



OPCW

Organisation for the Prohibition of Chemical Weapons

Disarmament and Technological Change

An OPCW Side Event at BWC MX2

A Review of Developments in Science and Technology Relevant to the Chemical and Biological Weapons Conventions

09:00 - 10:00

Friday 10 August 2018

Salle XXI

Scientific Advisory Board's Recommendations
to the Fourth Review Conference of
the Chemical Weapons Convention



A quick reference guide to the executive summary recommendations of the OPCW Scientific Advisory Board's report on developments in science and technology to the Fourth Review Conference (RC-4/DG-1, dated 30 April 2018).



Download RC-4/DG.1



The Plan

- **Overview of the SAB's Report to the 4th Review Conference of the CWC**
- **The Science Review Process of the SAB**
- **Taking Recommendations Forward**
- ***Discussions (Q&A)***





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Organisation for the Prohibition of Chemical Weapons

Overview of the SAB's Report to the 4th Review Conference of the CWC

An OPCW Side Event at BWC MX2

Geneva, 10 August 2018

Cheng Tang

SAB Vice Chair/2019 Chair Elect



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Organisation for the Prohibition of Chemical Weapons



Scientific Advisory Board 2018

(As of 6 June 2018)

SAB reports to the DG, who then submits its reports, alongside his response, to the EC.

First meeting in 1998

Meet once or twice per year

Chair and Vice-Chair elected by the members

Maximum of two consecutive three-year terms of office

25 independent experts

“To enable the Director-General, 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, Paragraph 21(h)

Scientific Advisory Board 2018

(As of 6 June 2018)

The Fourth Review Conference of the CWC



The Fourth Review Conference of the CWC

21 – 30 November 2018

Article VIII of the CWC:

“ 22. The Conference shall not later than one year after the expiry of the fifth and the tenth year after the entry into force of this Convention, and at such other times within that time period as may be decided upon, convene in **special sessions to undertake reviews of the operation of this Convention**. Such reviews shall **take into account any relevant scientific and technological developments**. At intervals of five years thereafter, unless otherwise decided upon, further sessions of the Conference shall be convened with the same objective. ”

Overview of the Report and the SAB's Advice to the Forth Review Conference

- Advances in Science and Technology
- Chemicals
- Science and Technology of Relevance to Verification
- Technologies for the Delivery Toxic Chemicals and Drugs
- Developments in Chemical Production and Discovery
- Assistance and Protection
- Science and Technology of Relevance to Chemical Safety and Security
- Science literacy and Science Advice

Scientific Advisory Board's Recommendations to the Fourth Review Conference of the Chemical Weapons Convention



A quick reference guide to the executive summary recommendations of the OPCW Scientific Advisory Board's report on developments in science and technology to the Fourth Review Conference (RC-4/DG.1, dated 30 April 2018).



Download RC-4/DG.1



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Overview of the Report and the SAB's Advice to the Forth Review Conference

- Advances in Science and Technology
- Chemicals
- Science and Technology to Verify
- Technologies for the D
- product of 5 years' review process
- Developments in Chemistry and Discovery
- recommendations focused on 8 different areas
- to Chemical Safety and Security
- Science literacy and S

83 pages

recommendations

focused on 8 different areas

to Chemical Safety and Security



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Review Conference

Fourth Session
21 – 30 November 2018

RC-4/DG.1
30 April 2018
Original: ENGLISH

REPORT OF THE SCIENTIFIC ADVISORY BOARD ON DEVELOPMENTS IN SCIENCE AND TECHNOLOGY FOR THE FOURTH SPECIAL SESSION OF THE CONFERENCE OF THE STATES PARTIES TO REVIEW THE OPERATION OF THE CHEMICAL WEAPONS CONVENTION

Introduction

1. The Scientific Advisory Board (SAB) was established by the Director-General in accordance with subparagraph 21(h) and paragraph 45 of Article VIII of the Chemical Weapons Convention (hereinafter "the Convention"), so that he could render to the Conference of the States Parties (hereinafter "the Conference") and the Executive Council (hereinafter "the Council") specialized advice in areas of science and technology relevant to the Convention. In keeping with this mandate, and as its contribution to the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention (hereinafter "the Fourth Review Conference"), to be held from 21 to 30 November 2018, the SAB has prepared this report, which analyses relevant developments in science and technology over the past five years and presents recommendations and observations that the SAB considers to be important for the review of the operation of the Convention and its future implementation.

This report contains an executive summary and recommendations addressing issues that may impact the implementation of the Convention and the work of the Technical Secretariat (hereinafter "the Secretariat"). The analysis of developments in science and technology that informed the recommendations, as well as additional, more detailed recommendations, are provided in Annex 1.

3. This is the fourth report for a Review Conference by the SAB on developments in science and technology relevant to the Convention. The three earlier reports were presented to the First Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention¹ (hereinafter "the First Review Conference"), the Second Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention² (hereinafter "the Second Review Conference"), and the Third Special Session of the Conference

¹ RC-1/DG.2, dated 23 April 2003.

² RC-2/DG.1, dated 28 February 2008 and Corr.1, dated 5 March 2008.

Board's Recommendations Review Conference of Weapons Convention



Executive summary recommendations of the SAB's report on developments in science and technology (RC-4/DG.1, dated 30 April 2018).



