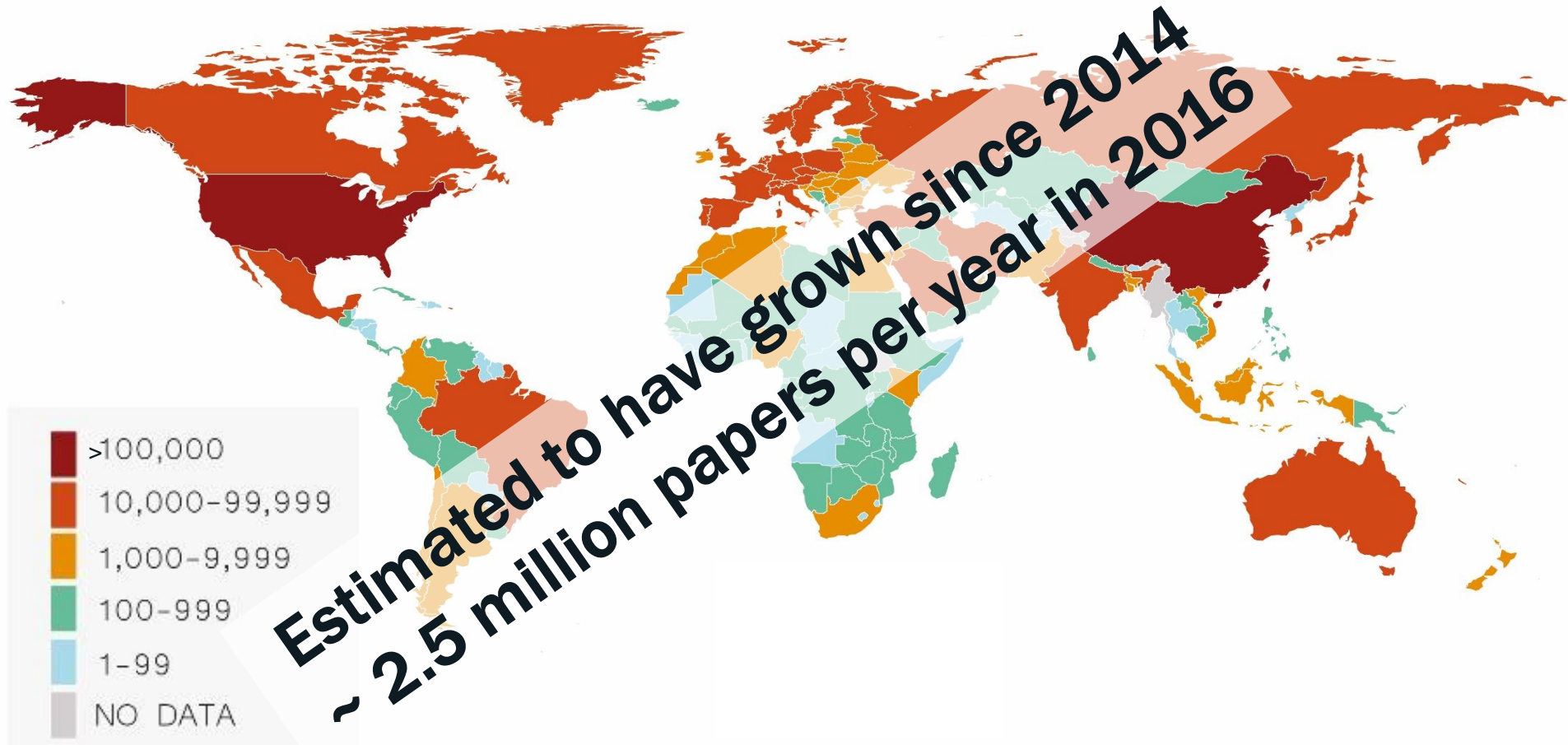
processes can to humans or their origin or of are produced



OPCW

How Much Science is Out There?

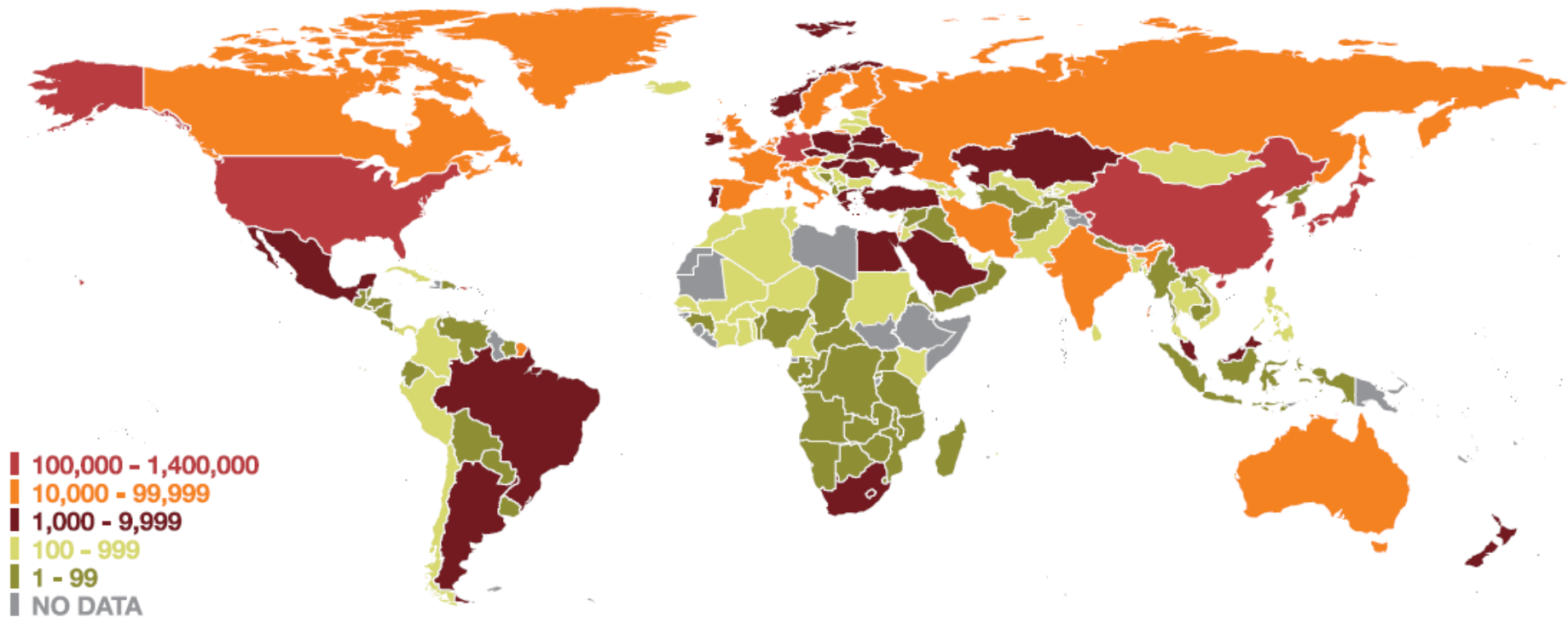
Scientific Publications in 2014



OPCW

How Much Science is Out There?

Equivalent patent applications by origin, 2016



Source: Standard map A17.

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



OPCW

■ All this advanced science and...



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



■ All this advanced science and...

■ Allegations of use of Chlorine Gas, Sulphur Mustard and Nerve Agents



C&EN
CHEMICAL & ENGINEERING NEWS

FEBRUARY 23, 2015

FINE CHEMICALS
Nonpharma business rules
InformEx show **P.24**

PITTCON IN N'AWLINS
Analytical conference will
draw thousands **P.50**

CHEMICAL WEAPONS IN WWI
How poison gas set a dark precedent 100 years ago **P.8**

 PUBLISHED BY THE AMERICAN CHEMICAL SOCIETY

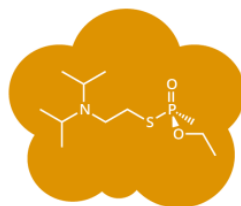
All this advanced science and...

Allegations of use of Chlorine Gas, Sulphur Mustard and Nerve Agents



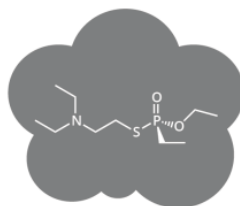
CHEMICAL WARFARE ☠ NERVE AGENTS

PART TWO: THE V SERIES THE V SERIES NERVE AGENTS ARE HIGHLY TOXIC CHEMICAL WARFARE AGENTS. THE 'V' STANDS FOR 'VENOMOUS'. THEY WERE DISCOVERED IN THE UK IN THE 1950s, AND LATER VX WAS DEVELOPED FOR MILITARY USE BY THE UNITED STATES, THOUGH IT HAS NEVER BEEN USED IN WARFARE.



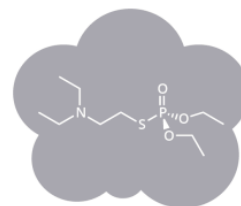
VX

(O-Ethyl-S-[2-diisopropylaminoethyl] methylphosphonothioate) (the compound known as 'Russian VX' is an isomer of this compound)



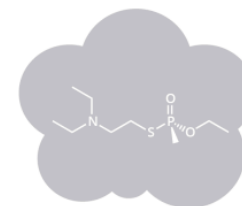
VE

O-Ethyl-S-[2-diethylaminoethyl] ethylphosphonothioate



VG

O,O-Diethyl-S-[2-diethylaminoethyl] phosphorothioate



VM

O-Ethyl-S-[2-diethylaminoethyl] methylphosphonothioate

SMELL & APPEARANCE

- VX** Pure VX is a colourless liquid, but more commonly it is an amber-coloured, oily, odourless liquid.
- VE** The other V series nerve agents are thought to be odourless, colourless liquids at room temperature (when pure). As they have not been studied in detail outside of military investigations as to their usefulness in warfare, little more is known about them.
- VG**
- VM** Generally, their volatilities are low, though VX is the member of the series with the lowest volatility.

DISCOVERY

1952-1955 UNITED KINGDOM

The V series nerve agents were discovered during work to synthesise pesticides and insecticides. VG was originally sold as an insecticide, under the name 'Amiton'. It was marketed from 1954, but later withdrawn after the issues with human toxicity became apparent.

UK research on the compounds stopped in 1956, but was traded with the US in exchange for information on building thermonuclear devices.

USAGE & FATALITIES

- ☠ As the V series agents exist primarily as low volatility liquids, they are designed for use as area-denial agents.
- 🐑 The only recorded human fatality as a result of VX is in Japan in 1994, when a sect used it to assassinate a former member. It may have also been used in Iraq by Saddam Hussein, though there is no conclusive evidence.
- 🐑 Sheep fared less well: Over 6000 were killed or injured in 1968 after a test in Utah, USA, with leftover VX leaking from a dispenser suggested as the likely accidental cause.
- 🚫 Production of VX was banned in the US in 1989. Its production and stockpiling was outlawed worldwide in 1993.

LETHALITY

FIGURES FOR VX

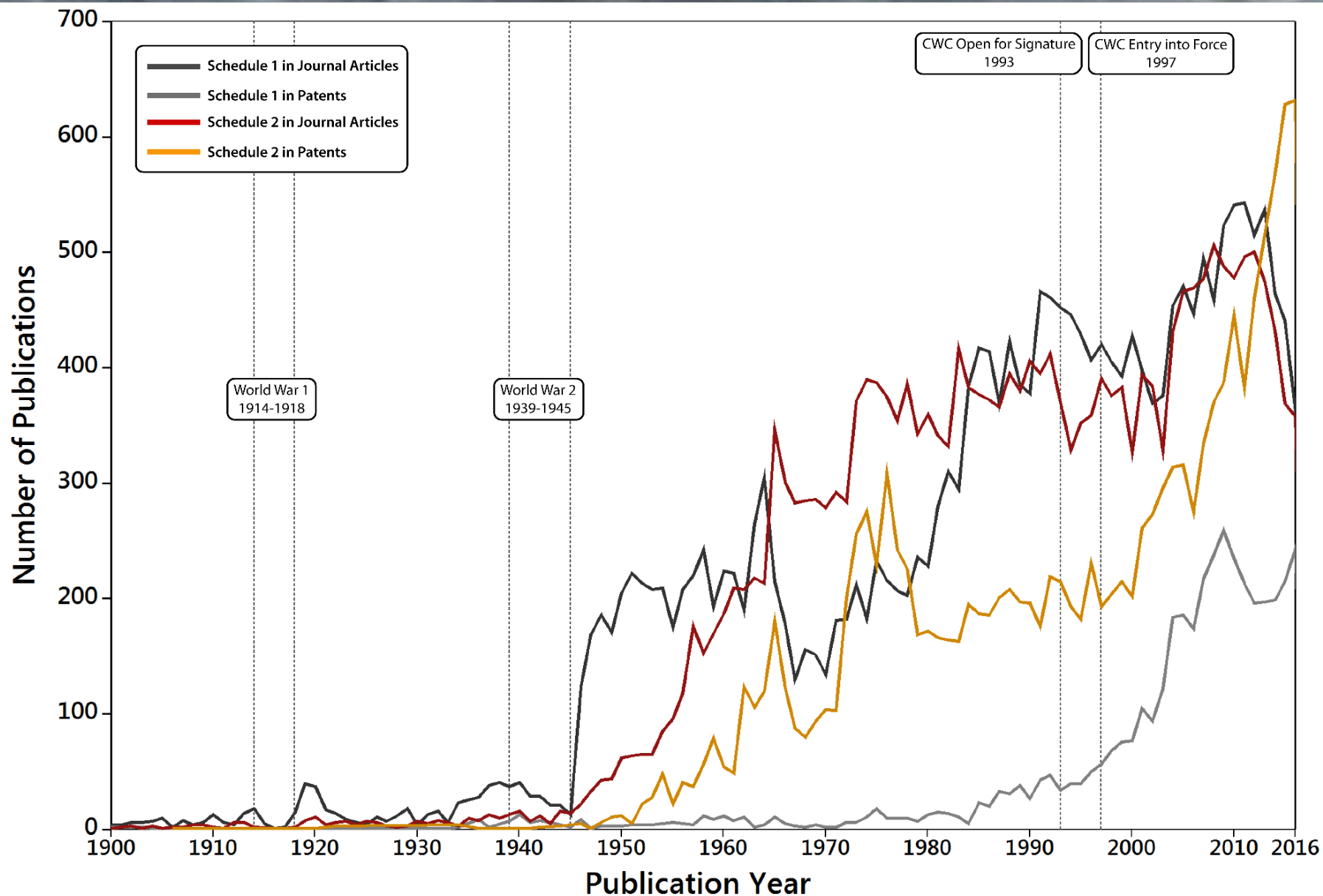
median lethal concentration	median lethal dose
15 milligram minutes per cubic metre	10 milligrams per person (skin exposure)

Due to the scarcity of research on the V series nerve agents, data on lethality is only reliably available for VX. The other V series agents are thought to have roughly similar toxicities.

They have low volatilities - VX is around 2000 times less volatile than sarin - so the primary method of exposure is often through skin contact, rather than inhalation.

EFFECTS OF NERVE AGENTS

- ACh** Inhibit breakdown of acetylcholine
- 👁** Cause contraction of the pupils
- 💧** Excessive mucus, tears, saliva & sweat
- 🤢** Nausea, gastrointestinal pain & vomiting
- 👤** Bronchoconstriction & chest tightness
- 🧠** Spasms, convulsions & loss of bowel control
- ☠** Coma & eventual death



266 *Guthrie, über einige Derivate*
 an diesem Tage 9,4 CC. = 0,1 Grm. Eisen war. Diese
 13,3 CC. gehen aber 0,1425 Grm. Fe,
 statt 0,1428 „ „, welche das Salz
 enthält.

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

Ueber einige Derivate der Kohlenwasserstoffe C_nH_m ;
 von F. Guthrie.

Erste Abhandlung*).

Die aus gleichviel Äquivalenten Wasserstoff und Kohlen-

stoff (H = 1, C = 12) geschichtliches Pro-
 zell die Aufmerksam-
 sich gezogen. W-
 hundert wurde di-
 durch solche Subs-
 Wasser haben, vor-
 daß dieser Kohlen-
 Und diese Ansicht
 man, wie schon fr-
 Zweifel gesetzt w-
 Alkohol wieder da-
 Die Isolierung
 verbindungen der

269 *Niemann, über die Einwirkung*
 daß mir kein Zweifel über die Bildung des Productes $C_2H_2S_2Cl$
 bleibt. Dann kann auch kein Zweifel darüber sein, daß dieser
 Körper eine Reihe von Substanzen entstehen läßt, welche
 den oben beschriebenen, aus der entsprechenden Amylenver-
 bindung entstehenden analog sind.

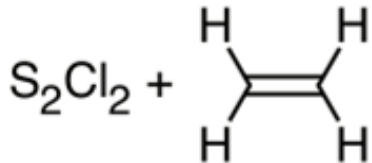
Ueber die Einwirkung des braunen Chlorschwefels
 auf Etlaylgas;
 von A. Niemann.