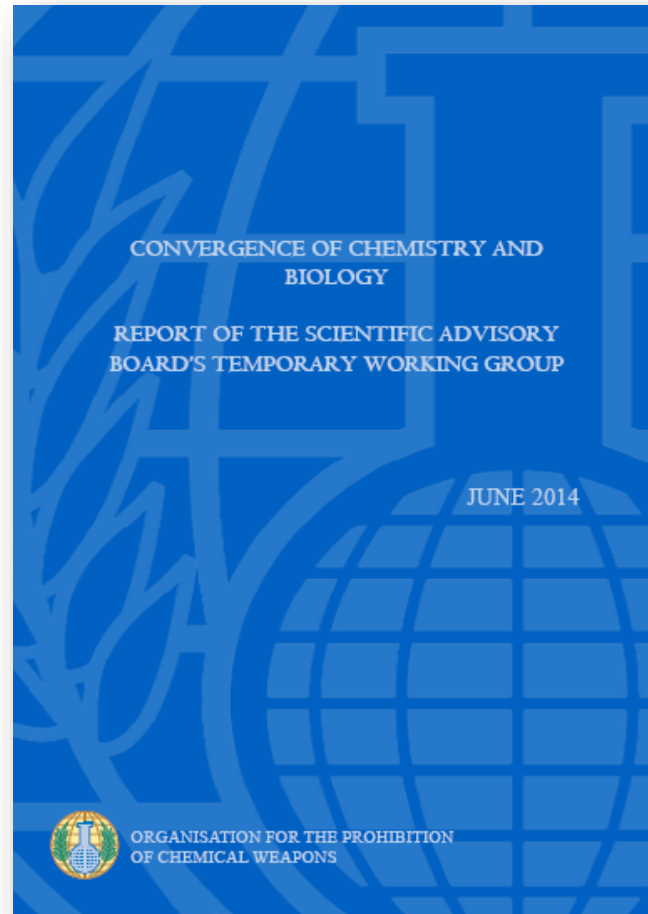
Download RC-4/DG.1



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Advances in science and technology

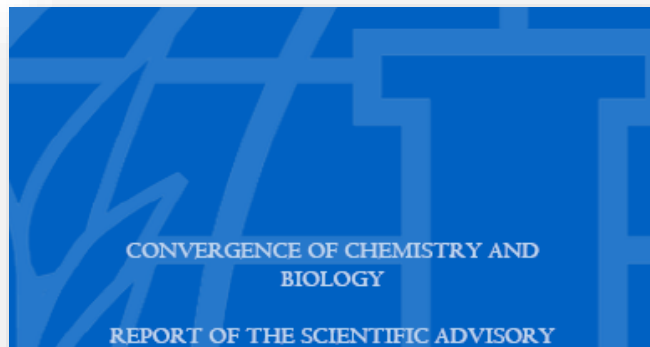
Monitoring the Convergence of Chemistry and Biology



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Advances in science and technology

Monitoring the Convergence of Chemistry and Biology



Report of the SAB's TWG on Convergence (Convergence of Chemistry and Biology): “Convergence is increasing the overlap between the remits of the Chemical Weapons Convention (CWC) and Biological Weapons Convention (BWC), historically restricted mainly to bioregulators and toxins. This will require increasing the interaction between CWC and BWC technical experts.”



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Advances in science and technology

Monitoring the Convergence of Chemistry and Biology

□ Given potential impact on the CWC of the convergence of chemistry and biology, the SAB and TS should keep under review developments in the following areas and report their implications for the Convention :

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



Advances in science and technology

Work across areas of overlap between CWC and BWC

□ SAB and TS should continue to

- work across areas of overlap between CWC and BWC and promote joint discussions among international experts in these areas
- assess developments in technical fields of increasing relevance to CWC: computational chemistry, big data, informatics and artificial intelligence, forensic science, remote sensing, and unmanned automated systems

□ Although biological or biomediated processes do not currently appear likely to be suitable for production of traditional CW agents, the TS should continue to monitor developments closely .



Advances in science and technology

production by synthesis

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



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Biological or biomediated process
covered by “production by synthesis”

Advances in science and technology

disarmament and technological change

- ❑ In view of the many interesting and potentially enabling technologies reviewed by the SAB in its report, the Board recommends the TS:
 - to consider ways in which such technologies may prove valuable in enhancing its capability to verify compliance with the Convention
 - to assist States Parties in improving their own capabilities. This should be informed by capability requirements , not the technology itself.
- ❑ **Dual use biotechnology advances and related security concern:**
 - Genome editing, Matabolic pathway engineering, Gene drivers, and Gene synthesis



Advances in science and technology *disarmament and technological change*

- In view of the many international reports on enabling technologies, the SAB is of the view that technological change is best considered from a practical perspective, focusing on capabilities relevant to the Convention, irrespective of scientific discipline.

Item 4 of the MX2 agenda "Review of science and technology developments relevant to the BWC as well as the identification of potential benefits and risks of new science and technology developments relevant to the BWC"

pathway engineering, Gene drivers, and

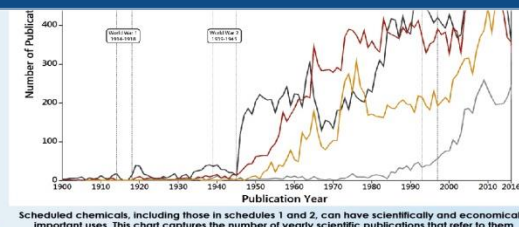
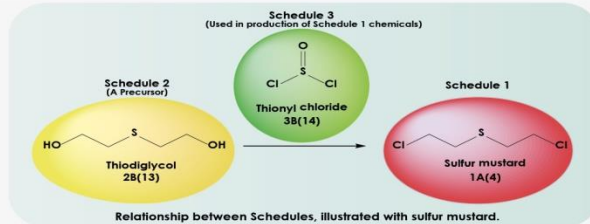
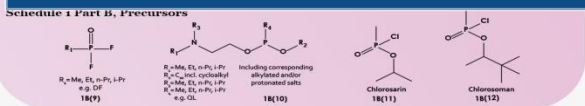


Advice on Chemicals

consideration of amendment of the Schedules of chemicals

Scheduled Chemicals under the Chemical Weapons Convention (CWC)

- Given changes in chemistry and chemical industry since schedules were finalised 25 years ago, a review of the schedules should be considered to assess whether:
 - the chemicals currently listed are in the appropriate schedule
 - any toxic chemicals or specific precursors should be added to or removed from the schedules – also, it should be considered whether it is technically feasible to accurately monitor Schedule III chemicals produced in very large quantities, e.g. over 100,000 tons/year



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

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Advice on Chemicals

Analysis of Toxins

Fact Sheets of the two toxins (Ricin and Saxitoxin) listed on the Schedule of Chemicals of the CWC



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Scientific Advisory Board

Twenty-First Session
23 – 27 June 2014

SAB-21/WP.3
28 February 2014
ENGLISH only

RICIN FACT SHEET

1. Challenges in development of analytical methods for ricin have been considered by the Scientific Advisory Board since its Sixth Session, in particular through the Temporary Working Group on Sampling and Analysis (which held its final meeting in September 2012). In addition to being listed in Schedule 1 of the Chemical Weapons Convention, ricin is covered by the Biological and Toxins Weapons Convention.



Figure 1: The castor bean plant *Ricinus communis* and its seeds (castor beans).
[Seed figure from Wikipedia]



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Scientific Advisory Board

Twenty-First Session
23 – 27 June 2014

SAB-21/WP.4
28 February 2014
ENGLISH only

SAXITOXIN FACT SHEET

1. Challenges in development of analytical methods for saxitoxin have been considered by the Scientific Advisory Board since its Sixth Session, in particular through the Temporary Working Group on Sampling and Analysis (which held its final meeting in September 2012). In addition to being listed in Schedule 1 of the Chemical Weapons Convention, saxitoxin is covered by the Biological and Toxins Weapons Convention.



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Advice on Chemicals

Analysis of Toxins

❑ TS should enhance efforts to strengthen capabilities of labs to identify the use of toxins for prohibited purpose and analyse samples for toxins:

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



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Analysis of toxins is same important to the BWC in case of investigating alleged use of Biological Weapons

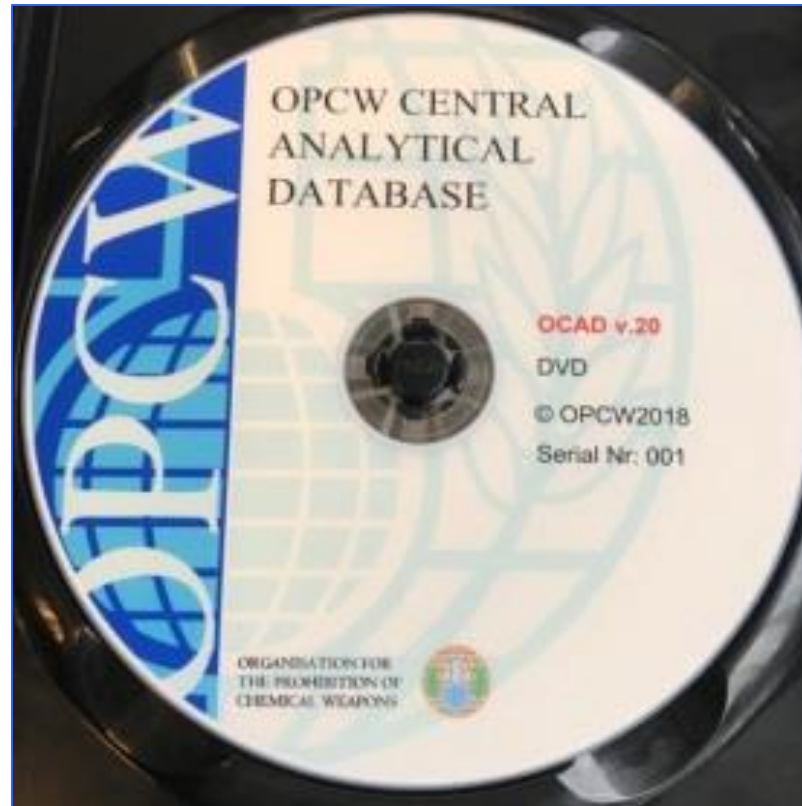
Science and technology relevant to verification *sampling & analysis and designated laboratories*

- ❑ Technical data related to sample analyses conducted for the OPCW should be shared among designated laboratories and published in peer-reviewed scientific journals,
- ❑ Strengthen the capabilities of the designated laboratories to detect and identify traces of non-scheduled chemicals and associated degradation and reaction products.
- ❑ Analysis of biomedical samples:
 - TS should actively encourage further research on potential markers of exposure and engage with experts from broad range of fields to identify promising approaches



Science and technology relevant to verification

OCAD and Investigative Capabilities



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Science and technology relevant to verification

OCAD and Investigative Capabilities

- ❑ Appropriate analytical data for chemicals that may pose a risk to the CWC or are needed to help differentiate permitted activities from prohibited activities should be added to the OCAD.
 - The Database could include isotopically labelled relatives and stereoisomers of scheduled compounds, salts of scheduled chemicals, TICs, CNS-acting chemicals, riot control chemicals, **bioregulators**, **toxins**, and unscheduled chemicals that have been identified as posing a risk to the Convention.
- ❑ To facilitate investigations of alleged use of chemical weapons and/or toxic chemicals for prohibited purposes
 - The TS should maintain a curated collection of reference samples and chemical data, including compiled data on abandoned chemical weapons, the environmental fate of toxic chemicals, and impurities associated with synthetic routes to nerve and blister agents
- ❑ Investigative techniques required for the verification of use of toxic chemicals include approaches used by the forensic community.
 - The TS, in consultation with relevant experts, should identify such commonly used forensic techniques and protocols to assess their applicability for its own activities.

SAB has established a Temporary Working Group on Investigative Technology to provide further advice to the Director General of the OPCW.



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Scientific literacy and science advice

- ❑ SAB and TS should maintain a “watching brief ” in areas most likely to have greatest impact on the CWC’s verification regime.
 - chemicals and technologies that markedly increase potential for hostile use of chemicals
 - technologies that provide substantially enhanced capabilities for verification purposes
- ❑ The SAB should continue to build close working relationships with relevant professional societies and science advisory bodies of other relevant international organisations to enable it to identify and assess developments that may impact the CWC or OPCW.