Die Angaben, welche man in den Lehrbüchern der Chemie
 über das Verhalten des Etlaylgases zum Chlorschwefel findet,

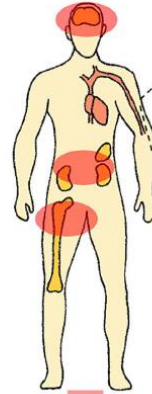
sind auch widersprechend.
 Chlorschwefel verwandelt sich
 in eine Flüssigkeit, die weniger
 brennbar sei, während
 der Halbchlorschwefel
 keine Veränderung erleidet.
 Dergleichen Versuche ange-
 ben kurz mittheile, obwohl
 die Möglichkeit, größere Mengen
 edigen Productes zu er-
 zeugen, nicht ausgeschlossen
 werden sind. Ich hoffe
 in der baldigen Zeit zu finden, diesen Gegenstand wieder
 aufnehmen und zum Abschlusse bringen zu können.

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

*) Ann. chim. phys. XXI, 423.
 **) Poggendorff's Annalen XIII, 298.

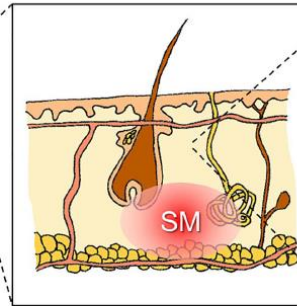


Systemic
distribution



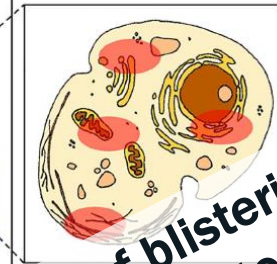
SM intoxication distant
from lesion site

Depot
formation



Chronic release of

Pleiotropic
effects



SM affects different
targets simultaneously

Mechanism of blistering is still not understood!

Fig. 3. Key problems of SM pathology. Systemic distribution: Intoxication of organs distant 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, Mönkhofweg 239a, 23562, Lübeck, Germany; ^b Institute of Medical and Marine Biotechnology, University of Lübeck, Ratzeburger Allee 160, 23652, Lübeck, Germany
^c Bundeswehr Institute of Pharmacology and Toxicology, Neuherbergstraße 11, 80937, Munich, Germany; ^d Universität der Bundeswehr, Fakultät für Humanwissenschaften, Department für Sportwissenschaft, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany
^e 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.

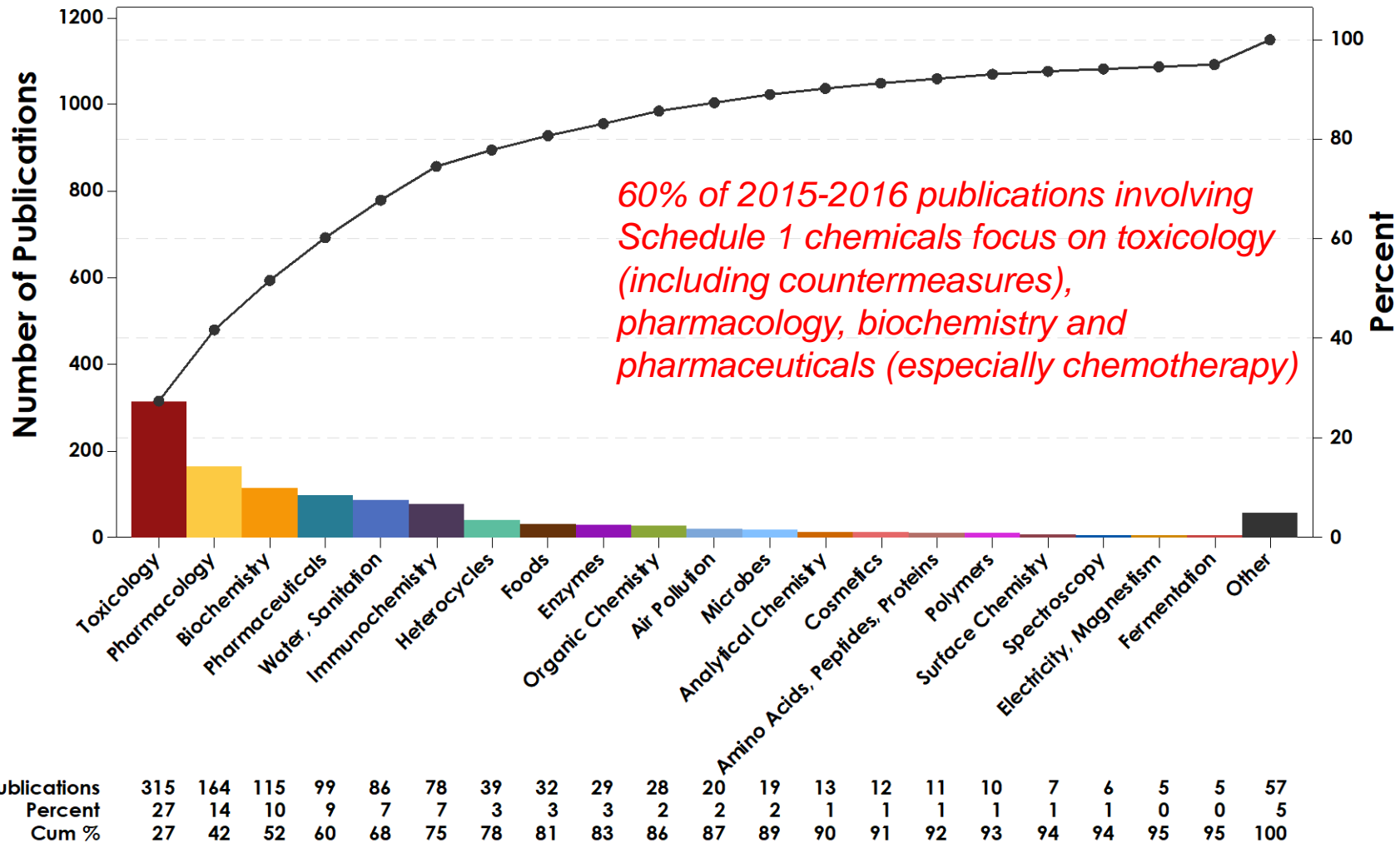
D. Rose, Toxicology Letters, 2017
 DOI: 10.1016/j.toxlet.2017.11.039

Systemic distribution



Depot formation

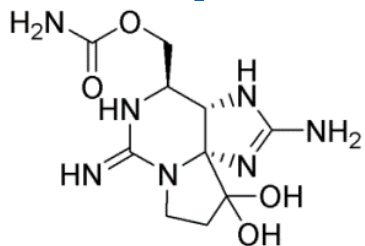
Pleiotropic effects



* Ann. chim. phys. XXI, 424.
 ** Poggendorff's Annalen XIII, 298.

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

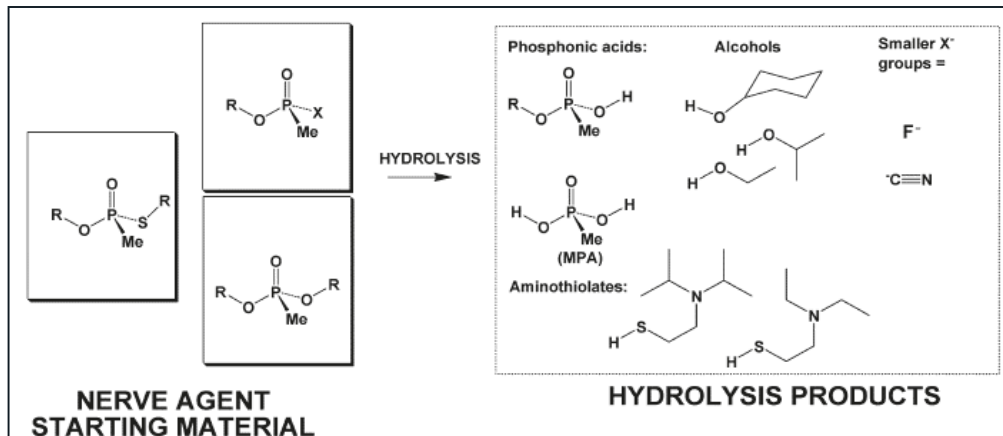
Implementation Requires Science and Technology!



Article II



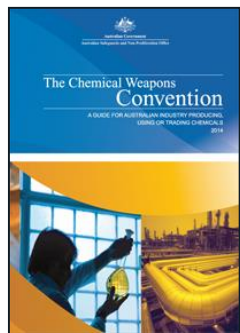
Article III



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?

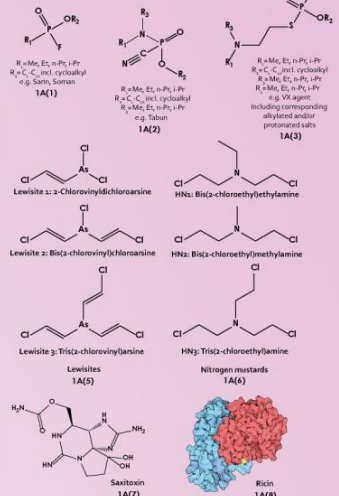
Schedule 1

Guidelines for Schedule 1

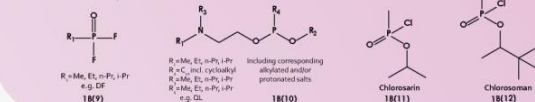
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

- (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, comparable properties;
 - (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



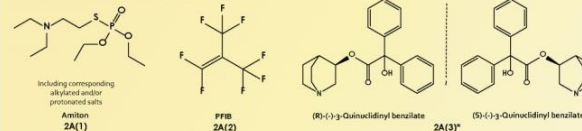
Schedule 2

Guidelines for Schedule 2

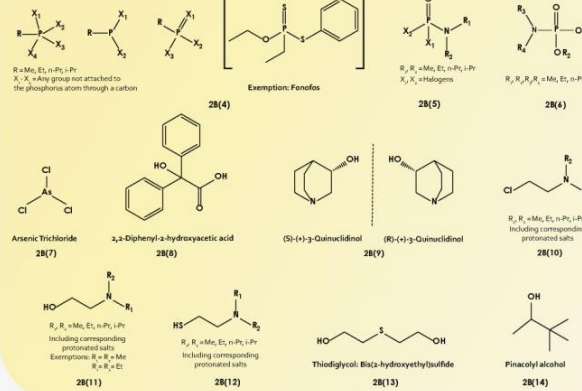
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:

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

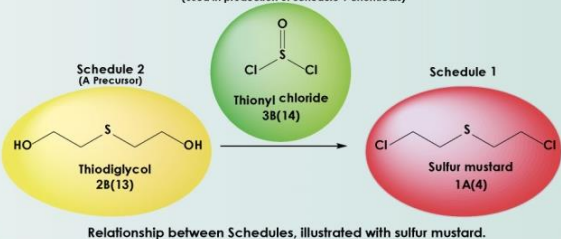
Schedule 2 Part A, Toxic Chemicals



Schedule 2 Part B, Precursors



Schedule 3 (Used in production of Schedule 1 chemicals)



Schedule 3

Guidelines for Schedule 3

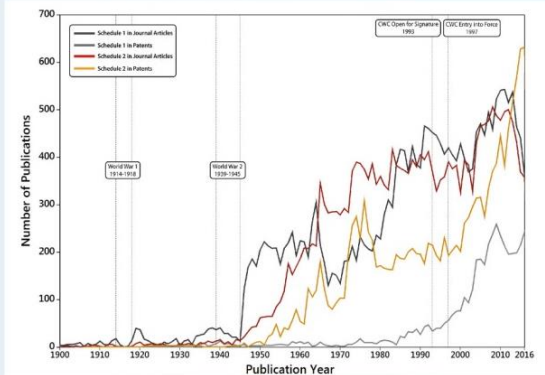
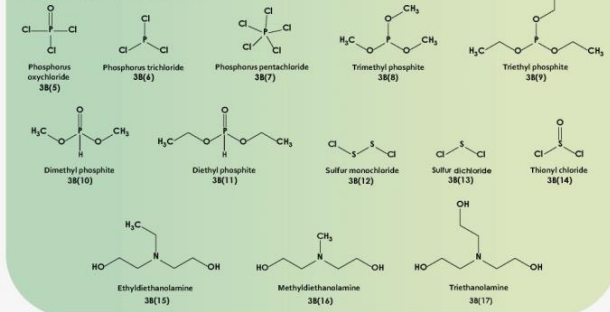
The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

- (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



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

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

Schedule 1

Schedule 2

Schedule 3

82

30

Chlorine

Sarin

VX

9 20000000

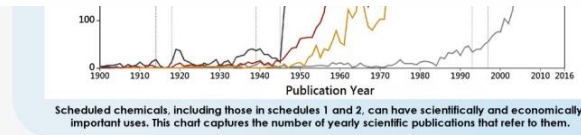
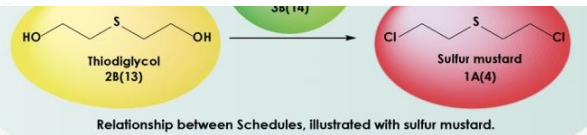
Show image

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



How Many Chemicals Do You Know About?

Schedule 1

Guidelines for Schedule 1

The following criteria apply to a chemical or precursor:

- (a) It has been defined in Article 2 of the Convention
- (b) It poses other risks to the public health or safety by virtue of its chemical or physical properties
- (c) It is a precursor of a Schedule 1 chemical or precursor

Schedule 2

Guidelines for Schedule 2

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

Schedule 1 Part A

1A(1)
R1-Me, Et, n-Pr, i-Pr, R2=C, C, incl. cyanoalkyl
 eg. Sarin, Soman

1A(2)
R1=Me, Et, n-Pr, i-Pr, R2=C, C, incl. cyanoalkyl
R3=Me, Et, n-Pr, i-Pr, R4=C, C, incl. cyanoalkyl
 eg. Tabun

1A(3)
R1=Me, Et, n-Pr, i-Pr, R2=C, C, incl. cyanoalkyl
R3=Me, Et, n-Pr, i-Pr, R4=C, C, incl. cyanoalkyl
R5=Me, Et, n-Pr, i-Pr, R6=C, C, incl. cyanoalkyl
 eg. VX

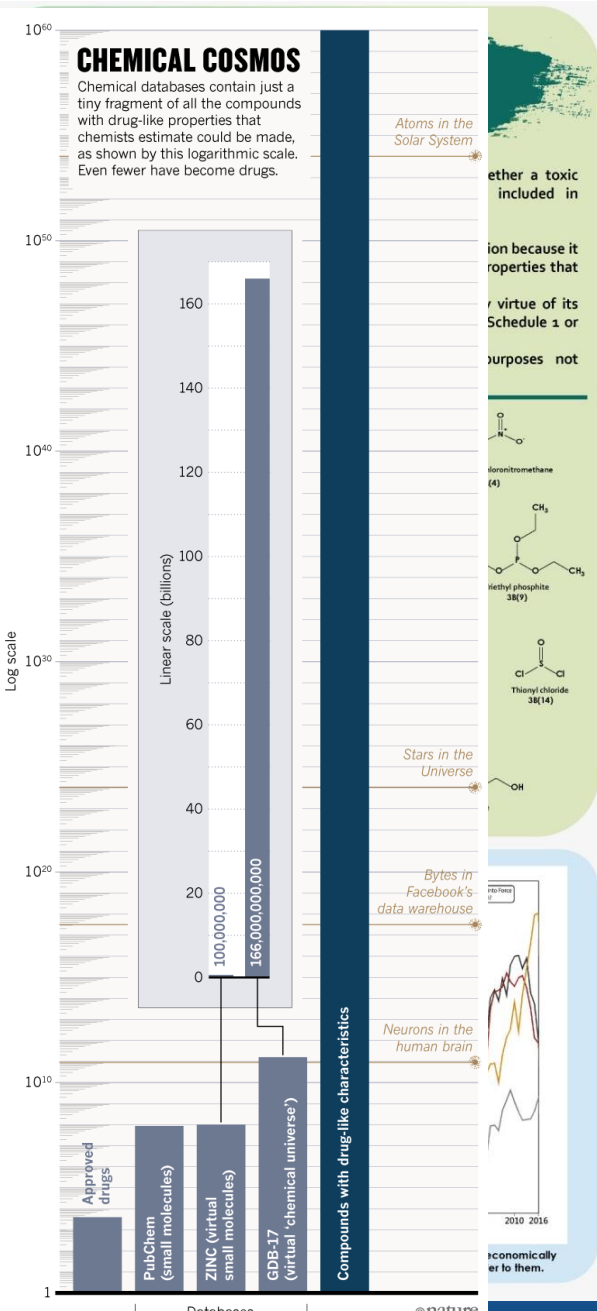
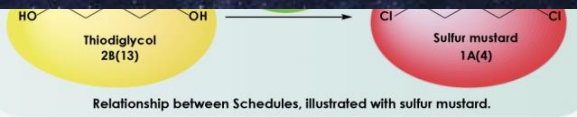
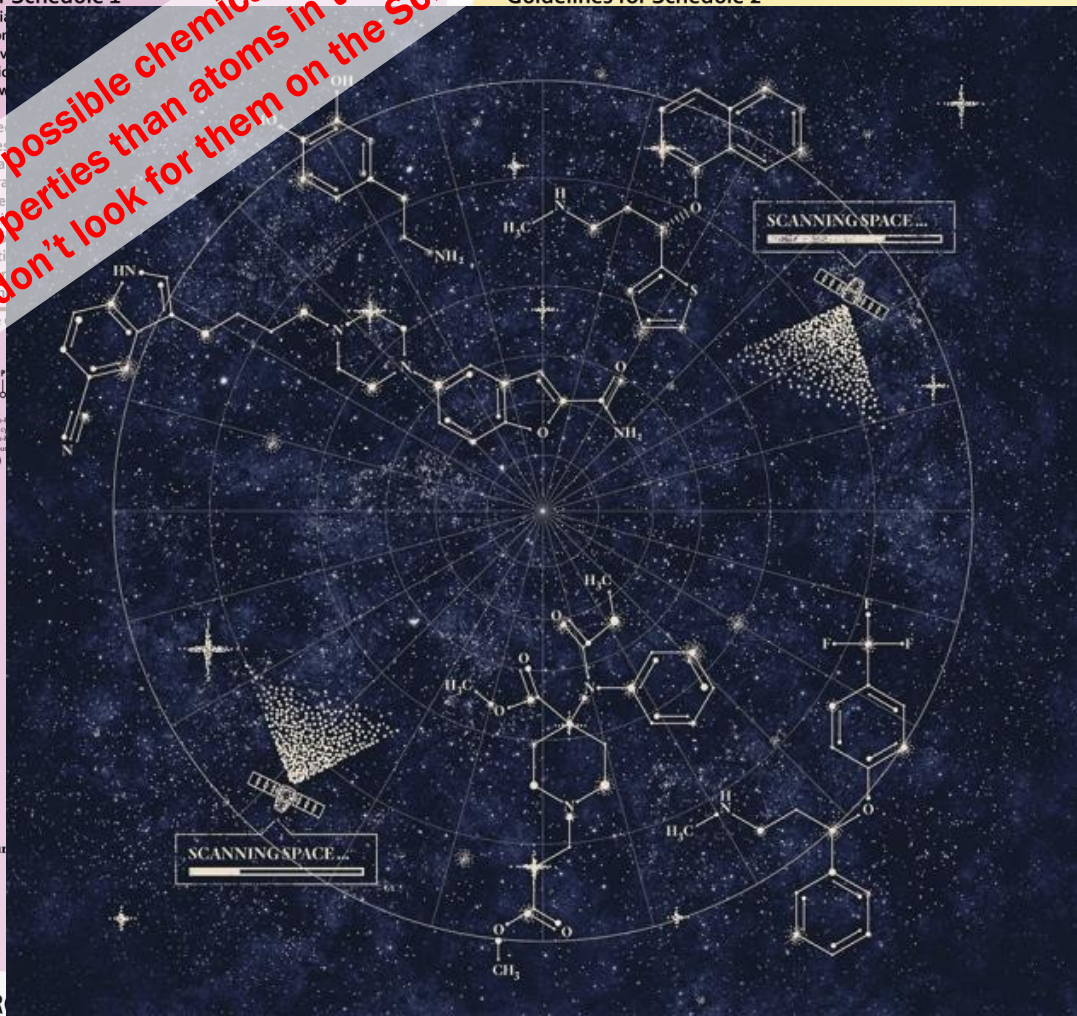
1A(4)
R1=Me, Et, n-Pr, i-Pr, R2=C, C, incl. cyanoalkyl
R3=Me, Et, n-Pr, i-Pr, R4=C, C, incl. cyanoalkyl
R5=Me, Et, n-Pr, i-Pr, R6=C, C, incl. cyanoalkyl
R7=Me, Et, n-Pr, i-Pr, R8=C, C, incl. cyanoalkyl
 eg. VX

1A(5)
R1=Me, Et, n-Pr, i-Pr, R2=C, C, incl. cyanoalkyl
R3=Me, Et, n-Pr, i-Pr, R4=C, C, incl. cyanoalkyl
R5=Me, Et, n-Pr, i-Pr, R6=C, C, incl. cyanoalkyl
R7=Me, Et, n-Pr, i-Pr, R8=C, C, incl. cyanoalkyl
R9=Me, Et, n-Pr, i-Pr, R10=C, C, incl. cyanoalkyl
 eg. VX

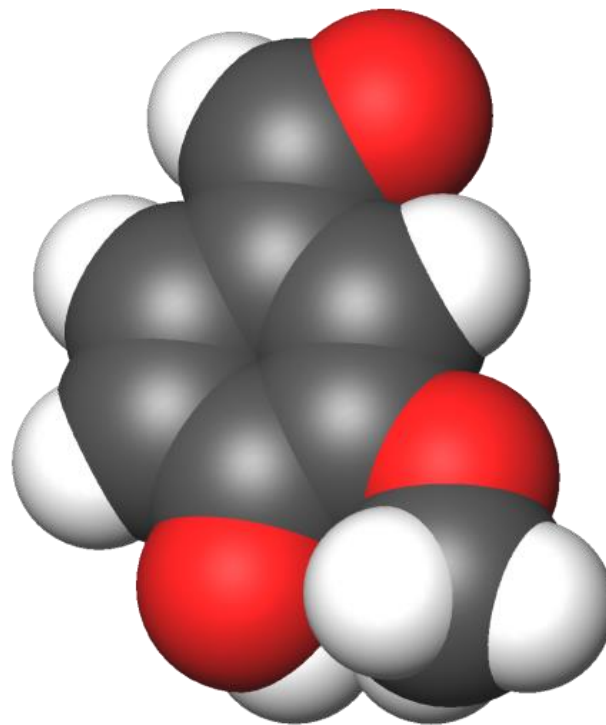
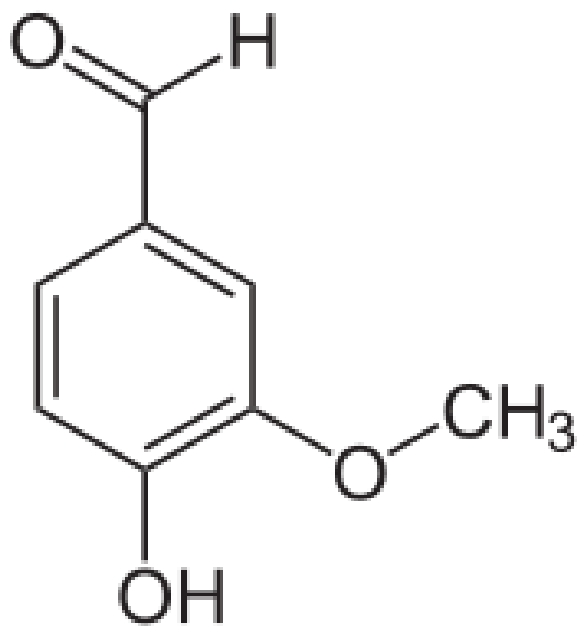
1A(7)
R1=Me, Et, n-Pr, i-Pr, R2=C, C, incl. cyanoalkyl
R3=Me, Et, n-Pr, i-Pr, R4=C, C, incl. cyanoalkyl
R5=Me, Et, n-Pr, i-Pr, R6=C, C, incl. cyanoalkyl
R7=Me, Et, n-Pr, i-Pr, R8=C, C, incl. cyanoalkyl
R9=Me, Et, n-Pr, i-Pr, R10=C, C, incl. cyanoalkyl
R11=Me, Et, n-Pr, i-Pr, R12=C, C, incl. cyanoalkyl
R13=Me, Et, n-Pr, i-Pr, R14=C, C, incl. cyanoalkyl
R15=Me, Et, n-Pr, i-Pr, R16=C, C, incl. cyanoalkyl
R17=Me, Et, n-Pr, i-Pr, R18=C, C, incl. cyanoalkyl
R19=Me, Et, n-Pr, i-Pr, R20=C, C, incl. cyanoalkyl
 eg. VX

Schedule 1 Part B

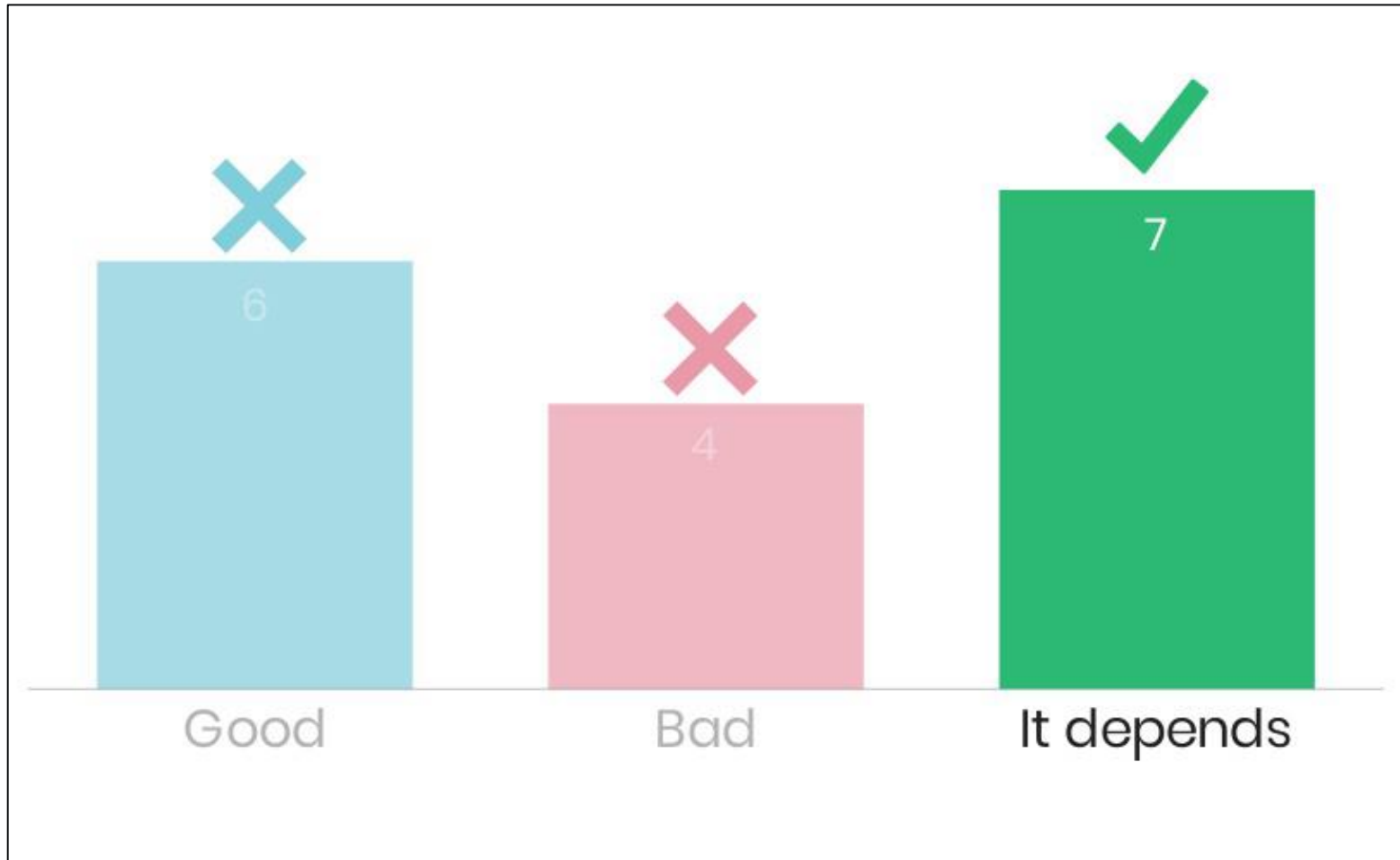
1B(9)
R1=Me, Et, n-Pr, i-Pr, R2=C, C, incl. cyanoalkyl
R3=Me, Et, n-Pr, i-Pr, R4=C, C, incl. cyanoalkyl
R5=Me, Et, n-Pr, i-Pr, R6=C, C, incl. cyanoalkyl
R7=Me, Et, n-Pr, i-Pr, R8=C, C, incl. cyanoalkyl
R9=Me, Et, n-Pr, i-Pr, R10=C, C, incl. cyanoalkyl
R11=Me, Et, n-Pr, i-Pr, R12=C, C, incl. cyanoalkyl
R13=Me, Et, n-Pr, i-Pr, R14=C, C, incl. cyanoalkyl
R15=Me, Et, n-Pr, i-Pr, R16=C, C, incl. cyanoalkyl
R17=Me, Et, n-Pr, i-Pr, R18=C, C, incl. cyanoalkyl
R19=Me, Et, n-Pr, i-Pr, R20=C, C, incl. cyanoalkyl
R21=Me, Et, n-Pr, i-Pr, R22=C, C, incl. cyanoalkyl
R23=Me, Et, n-Pr, i-Pr, R24=C, C, incl. cyanoalkyl
R25=Me, Et, n-Pr, i-Pr, R26=C, C, incl. cyanoalkyl
R27=Me, Et, n-Pr, i-Pr, R28=C, C, incl. cyanoalkyl
R29=Me, Et, n-Pr, i-Pr, R30=C, C, incl. cyanoalkyl
R31=Me, Et, n-Pr, i-Pr, R32=C, C, incl. cyanoalkyl
R33=Me, Et, n-Pr, i-Pr, R34=C, C, incl. cyanoalkyl
R35=Me, Et, n-Pr, i-Pr, R36=C, C, incl. cyanoalkyl
R37=Me, Et, n-Pr, i-Pr, R38=C, C, incl. cyanoalkyl
R39=Me, Et, n-Pr, i-Pr, R40=C, C, incl. cyanoalkyl
R41=Me, Et, n-Pr, i-Pr, R42=C, C, incl. cyanoalkyl
R43=Me, Et, n-Pr, i-Pr, R44=C, C, incl. cyanoalkyl
R45=Me, Et, n-Pr, i-Pr, R46=C, C, incl. cyanoalkyl
R47=Me, Et, n-Pr, i-Pr, R48=C, C, incl. cyanoalkyl
R49=Me, Et, n-Pr, i-Pr, R50=C, C, incl. cyanoalkyl
R51=Me, Et, n-Pr, i-Pr, R52=C, C, incl. cyanoalkyl
R53=Me, Et, n-Pr, i-Pr, R54=C, C, incl. cyanoalkyl
R55=Me, Et, n-Pr, i-Pr, R56=C, C, incl. cyanoalkyl
R57=Me, Et, n-Pr, i-Pr, R58=C, C, incl. cyanoalkyl
R59=Me, Et, n-Pr, i-Pr, R60=C, C, incl. cyanoalkyl
R61=Me, Et, n-Pr, i-Pr, R62=C, C, incl. cyanoalkyl
R63=Me, Et, n-Pr, i-Pr, R64=C, C, incl. cyanoalkyl
R65=Me, Et, n-Pr, i-Pr, R66=C, C, incl. cyanoalkyl
R67=Me, Et, n-Pr, i-Pr, R68=C, C, incl. cyanoalkyl
R69=Me, Et, n-Pr, i-Pr, R70=C, C, incl. cyanoalkyl
R71=Me, Et, n-Pr, i-Pr, R72=C, C, incl. cyanoalkyl
R73=Me, Et, n-Pr, i-Pr, R74=C, C, incl. cyanoalkyl
R75=Me, Et, n-Pr, i-Pr, R76=C, C, incl. cyanoalkyl
R77=Me, Et, n-Pr, i-Pr, R78=C, C, incl. cyanoalkyl
R79=Me, Et, n-Pr, i-Pr, R80=C, C, incl. cyanoalkyl
R81=Me, Et, n-Pr, i-Pr, R82=C, C, incl. cyanoalkyl
R83=Me, Et, n-Pr, i-Pr, R84=C, C, incl. cyanoalkyl
R85=Me, Et, n-Pr, i-Pr, R86=C, C, incl. cyanoalkyl
R87=Me, Et, n-Pr, i-Pr, R88=C, C, incl. cyanoalkyl
R89=Me, Et, n-Pr, i-Pr, R90=C, C, incl. cyanoalkyl
R91=Me, Et, n-Pr, i-Pr, R92=C, C, incl. cyanoalkyl
R93=Me, Et, n-Pr, i-Pr, R94=C, C, incl. cyanoalkyl
R95=Me, Et, n-Pr, i-Pr, R96=C, C, incl. cyanoalkyl
R97=Me, Et, n-Pr, i-Pr, R98=C, C, incl. cyanoalkyl
R99=Me, Et, n-Pr, i-Pr, R100=C, C, incl. cyanoalkyl



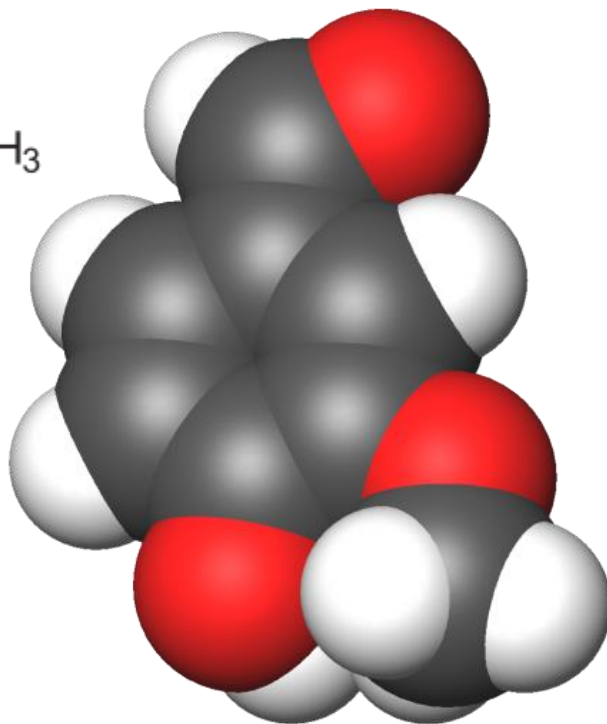
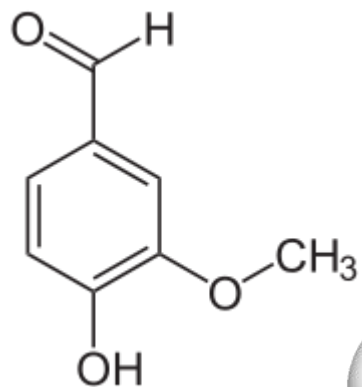
“Good” Chemical or “Bad” Chemical?