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Item 8 of the MX2 agenda: “Any other science and technology developments of relevance to the Convention and also to the activities of relevant multilateral organisations such WHO, OIE, FAO, IPPC and OPCW”

The Hague Ethical Guidelines

*Applying the norms of the practice of chemistry to supporting
the Chemical Weapons Convention*





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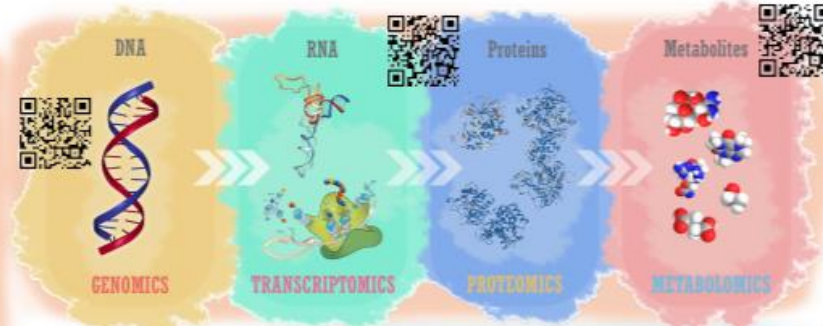
The SAB Review Process on Science and Technology

Zrinka Kovarik, Ph.D., member of OPCW Scientific Advisory Board (SAB)
Permanent Research Adviser, Institute for Medical Research and
Occupational Health, Zagreb, Croatia

Convergence of the Sciences



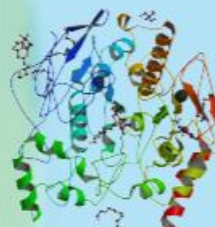
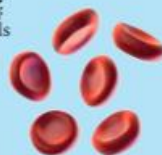
The Scientific Advisory Board on 'Convergence'



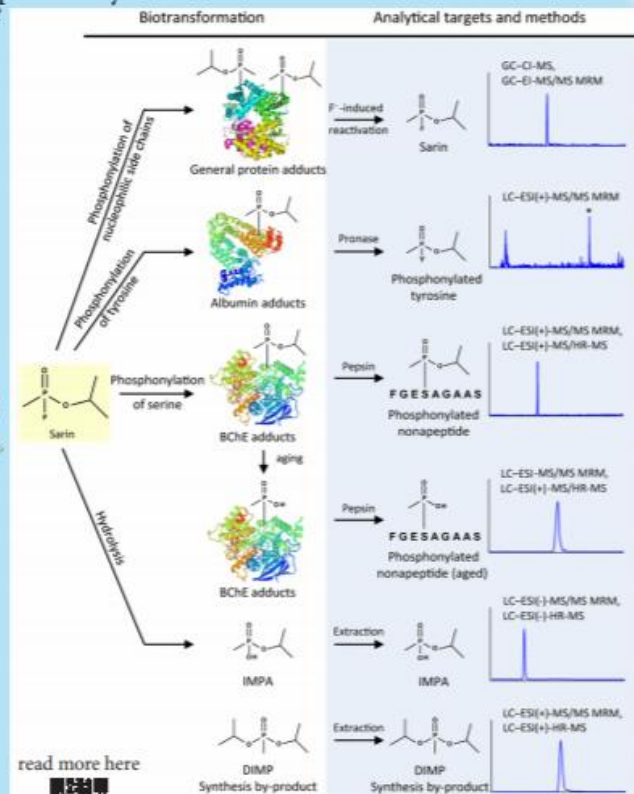
Chemical production

Biomedical Sample Analysis

is this chemistry, or biology?



Soman adduct of electric eel acetylcholinesterase

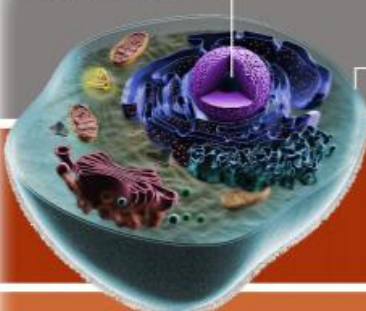


read more here



John, H., van der Schans, M.J., Koller, M. et al. Forensic Toxicol (2018) 36: 61.

Animal cell and its organelles

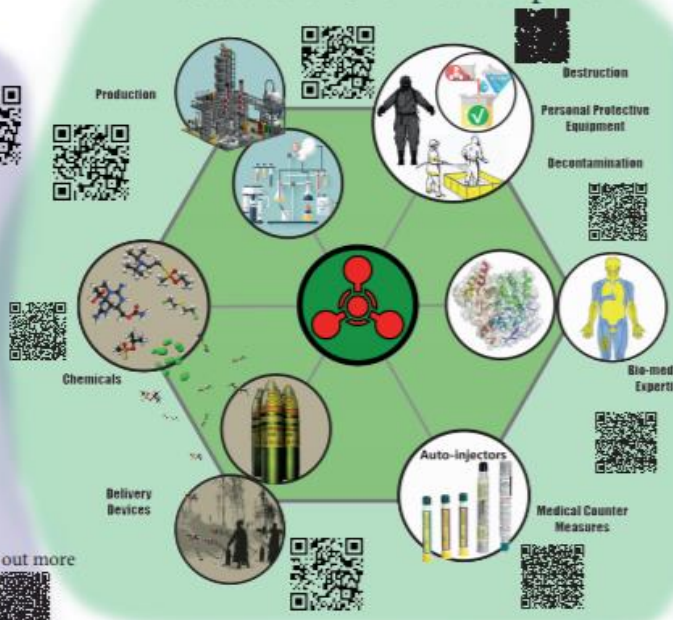


Supramolecular complexes

Macromolecules

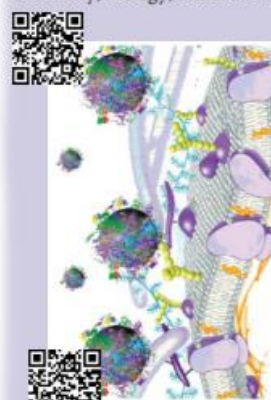
Chemical building blocks

The Science of Chemical Weapons?