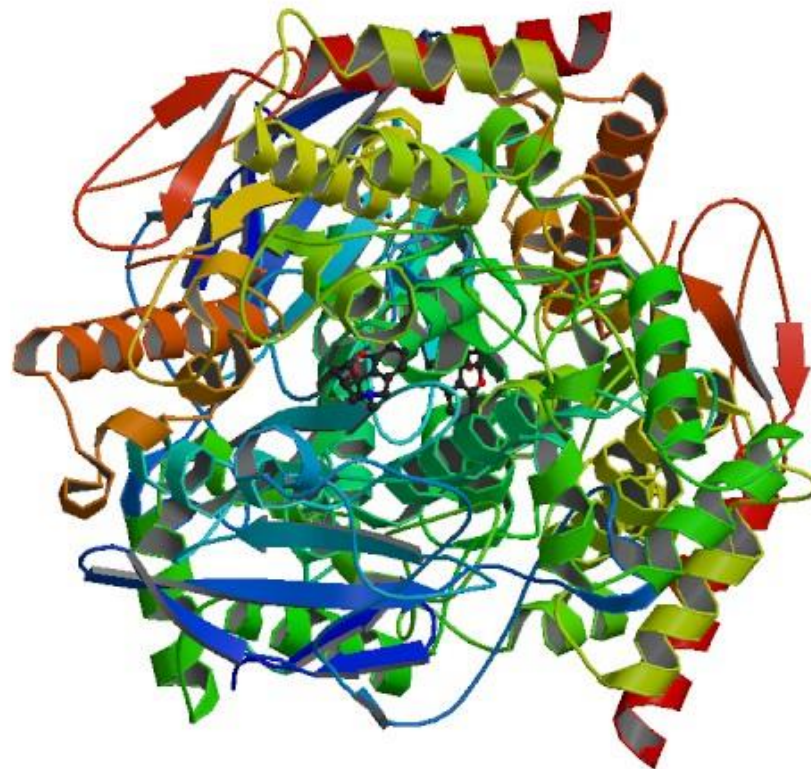
“Good” Chemical or “Bad” Chemical? (response from audience)



“Good” Chemical or “Bad” Chemical?



“Good” Biological or “Bad” Biological?



OPCW

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



“Good” Biological or “Bad” Biological?

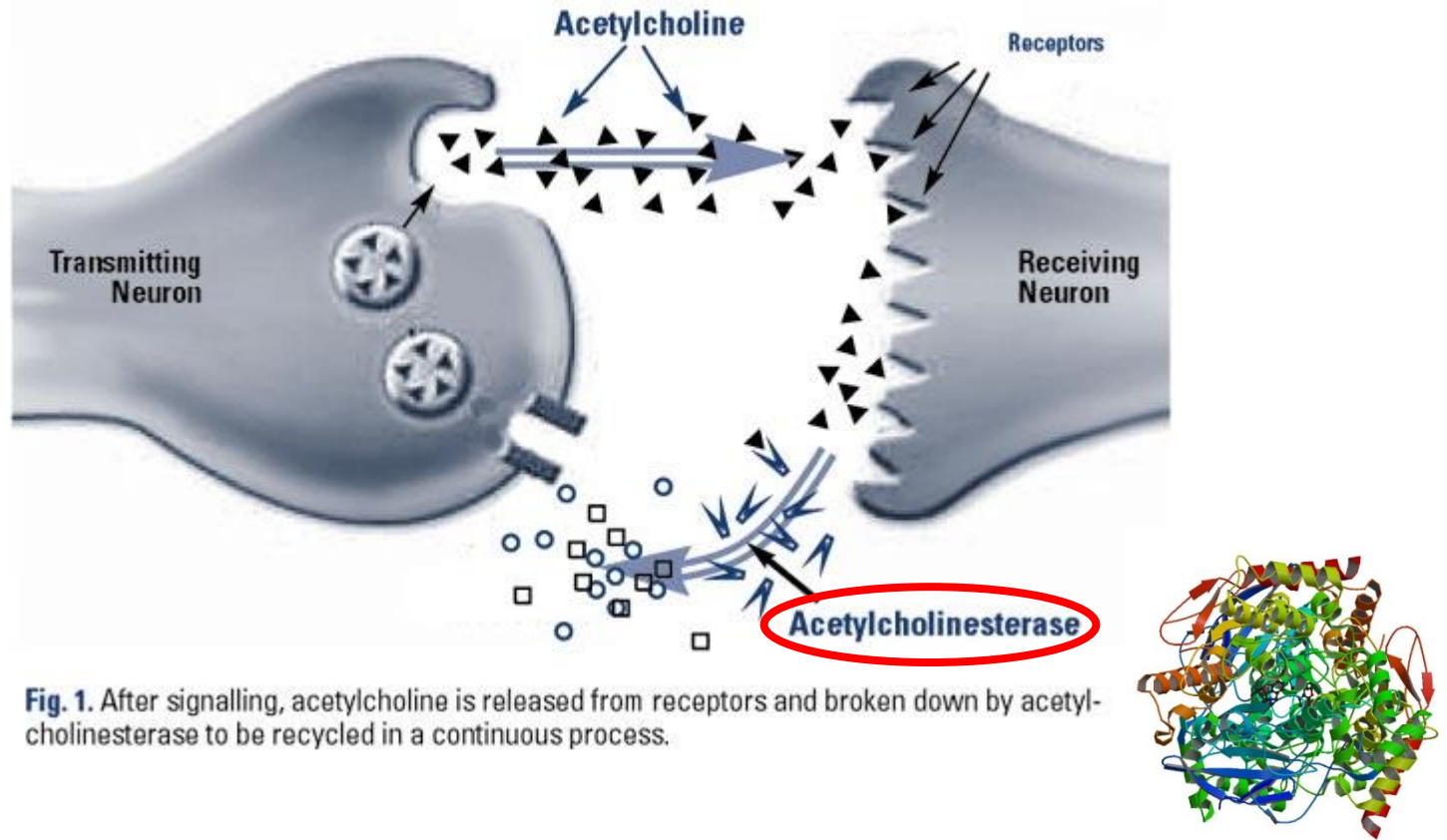
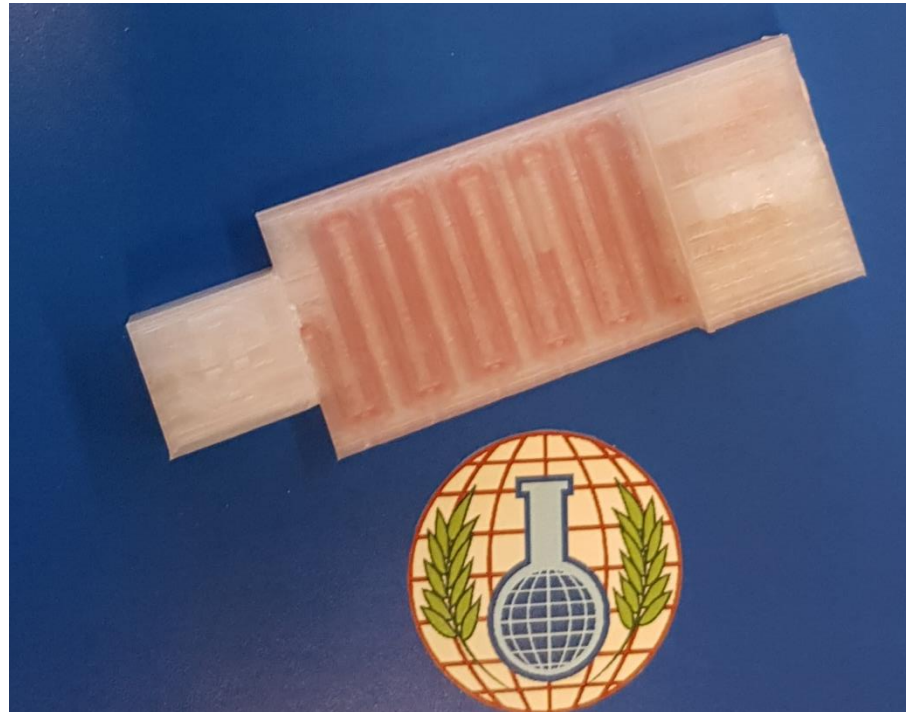


Fig. 1. After signalling, acetylcholine is released from receptors and broken down by acetylcholinesterase to be recycled in a continuous process.

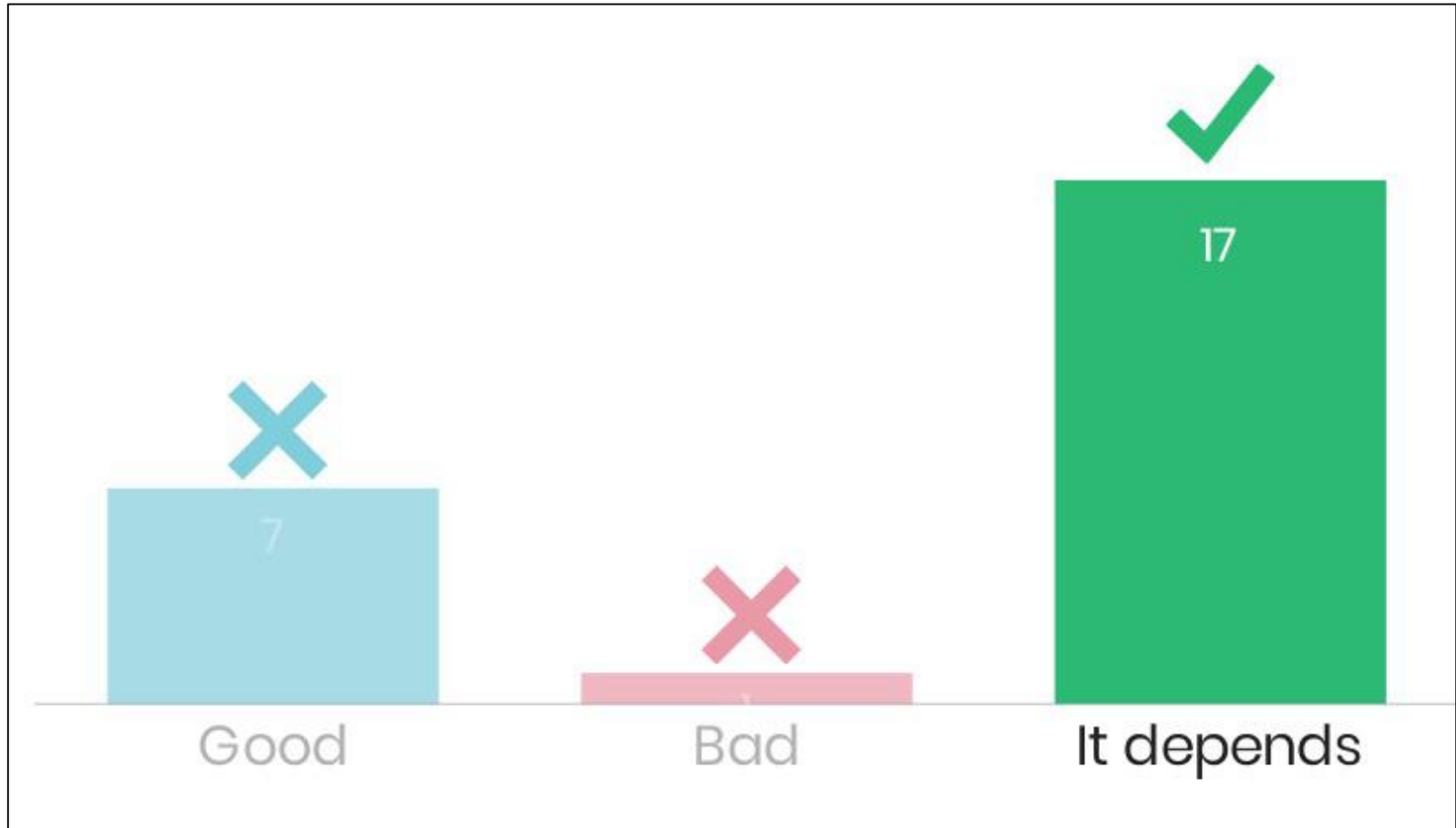


“Good” Device or “Bad” Device?



OPCW

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

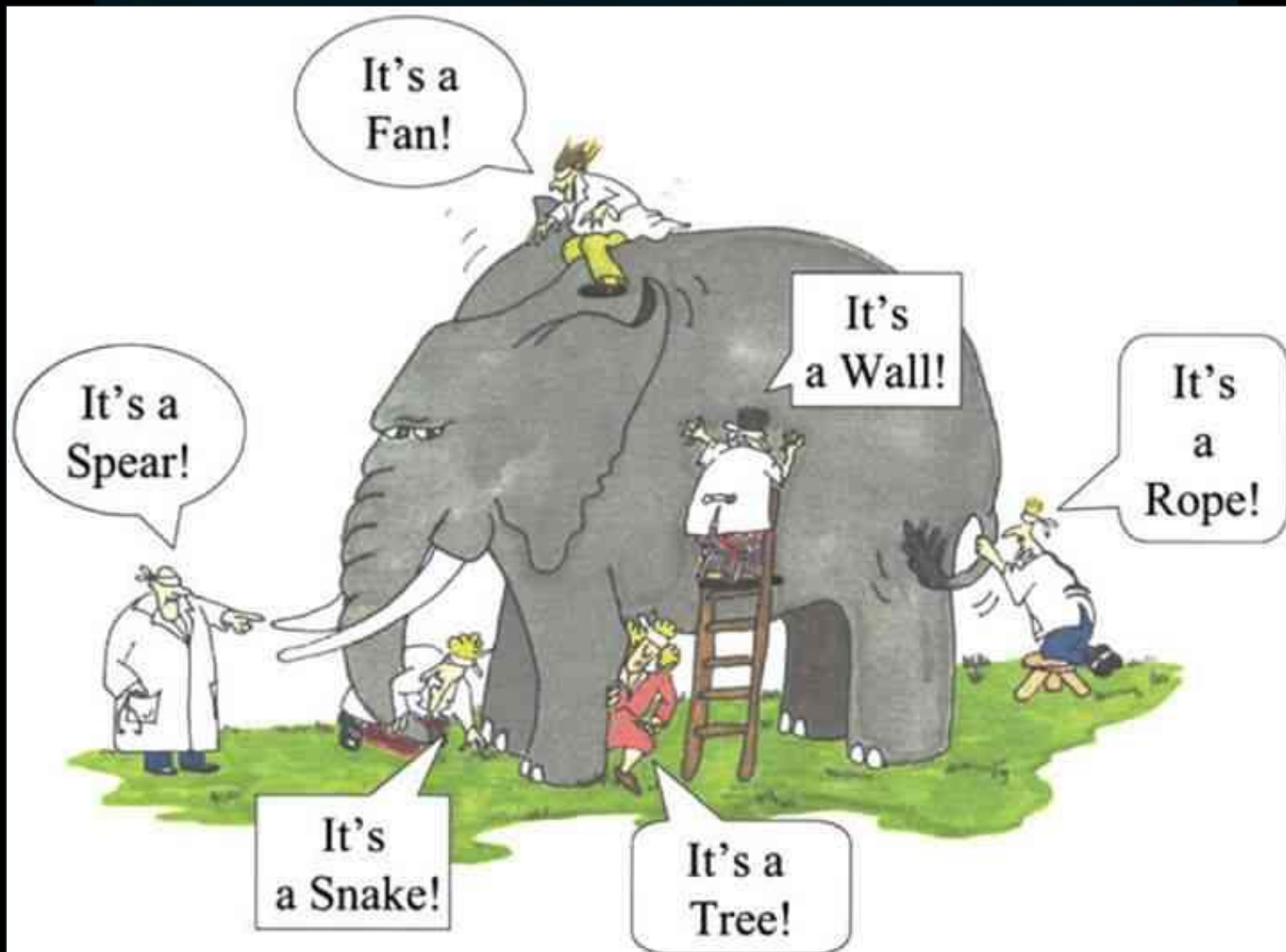


Are You
Afraid Yet?
The Science Behind SCARY STUFF



Written by **Stephen James O'Meara**

Illustrated by **Jeremy Kaposy**



It's a Fan!

It's a Snake!

It's a Wall!

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



It's a
Spear!

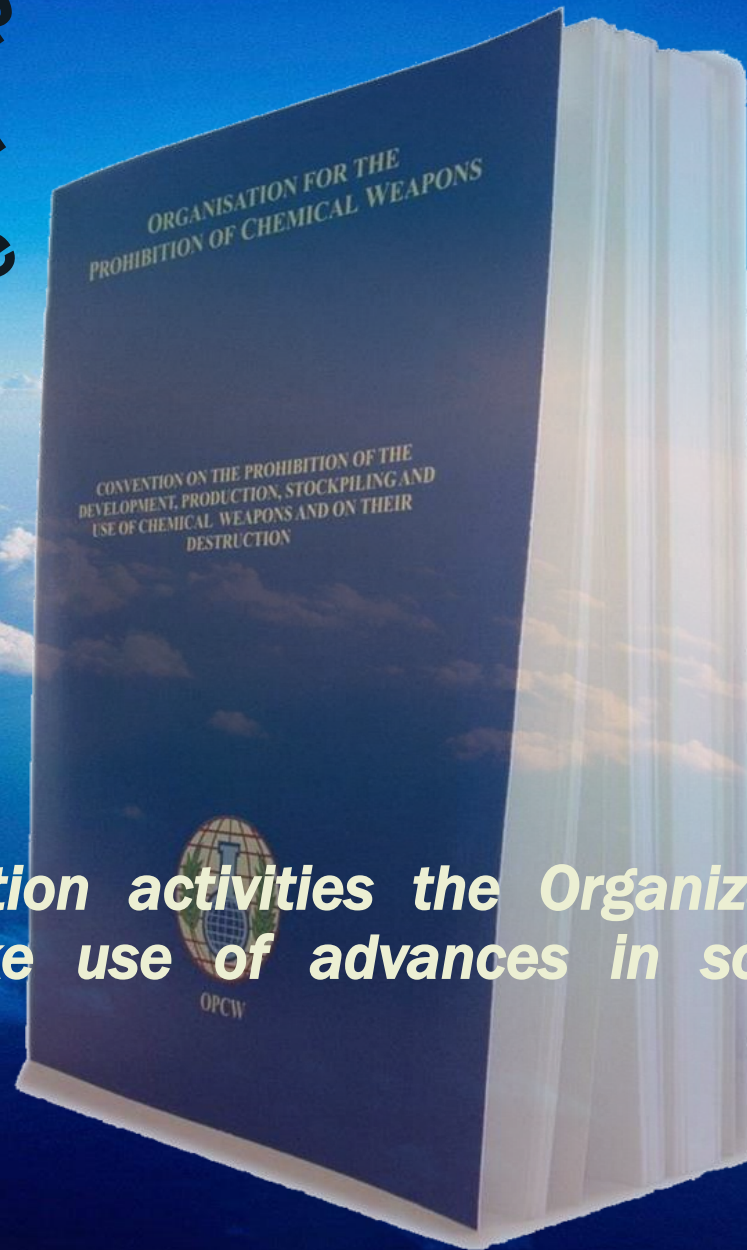


It's
a
Rope!



**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**

Too mu
Need sci
recogn
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"In undertak
consider m
technology"

- CWC Article VIII, paragraph 6



Organization shall
science and

Too many
Need some
recognition

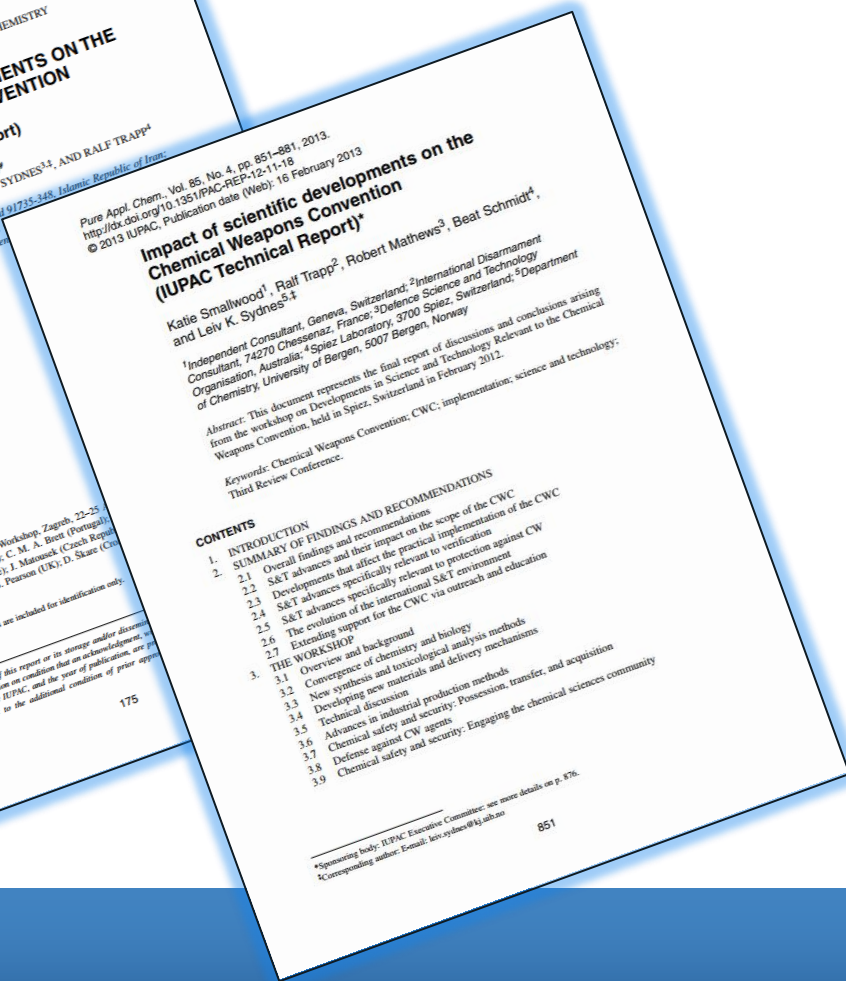
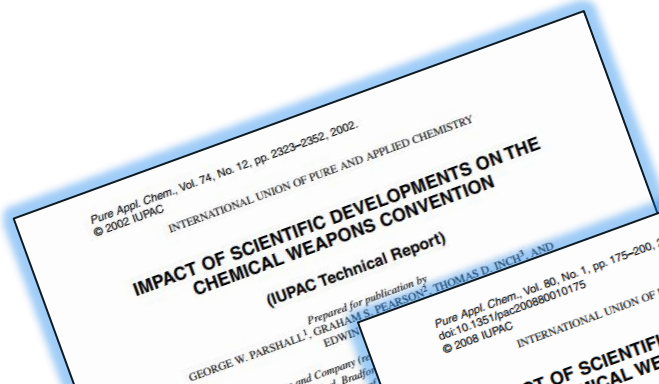
"In under
consider
technology

- CWC Ar



shall
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In the Lead Up To Previous Review Conferences



INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY




OPCW

Toward The Fourth Review Conference: Find a Tricorder!

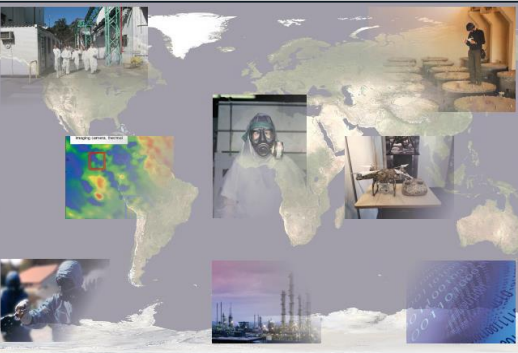
CONVERGENCE OF CHEMISTRY AND BIOLOGY

REPORT OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP

JUNE 2014




ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS




VERIFICATION

REPORT OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP

June 2015




ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS



EDUCATION AND ENGAGEMENT:
Promoting a Culture of Responsible Chemistry

FINAL REPORT OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP

NOVEMBER 2014



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Toward The Fourth Review Conference: Find a Tricorder!



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



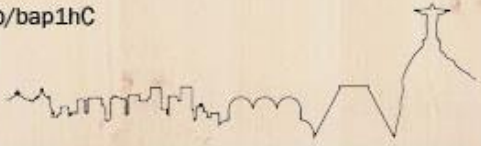
Chemical Warfare Agents: Toxicity, Emergency Response and Medical Countermeasures

Paris, France. 26 to 27 September 2016
 SAB-24/WP.2, dated 14 October 2016, URL: <http://q-r.to/bap1h4>
 Coorganizer:



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:



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:



Twenty-first Session
 23 - 27 June 2016



as
 of an
 stric-
 saion,
 psatin,
 phenone,
 imetane,
 me. Their
 appear in

the Parties as a
 17/2014, dated
 1 May 2014, estab-
 lished by the SAB
 (Appendix 5) might
 also be provided as
 a reference to the
 criteria of an RCA
 (and thus should
 not be declared as
 an RCA).

1.4 The list of 17 RCAs (Appendix 4) is the point of reference in support of the criteria of an RCA (and thus should not be declared as an RCA).

1.5 This original list of 59 has been reviewed and an additional chemical (pipazine) that meets the inclusion criteria was identified. This chemical does not meet the definition of an RCA and is included at the end of the table of Appendix 5.

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/bap1ey>
Coorganizer: VERIFIN



Chemical Weapons Convention Intermeasures
Paris, France. 20 to 22 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. 20 to 25 July 2017
SAB-26/WP.1, dated 14 July 2017, URL: <http://q-r.to/bap1hd>
Coorganizers: IUPAC, The National Academies of Sciences, Engineering and Medicine

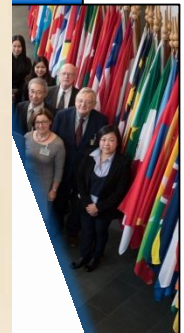


International Workshop on Chemical Security
Zagreb, the Republic of Croatia. 3 to 5 October 2017
SAB-26/WP.2, dated 19 October 2017, URL: <http://q-r.to/bap1hd>
Coorganizers: Zagreb, Ministry of Economy



25 Events
676 Attendees
405 Speakers
30 Reports

- 256 individuals
- 56 Nationalities
- 191 individuals
- 56 Nationalities



OPCW

(b) What are
aforementioned by
CS-2016-978(E) downloaded 26/05/2016

chem-
Appendix 4.
1.4 The list of 17 RCAs (Appendix 4) is the list of reference in support of the point of reference in paragraph 1 of the preamble to the Convention (the 'reference list') as of 1 May 2014. The additional 42 reference RCAs (Appendix 5) might also be provided as a reference list for the criteria of an RCA (and thus should not be declared as an RCA).
1.5 This original list of 59 has been reviewed and an additional chemical (pipazine) that meets the inclusion criteria was identified. This chemical does not meet the definition of an RCA and is included at the end of the table of Appendix 5.

Available at www.opcw.org/information/CWC_YA_enr201606b-117-2014_e_01

Presentation by Dr Christopher Timperley



OPCW

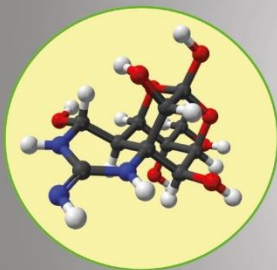
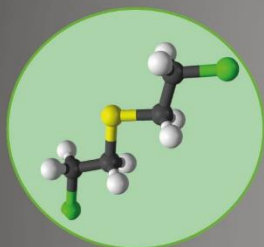


Science for Diplomats at EC-87

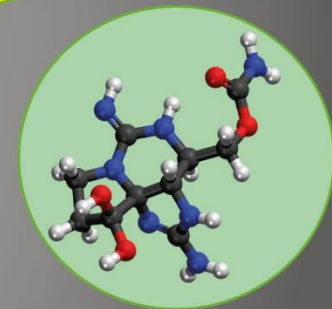
Science, Technology and the Chemical Weapons Convention:

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)

2017

MAJOR CHEMICAL WEAPONS ZERO MILESTONE:

95 PER CENT OF CHEMICAL WEAPONS
DECLARED BY POSSESSOR STATES
DESTROYED

Photo: U.S. Army



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



VERIFICATION

REPORT OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP

June 2015



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS



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, "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 Conference⁴ 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.
- 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

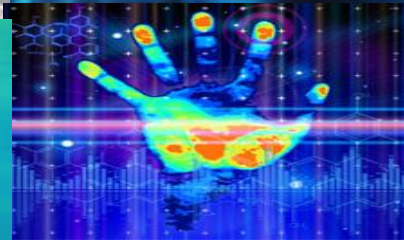
¹ Funding for the workshop was provided in part through project III (Science and Technology Assessment of Developments in Science and Technology) of the Central Decision (CFSP) 2015/259 dated 17 February 2015. <http://eu-lex.europa.eu/legal-content/EN/TXT/summary/?uri=CELEX:32015D0210:0114:01.ENG>

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 2016). Available at www.opcw.org/fileadmin/OPCW/SAB/wp/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 ANZFSI International Symposium on the forensic sciences, Sydney 2010. *Australian Journal of Forensic Sciences*, 2011, 43:2-3, 89-103. <http://www.tandfonline.com/doi/10.431-3>

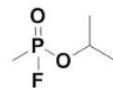
⁵ C. Roux, F. Crignone, O. Ribaux. *Current Issues in Criminal Justice*, 2012, 24(1), 7-24. <http://www.austlii.edu.au/au/other/LLS/australiainst/2012/16.pdf>



Medical countermeasures and emergency response



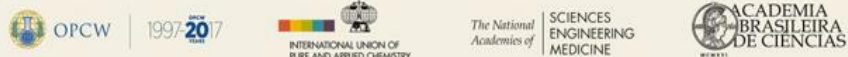
Tabun (GA)



Sarin (GB)



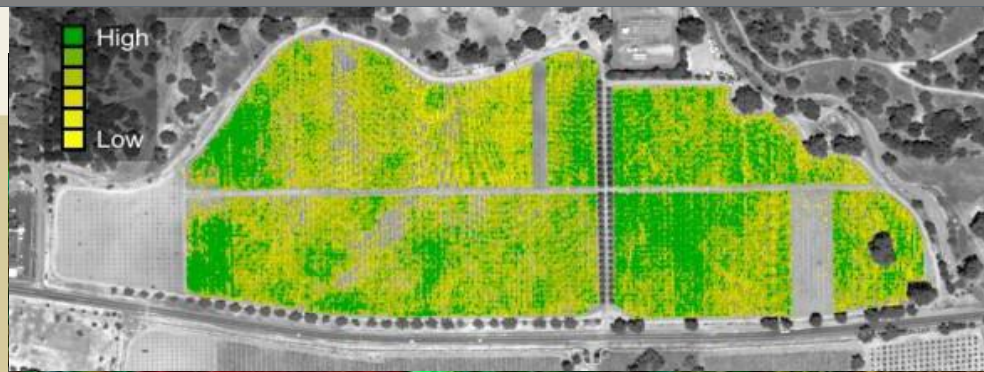
Innovative technologies for chemical security



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

INTERNATIONAL WORKSHOP ON INNOVATIVE TECHNOLOGIES FOR CHEMICAL SECURITY

Science for Peace
#ScienceforPeace



ORGANISATION FOR
THE PROHIBITION OF
CHEMICAL WEAPONS
WWW.OPCW.ORG



INTERNATIONAL UNION
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APPLIED CHEMISTRY
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THE NATIONAL ACADEMIES
OF SCIENCES, ENGINEERING,
AND MEDICINE
WWW.NATIONALACADEMIES.ORG



BRAZILIAN ACADEMY
OF SCIENCES
WWW.ABC.ORG.BR



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. PARSHALL¹, GRAHAM S. PEARSON², THOMAS D. INCH³, AND EDWIN D. BECKER⁴

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

Pure Appl. Chem., Vol. 80, No. 1, pp. 175-200, 2008.
doi:10.1351/pac20080010175
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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-MOOD¹, PIETER S. STEYN², LEIV K. SYDNES^{3,4}, AND RALF TRAPP⁴

¹Medical Toxicology Centre, Imam Reza Hospital, Mashhad 91725-348, Islamic Republic of Iran; ²University of Stellenbosch, Matieland, 7602, South Africa; ³Department of Chemistry, University of Bergen, 5007 Bergen, Norway; ⁴International 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 Smallwood¹, Ralf Trapp², Robert Mathews³, Beat Schmidt⁴, and Leiv K. Sydnès^{5,4}

¹Independent Consultant, Geneva, Switzerland; ²International Disarmament Consultant, 74270 Chessenaz, France; ³Defence Science and Technology Organisation, Australia; ⁴Spiez Laboratory, 3700 Spiez, Switzerland; ⁵Department 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

1. INTRODUCTION
2. SUMMARY OF FINDINGS AND RECOMMENDATIONS
 - 2.1 Overall findings and their impact on the scope of the CWC
 - 2.2 S&T advances that affect the practical implementation of the CWC
 - 2.3 Developments that affect the practical implementation of the CWC
 - 2.4 S&T advances specifically relevant to protection against CW
 - 2.5 The evolution of the international S&T environment
 - 2.6 Extending support for the CWC via outreach and education
3. THE WORKSHOP
 - 3.1 Overview and background
 - 3.2 Convergence of chemistry and biology
 - 3.3 New synthesis and toxicological analysis methods
 - 3.4 Developing new materials and delivery mechanisms
 - 3.5 Technical discussion
 - 3.6 Advances in industrial production methods
 - 3.7 Chemical safety and security: Possession, transfer, and acquisition
 - 3.8 Defense against CW agents
 - 3.9 Chemical safety and security: Engaging the chemical sciences community

International Advisory Board: IUPAC Workshop, Bergen, 2012 (UK): Wataru Ando (Japan); Joseph F. Bunnett (USA); Wil Chen (China); Rita Corradi (Belgium); Claude Eon (France); Folke Ingman (Sweden); Detlef Munnig (Germany); Boris Myasodov (Russia); Norma S. Noldman (France); John Ralston (Australia); M. M. Sharma (India); Thomas Y. Taitwell (Canada).