Nanotechnology:

Chemistry; Biology; Materials and more



find out more



S. Bucak, B.Yavuztürk, A. Demir Sezer (2012). Magnetic Nanoparticles: Synthesis, Surface Modifications and Application in Drug Delivery, Recent Advances in Novel Drug Carrier Systems, PhD. A. Demir Sezer (Ed.), InTech, DOI: 10.5772/52115

International Workshops of the OPCW Scientific Advisory Board

A European Union Funded Project

In Support of Scientific Review for the Fourth Review Conference of the Chemical Weapon Convention

4 Workshops with a total attendance of **187**

159 Individuals from **40** States Parties

111 Presentations from **91** Individual Presenters



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the Prohibition of
Chemical Weapons





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:

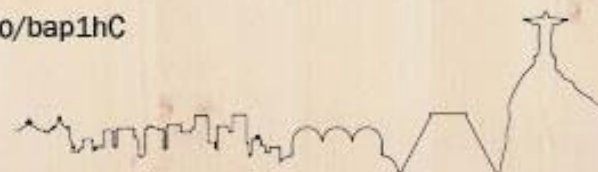
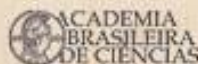


Innovative Technologies for Chemical Security

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:

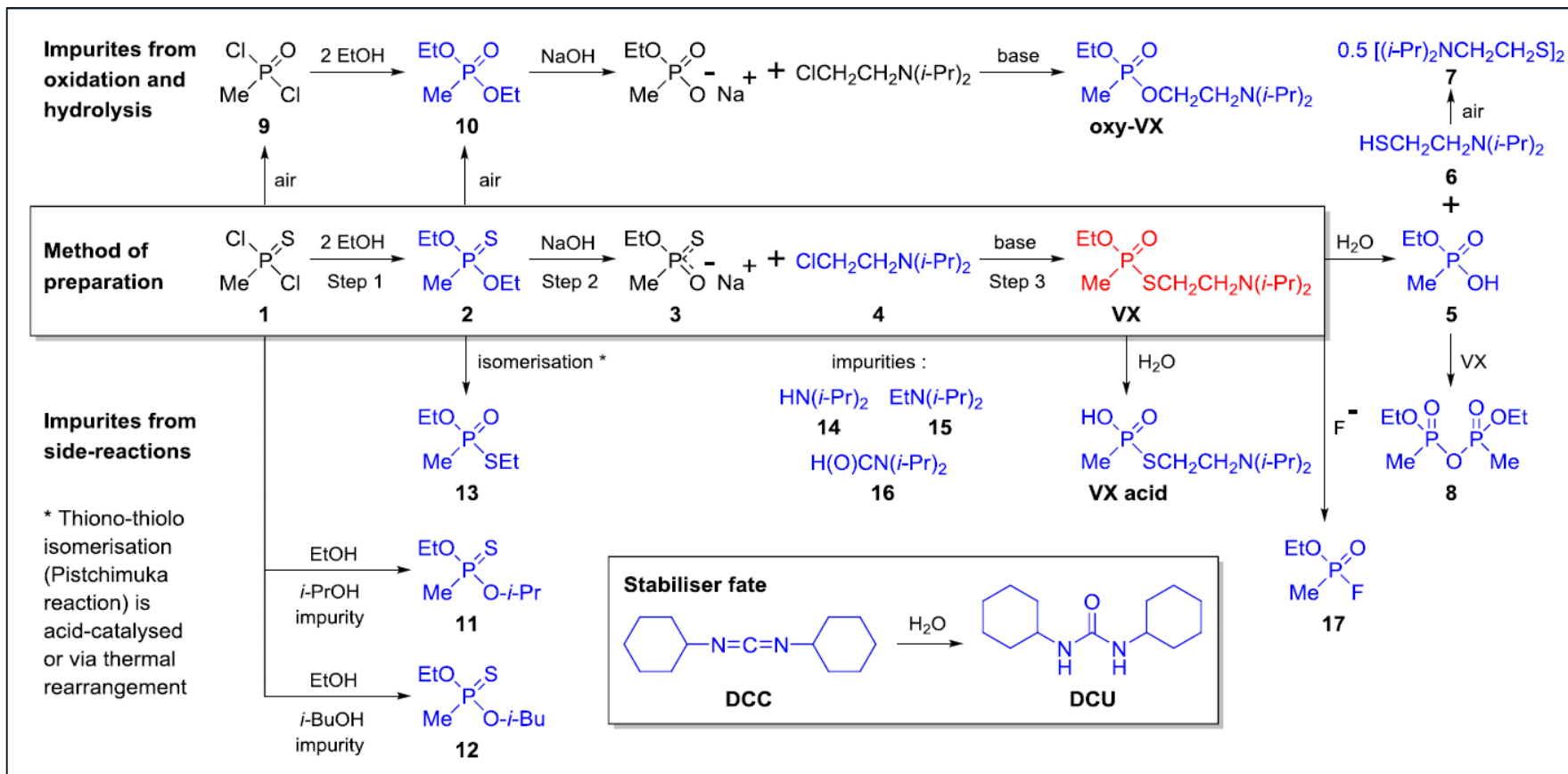


REPUBLIC OF CROATIA
MINISTRY OF ECONOMY





Chemical Forensics



Anal Bioanal Chem, 2014, 406, 5121–5135

DOI 10.1007/s00216-014-7963-9



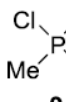
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Chemical Forensics

Expertise in chemical forensics: narcotics



Impurities from oxidation and hydrolysis



9

Method of preparation



1

Impurities from side-reactions

* Thiono-thiolo isomerisation (Pistchimuka reaction) is acid-catalysed or via thermal rearrangement