[#]Institutional affiliations of all authors included for identification only.
^{*}Corresponding author

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International Advisory Board: IUPAC Workshop, Zagreb, 2008 (C. Bai (China); M. Balali-Mood (Iran); C. M. A. Brett (Portugal); M. Isobe (Japan); R. Lohinski (France); J. Matoszek (Czech Republic); G. W. Parshall (USA); G. S. Pearson (UK); D. Skarabec (Slovenia); L. F. Tetra (Germany)).

[#]Institutional affiliations of all authors included for identification only.
^{*}Corresponding author

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[#]Sponsoring body: IUPAC Executive Committee; see more details on p. 876.
^{*}Corresponding author: E-mail: leiv.sydnès@kj.uib.no

851

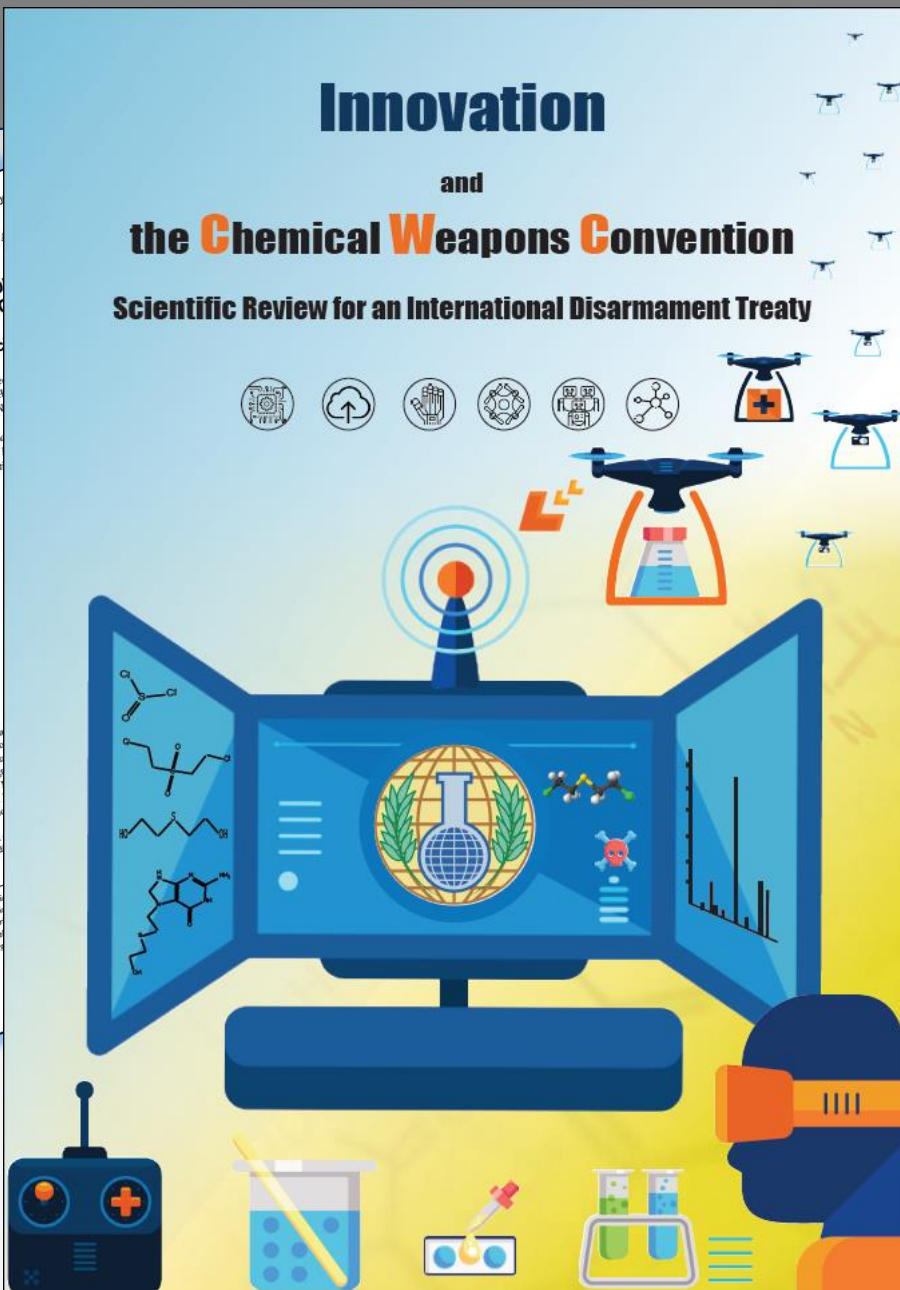


Innovation

and

the Chemical Weapons Convention

Scientific Review for an International Disarmament Treaty



Pure Appl. Chem., Vol. 74, No. 12, pp. 2323-2352, 2012
© 2012 IUPAC
INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

IMPACT OF SCIENTIFIC AND TECHNOLOGICAL INNOVATION ON THE CHEMICAL WEAPONS CONVENTION (IUPAC Technical Report)

Prepared by
GEORGE W. PARSHALL¹, GRAHAM J. HARRISON², and EDWARD J. MANNING³
¹E. I. DuPont de Nemours and Company, 1400 W. 12th St., Newark, DE 19711, USA
²Peace Studies, University of Bradford, Bradford, West Yorkshire, UK
³National Institute of Defence, Oslo, Norway

International Advisory Committee (UK: Warwick Academy of Science and Technology; China: Tsinghua University; France: Institut National de la Santé et de la Recherche Médicale; Norway: The Norwegian Institute of Science and Technology)

*Institutional
*Corresponding

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on the

ws³, Beat Schmidt⁴,

International Disarmament
Science and Technology
Spiez, Switzerland; ⁵Department
of Science and Technology,
Oslo, Norway

of discussions and conclusions arising
from the Scientific Review of the
Convention and Technology Relevant to the Chemical
Weapons Convention in February 2012.

1. C. implementation; science and technology;

RECOMMENDATIONS

the scope of the CWC
the implementation of the CWC
to verification
to protection against CW
and S&T environment
via outreach and education

and biology
logical analysis methods
and delivery mechanisms
production methods
security: Possession, transfer, and acquisition
agents
security: Engaging the chemical sciences community

Advisory Committee: see more details on p. 876.
Review Committee: see more details on p. 876.
IUPAC Secretariat: see more details on p. 876.

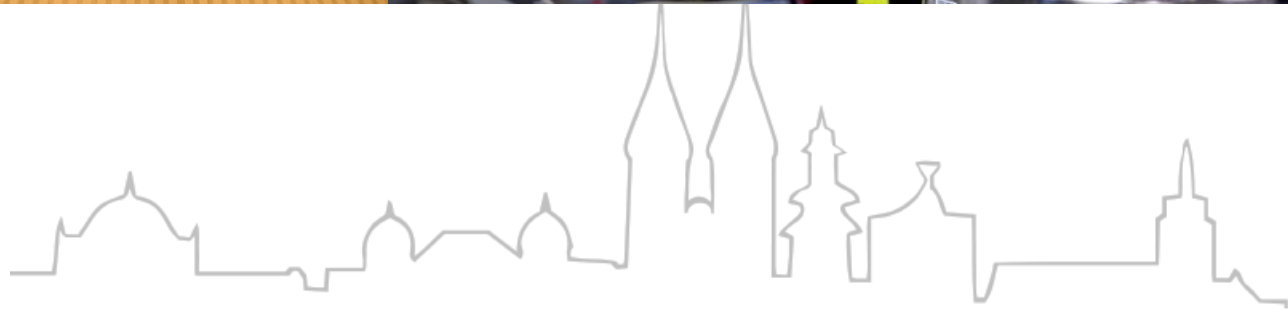


Trends in chemical production



Institut za
medicinska
istraživanja
i medicinu
rada

Institute
for Medical
Research and
Occupational
Health



Scheduled Chemicals under the Chemical Weapons Convention (CWC)

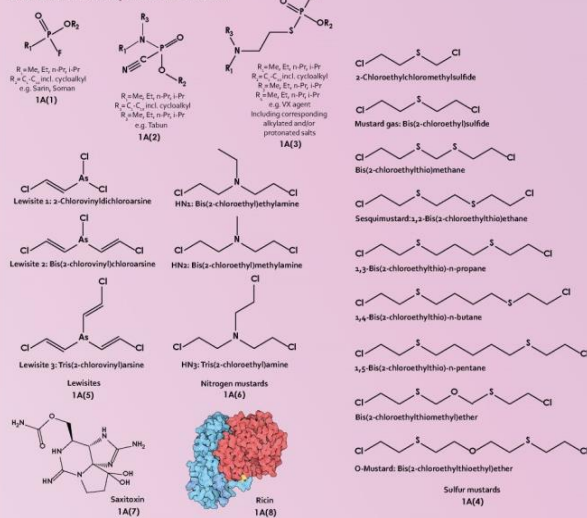
Schedule 1

Guidelines for Schedule 1

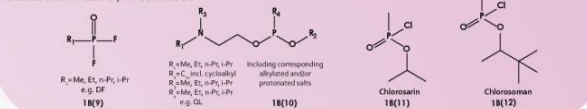
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

- It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article II;
- 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:
 - 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, comparable properties;
 - It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;
 - 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 otherwise;
- It has little or no use for purposes not prohibited under this Convention.

Schedule 1 Part A, Toxic Chemicals



Schedule 1 Part B, Precursors



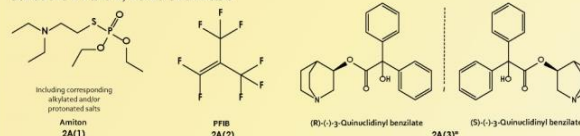
Schedule 2

Guidelines for Schedule 2

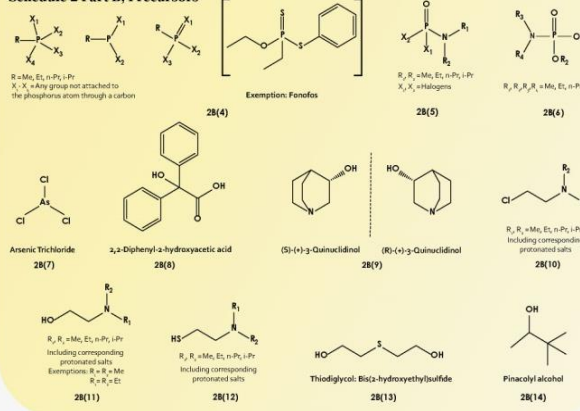
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:

- 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;
- 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;
- 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;
- It is not produced in large commercial quantities for purposes not prohibited under this Convention.

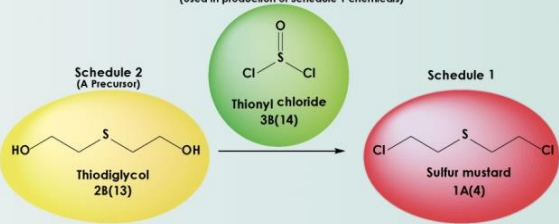
Schedule 2 Part A, Toxic Chemicals



Schedule 2 Part B, Precursors



Schedule 3 (Used in production of Schedule 1 chemicals)



Relationship between Schedules, illustrated with sulfur mustard.

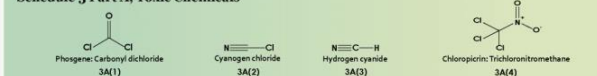
Schedule 3

Guidelines for Schedule 3

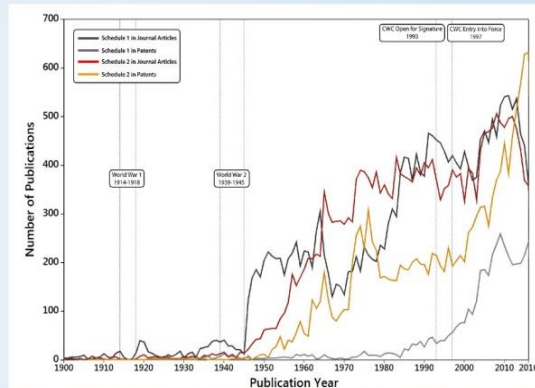
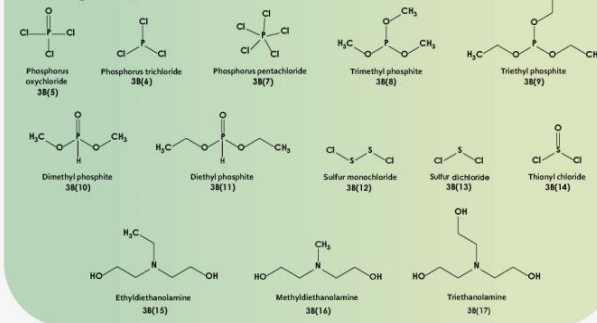
The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

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



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

Threat spectrum

Classical CW	Other chemicals	Bioregulators Peptides	Toxins	Genetically modified BW	Traditional BW
blister agents nerve agents toxic gases	Toxic industrial, pharmaceutical and agricultural chemicals CNS-active chemicals	substance P neurokinins	botulinum saxitoxin ricin	modified/tailored bacteria and viruses	bacteria viruses rikettsia anthrax plague tularemia
← Chemical agents →		← Agents of biological origin →			
← Poisons →		← Infectious Agents →			
← Chemical Weapons Convention (Article II) →			← Biological and Toxin Weapons Convention (Article I) →		

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

Threat spectrum

Classical CW	Other chemicals	Bioregulators Peptides	Toxins	Genetically modified BW	Traditional BW
<div style="border: 2px solid red; padding: 5px;"> blister agents nerve agents toxic gases </div>	Toxic industrial, pharmaceutical and agricultural chemicals CNS-active chemicals	substance P neurokinins	botulinum saxitoxin ricin	modified/tailored bacteria and viruses	bacteria viruses rickettsia anthrax plague tularemia
← Chemical agents →			← Agents of biological origin →		
← Poisons →		← Infectious Agents →			
← Chemical Weapons Convention (Article II) →			← Biological and Toxin Weapons Convention (Article I) →		

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Classical CW	Other chemicals	Bioregulators Peptides	Toxins	Genetically modified BW	Traditional BW
blister agents nerve agents toxic gases	Toxic industrial, pharmaceutical and agricultural chemicals <div style="border: 2px solid red; padding: 5px; display: inline-block;">CNS-active chemicals</div>	substance P neurokinins	botulinum saxitoxin ricin	modified/tailored bacteria and viruses	bacteria viruses rickettsia anthrax plague tularemia
← Chemical agents →		← Agents of biological origin →			
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Threat spectrum

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← Chemical agents →		← Agents of biological origin →			
← Poisons →		← Infectious Agents →			

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 any 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

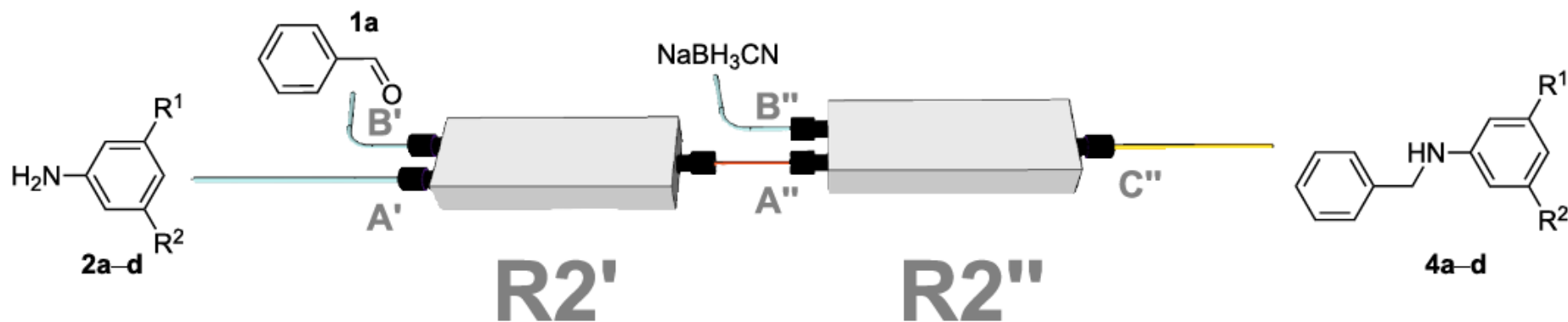
© Filinvest

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.

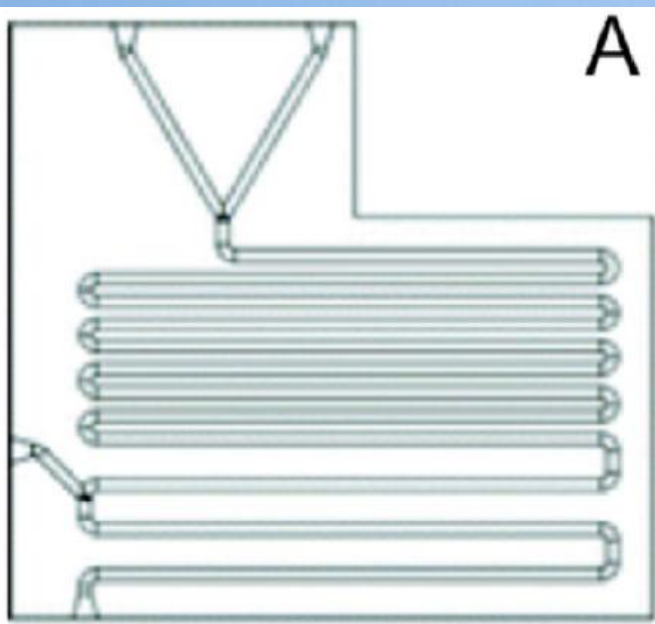


3D printing

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.

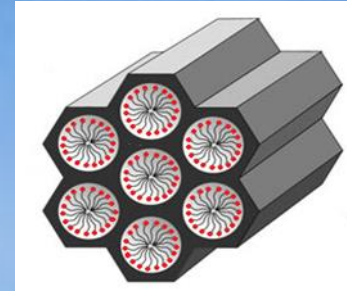
Bethany C. Gross, Jayda L. Erkal, Sarah Y. Lockwood, Chengpeng Chen, and Dana M. Spence*



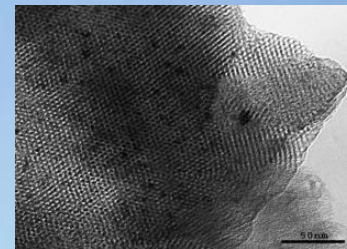
Copyright 2013 American Chemical Society

Nanotechnology

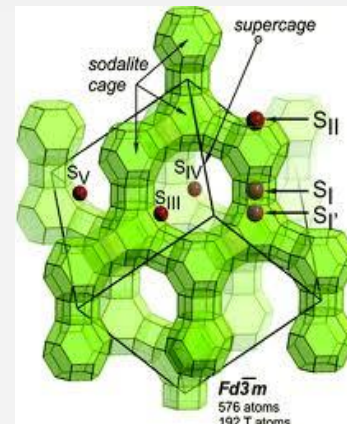
Nanotechnology has enabled advances in detection technology by incorporation of antibody or enzyme sensing elements that might be used for on-site inspections



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

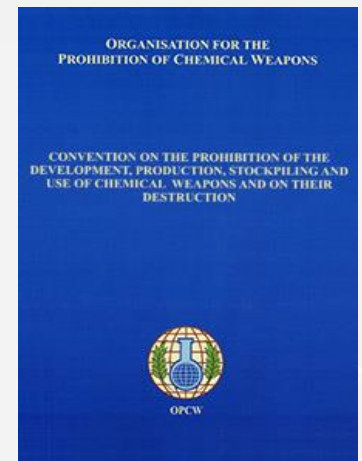
Schedules

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



rest

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.

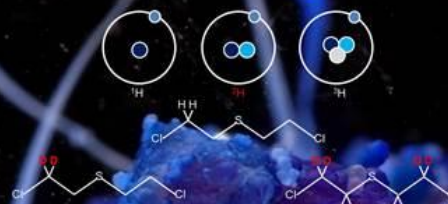
2. OBJECTIVE

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].

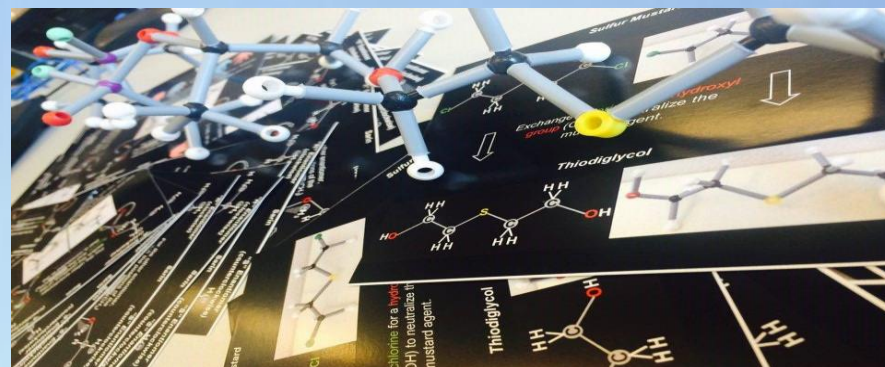
SCIENCE FOR DIPLOMATS

ISOTOPIC LABELS, STEREOISOMERS, & SCHEDULED CHEMICALS

WHY DOES THIS MATTER? A REVIEW OF THE SAB'S ADVICE



WEDNESDAY 13 JULY 2016
13:30-15:00
OOMS ROOM
LIGHT LUNCH PROVIDED AT 13:00



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



erest

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

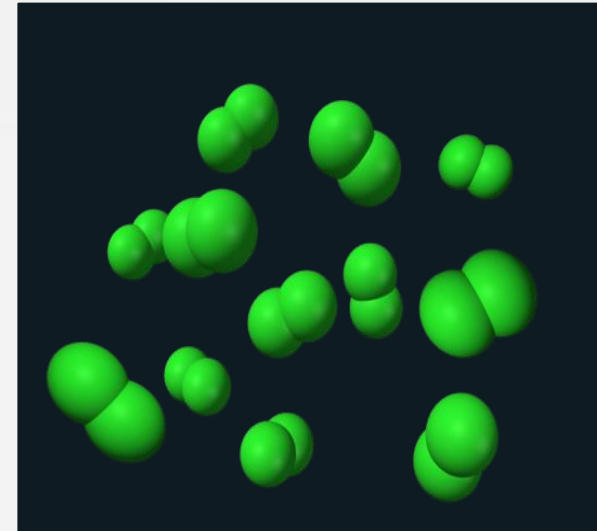
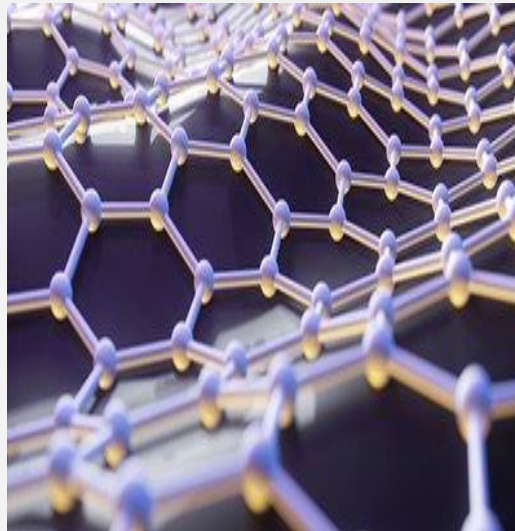


Protection

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



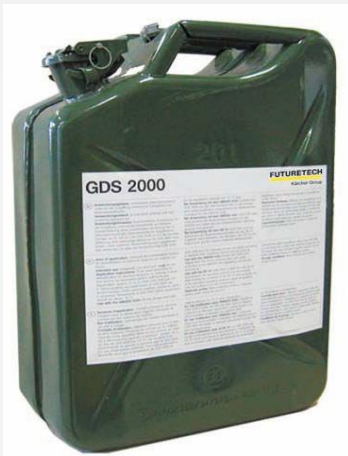
Decontamination

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

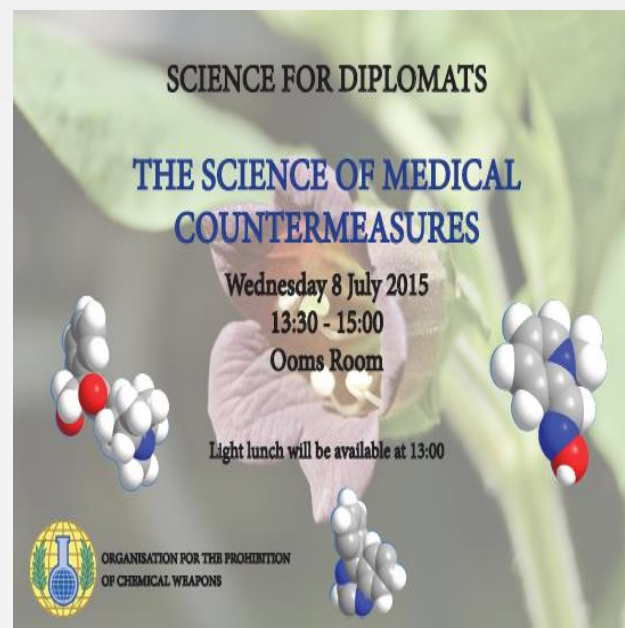
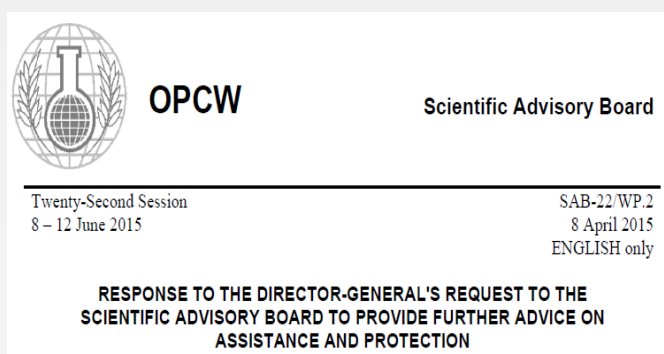
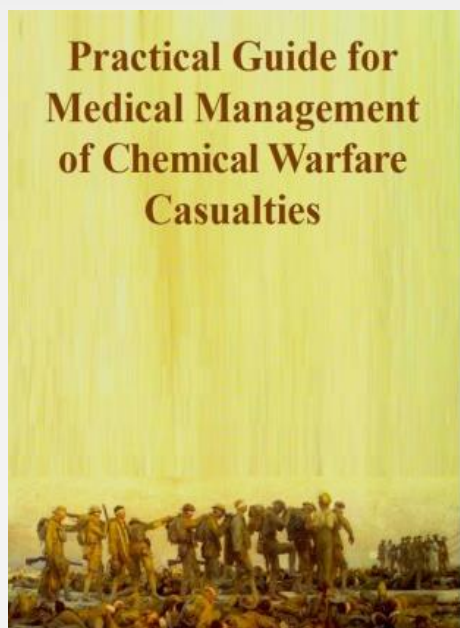


rest

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



Riot control agents (RCAs)

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

Only 17 met CWC-definition of RCA

Science for Diplomats at EC-84
What Defines a Riot Control Agent?

Come activate your **TRP receptors!**
and learn about the biochemistry of **Riot Control Agents!**

Wednesday, 8 March 2017
Ooms Room | 13.30-14.45
Light lunch available at 13.00

OPCW

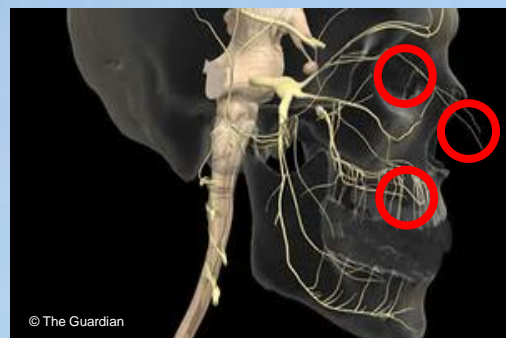
Sauce	Impact	Persistence
Chinese Hot Chili	High	Low
Chinese Yellow Chili	High	Low
Japanese Wasabi	High	Low
Mexican Black Mustard	High	Low
Pea-Soy	High	Low
Red Hot Chili Sauce	High	Low
Sriracha	High	Low
Yuzufruit	High	Low
Wasabi-Like	High	Low
Wasabi-Yeast	High	Low

Science for Diplomats at EC-84
What Defines a Riot Control Agent?

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Wednesday, 8 March 2017
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OPCW



The Scientific Advisory Board and Riot Control Agents

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>

Science for Diplomats at EC-84 on Riot Control Agents
URL: <https://q-r.to/bapS7f>

Guide to Schedule Chemical Poster
URL: <https://q-r.to/bapSCK>

Riot Control Agents Poster
URL: <https://q-r.to/bapSCG>

Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 3
Schedule 3 Part A: Toxic Chemicals

Chemical	SMILES	Chemical Name
1	<chem>CC(=O)N</chem>	Acetamide
2	<chem>CC(=O)O</chem>	Acetic acid
3	<chem>CC(=O)OC</chem>	Acetic anhydride
4	<chem>CC(=O)OC(=O)C</chem>	Acetic acid diethyl ester
5	<chem>CC(=O)OC(=O)OC</chem>	Acetic acid diisopropyl ester
6	<chem>CC(=O)OC(=O)OC(=O)C</chem>	Acetic acid diisobutyl ester
7	<chem>CC(=O)OC(=O)OC(=O)OC</chem>	Acetic acid dibutyl ester
8	<chem>CC(=O)OC(=O)OC(=O)OC(=O)C</chem>	Acetic acid dihexyl ester
9	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC</chem>	Acetic acid dioctyl ester
10	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)C</chem>	Acetic acid dodecyl ester
11	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC</chem>	Acetic acid dodecyl ester
12	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)C</chem>	Acetic acid dodecyl ester
13	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC</chem>	Acetic acid dodecyl ester
14	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)C</chem>	Acetic acid dodecyl ester
15	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC</chem>	Acetic acid dodecyl ester
16	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)C</chem>	Acetic acid dodecyl ester
17	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC</chem>	Acetic acid dodecyl ester
18	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)C</chem>	Acetic acid dodecyl ester
19	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC</chem>	Acetic acid dodecyl ester
20	<chem>CC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)OC(=O)C</chem>	Acetic acid dodecyl ester

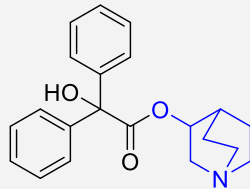
Central nervous system (CNS) acting chemicals



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

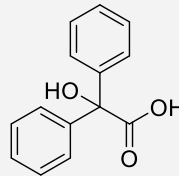
OPCW should start preparations for verification activities to prepare for any future IAU



3-quinuclidinyl benzilate (BZ)

Schedule 2.A.3

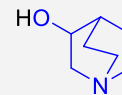
made from



2,2-diphenyl-2-hydroxyacetic acid

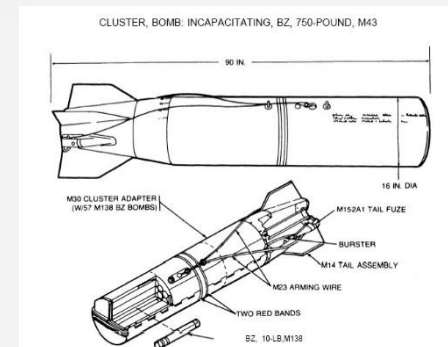
Schedule 2.B.8

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**

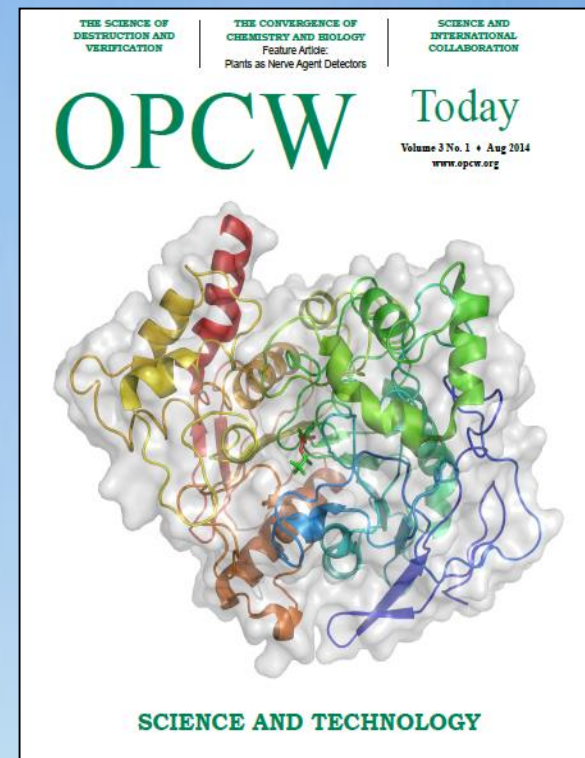
OPCW Laboratory and designated laboratory network should engage with other networks of laboratories to share best practice in toxin identification and analysis



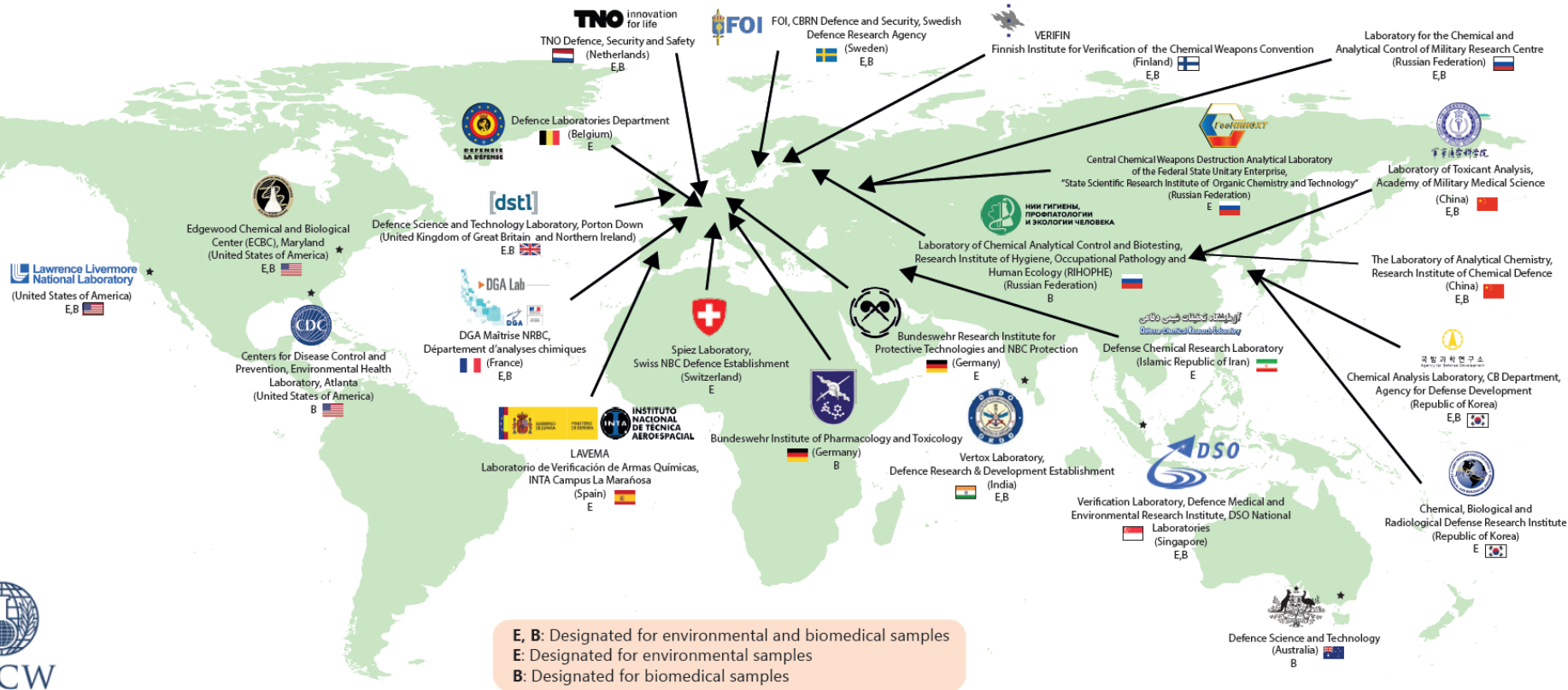
Monitoring chemical change

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.