HF

Image courtesy of TNS Sofres
www.flickr.com/photos/124561666@N02/

CH₃

Anal Bioanal Chem

DOI 10.1007/s00216-014-7963-9

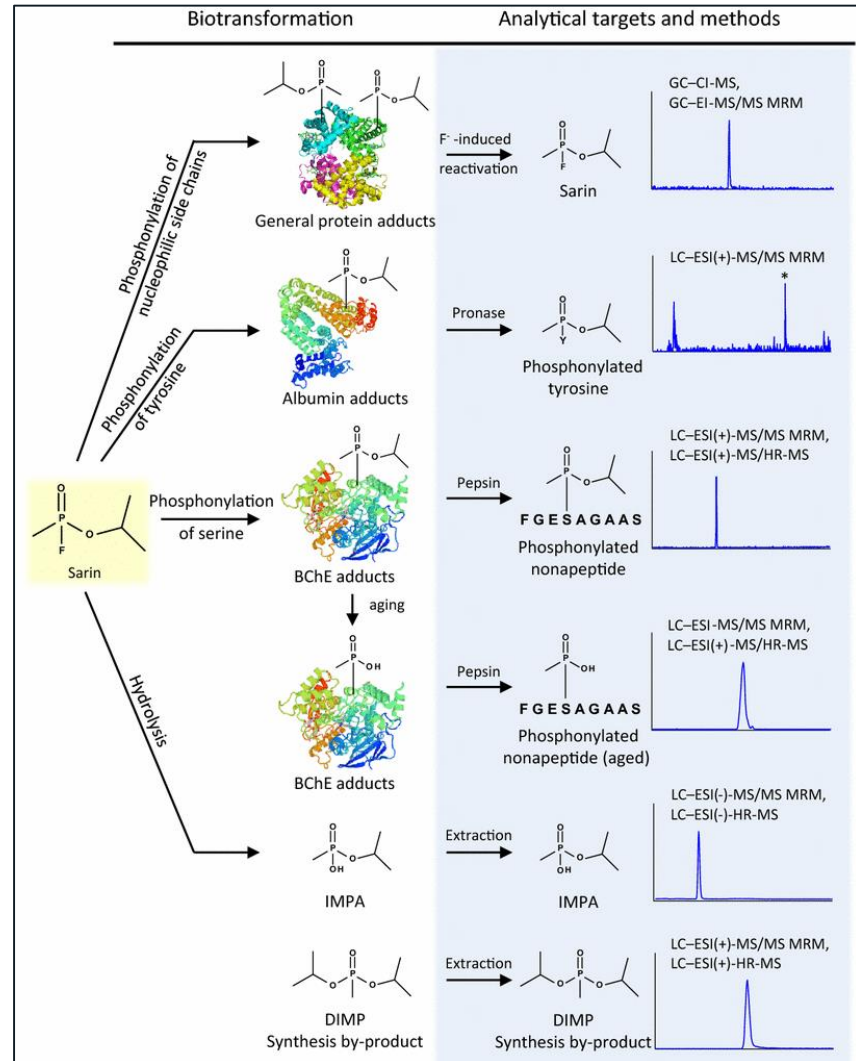


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Biomedical Sampling and Analysis

Biomedical Samples

H. John, et al; *Forensic Toxicol* (2017)
DOI 10.1007/s11419-017-0376-7



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Biomedical Sampling and Analysis

L- α -Phosphatidylglycerol Chlorohydrins as Potential Biomarkers for Chlorine Gas Exposure

Petrus Hemström, Andreas Larsson, Linda Elfsmark, and Crister Åstot*

The Swedish Defense Research Agency, FOI CBRN Defense and Security, 90182 Umeå, Sweden

Anal. Chem., 2016, 88 (20), pp 9972–9979

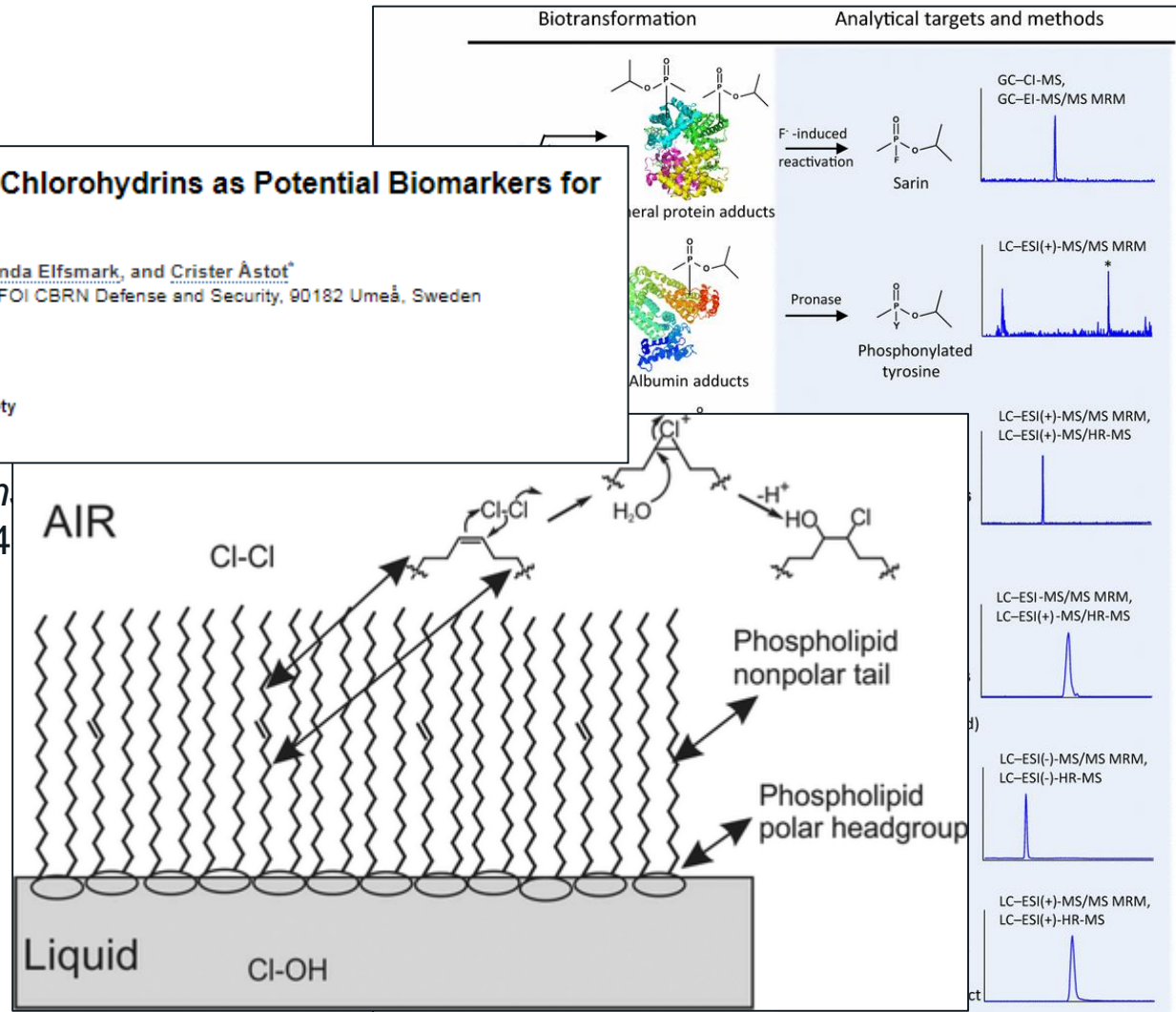
DOI: 10.1021/acs.analchem.6b01898

Publication Date (Web): September 27, 2016

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*Phone: +46 90106808. E-mail: astot@foi.se.

H. John, et al; *Foren*
DOI 10.1007/s114



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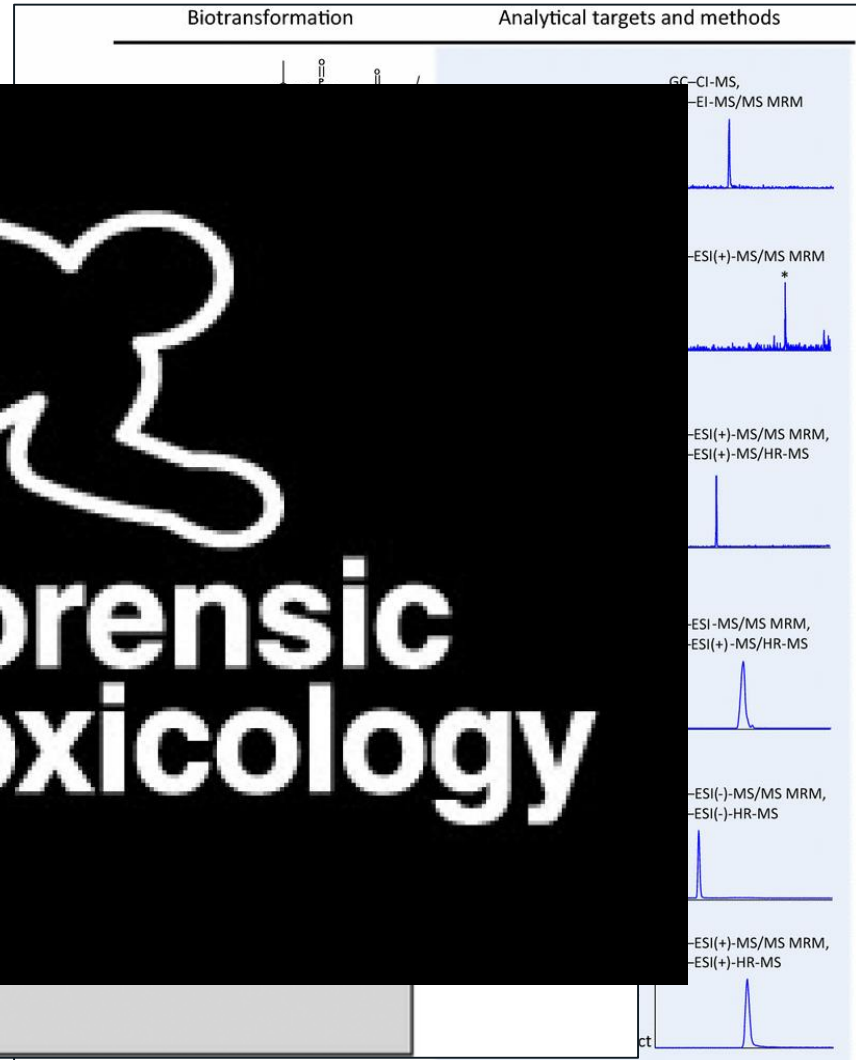
Biomedical Sampling and Analysis