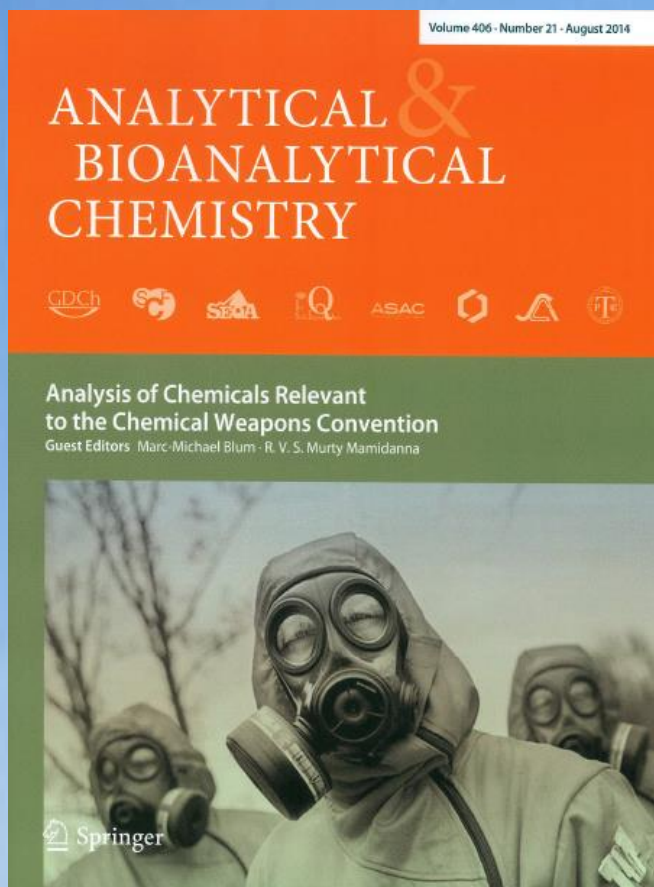
Designated laboratories (DLs)



- 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



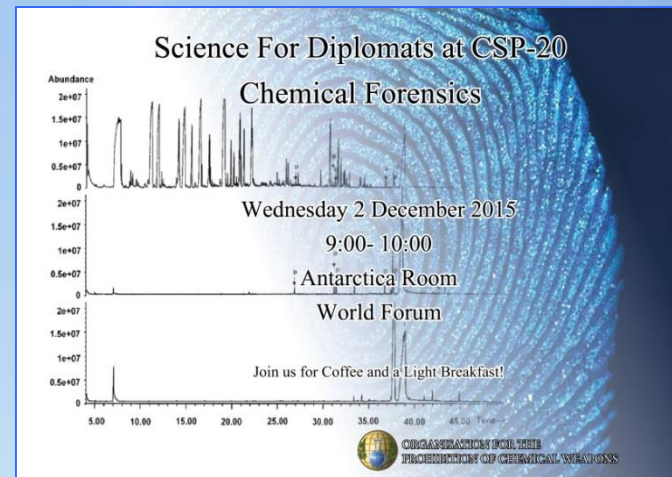
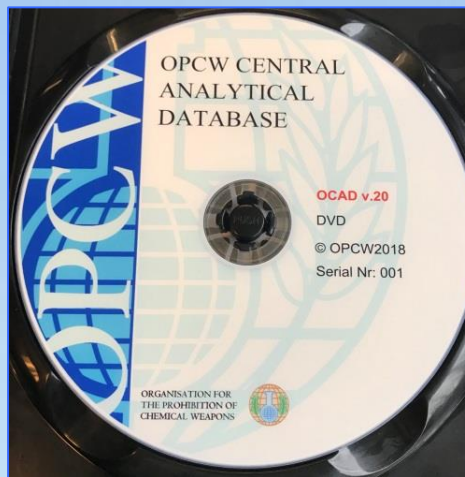
Proficiency Tests do not address identification of poisoning by non-sch. chemicals

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

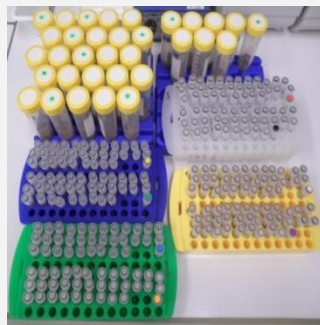


Sample handling and storage

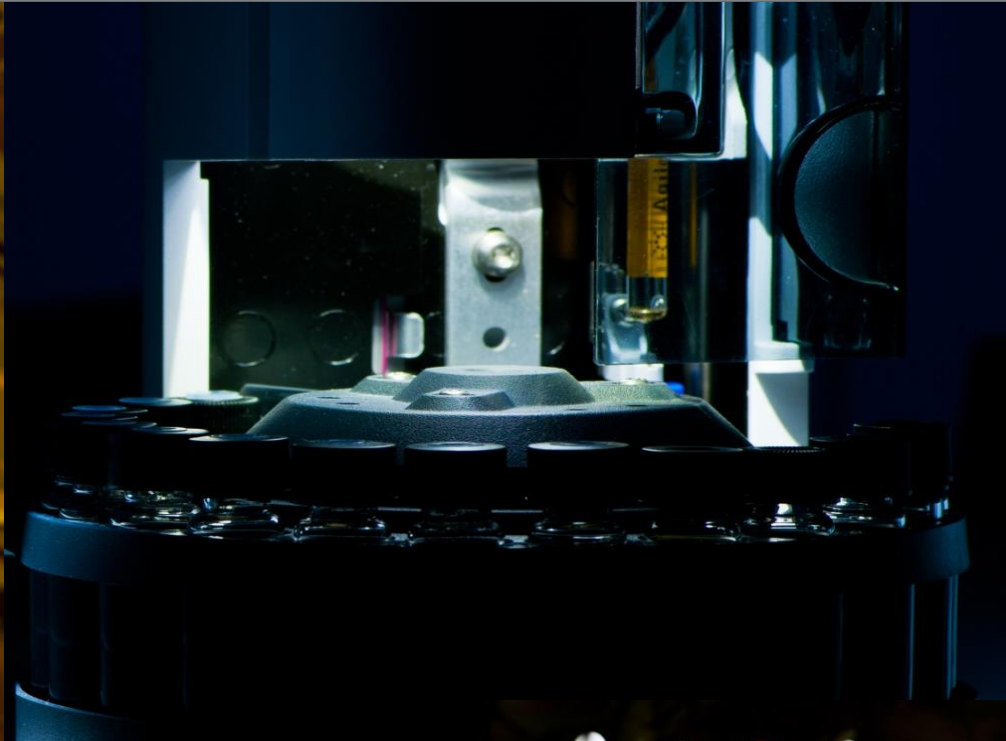
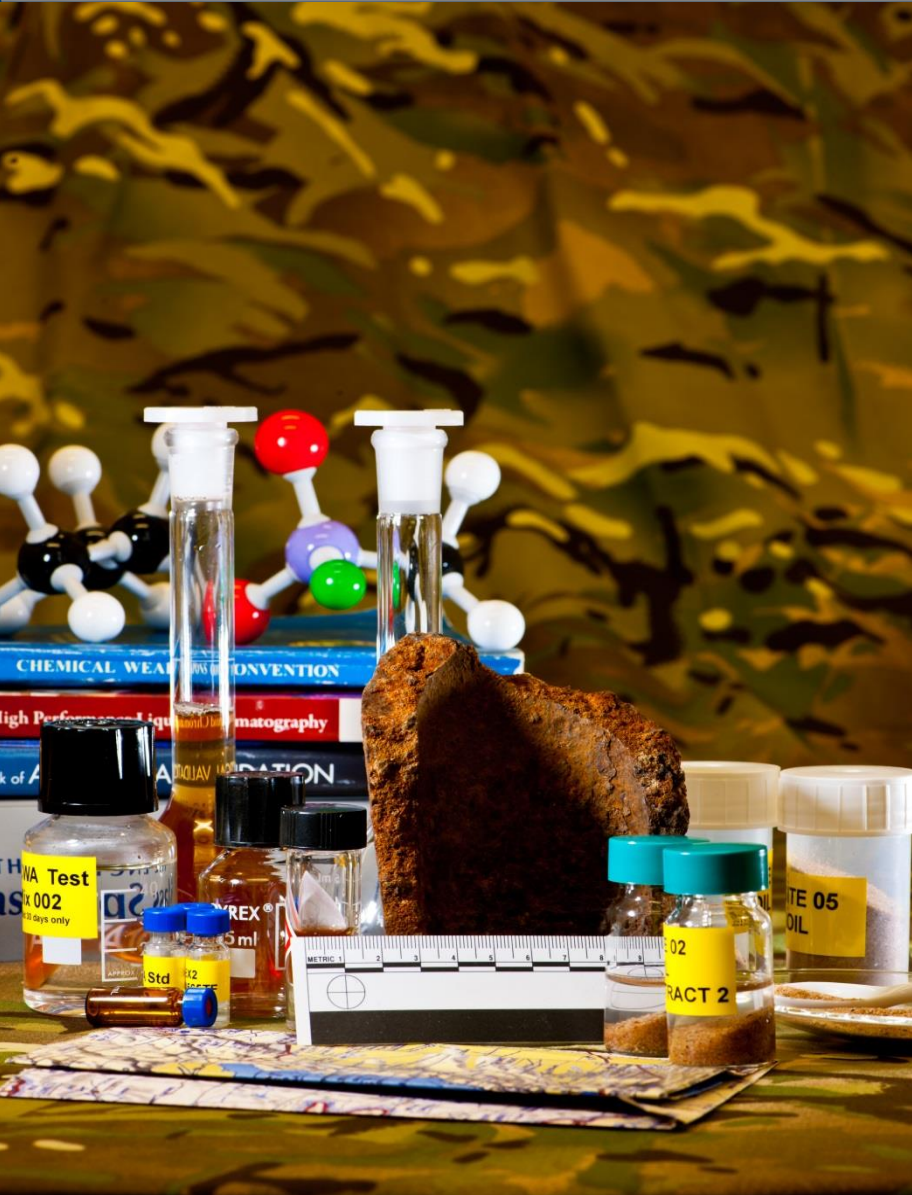
Further documentation on the stability of samples just after sampling and during transport to the OPCW Laboratory; sample handling during splitting, handling, storage and disposal of samples at the OPCW Laboratory; should be pursued and shared with relevant stakeholder laboratories

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:

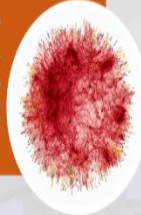
Question 1:

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



"Working together for a
world free of chemical weapons"

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



OPCW

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 decades. But a viable solution still evades us.

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

[Photos & Video →](#)





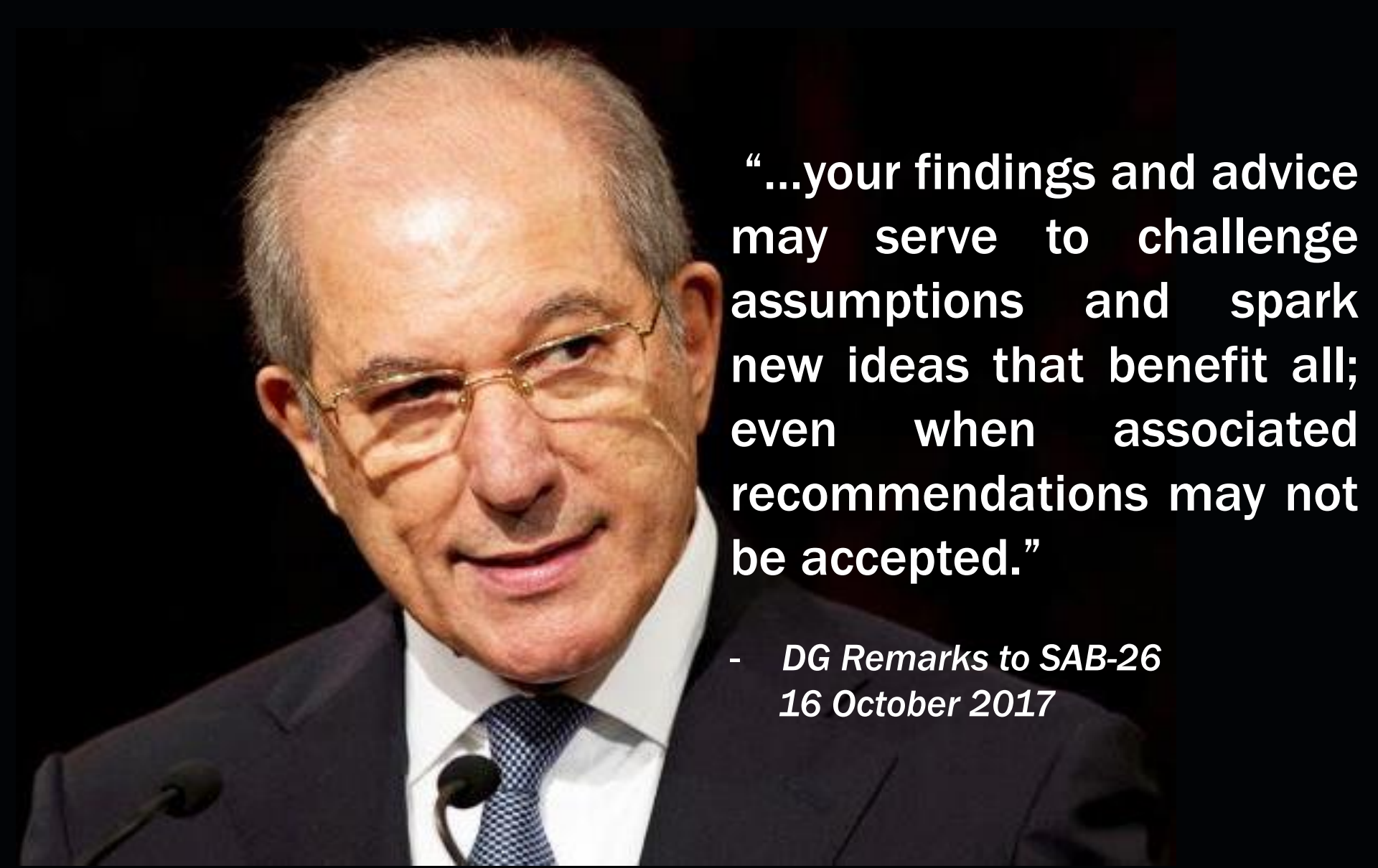
“...I encourage you to be forward thinking, innovative and bold as you draft this report

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

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



OPCW



“...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***



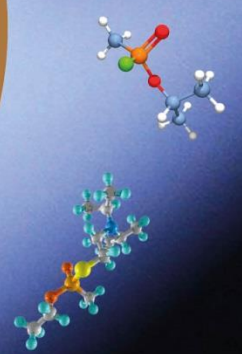
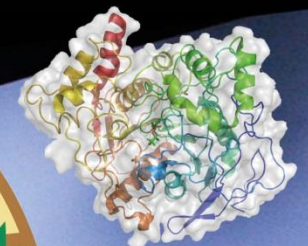
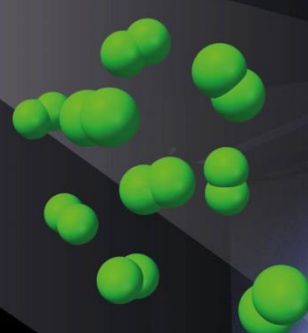
OPCW

OPCW Scientific Advisory Board Briefing to States Parties

Thursday 22 March 2018

Jeper 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