Forensic Toxicology

Liquid

Cl-OH



L- α -Ph
Chlori

Petrus He
The Swedi

Anal. Chem
DOI: 10.102
Publication
Copyright
*Phone: +46

H. Jo
DC



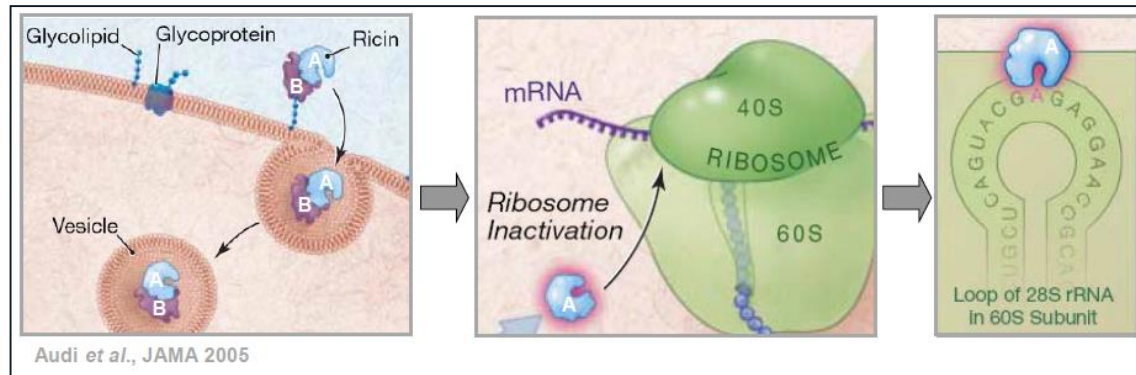
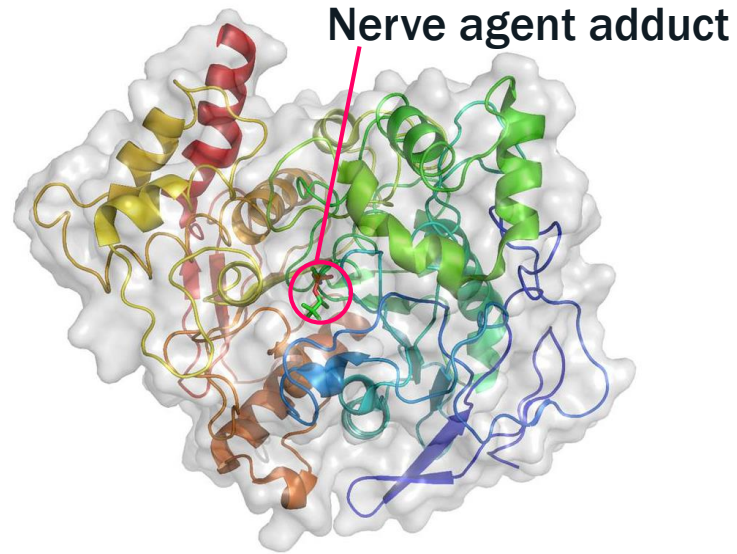
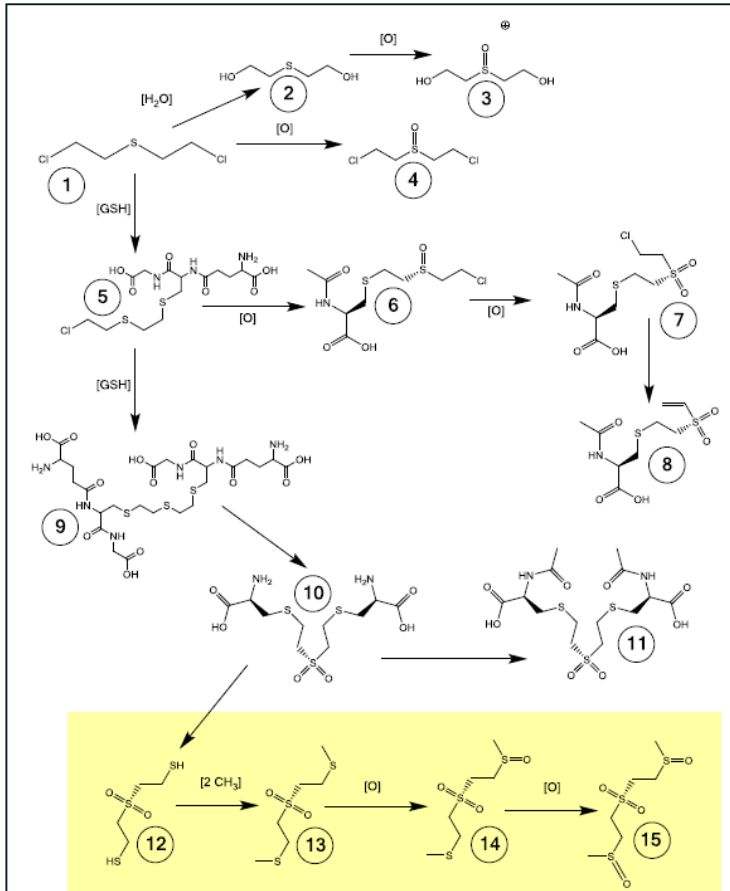
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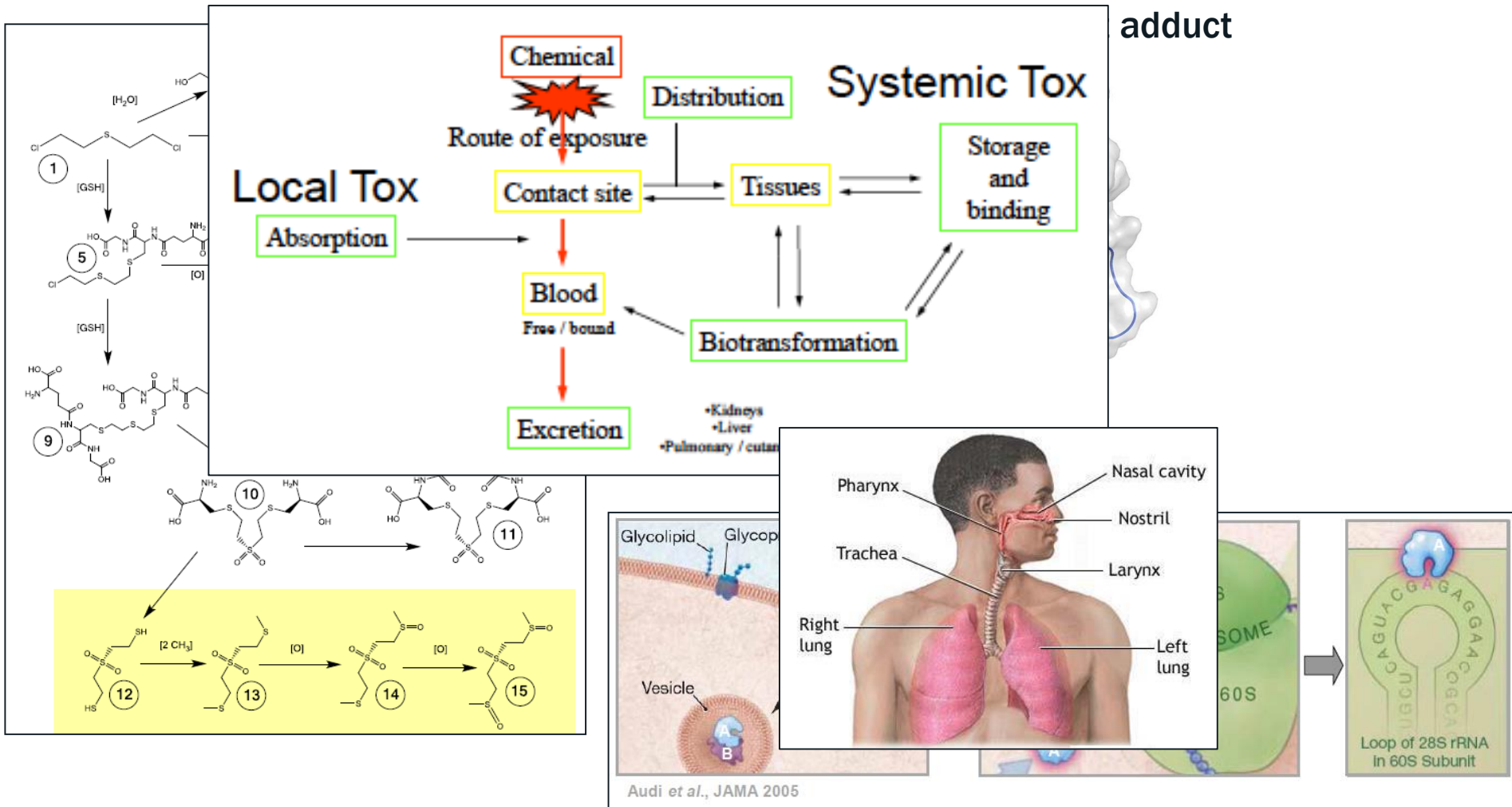
SGDSN
SECRETARIAT GÉNÉRAL
DE LA DÉFENSE ET DE
LA SÉCURITÉ NATIONALE



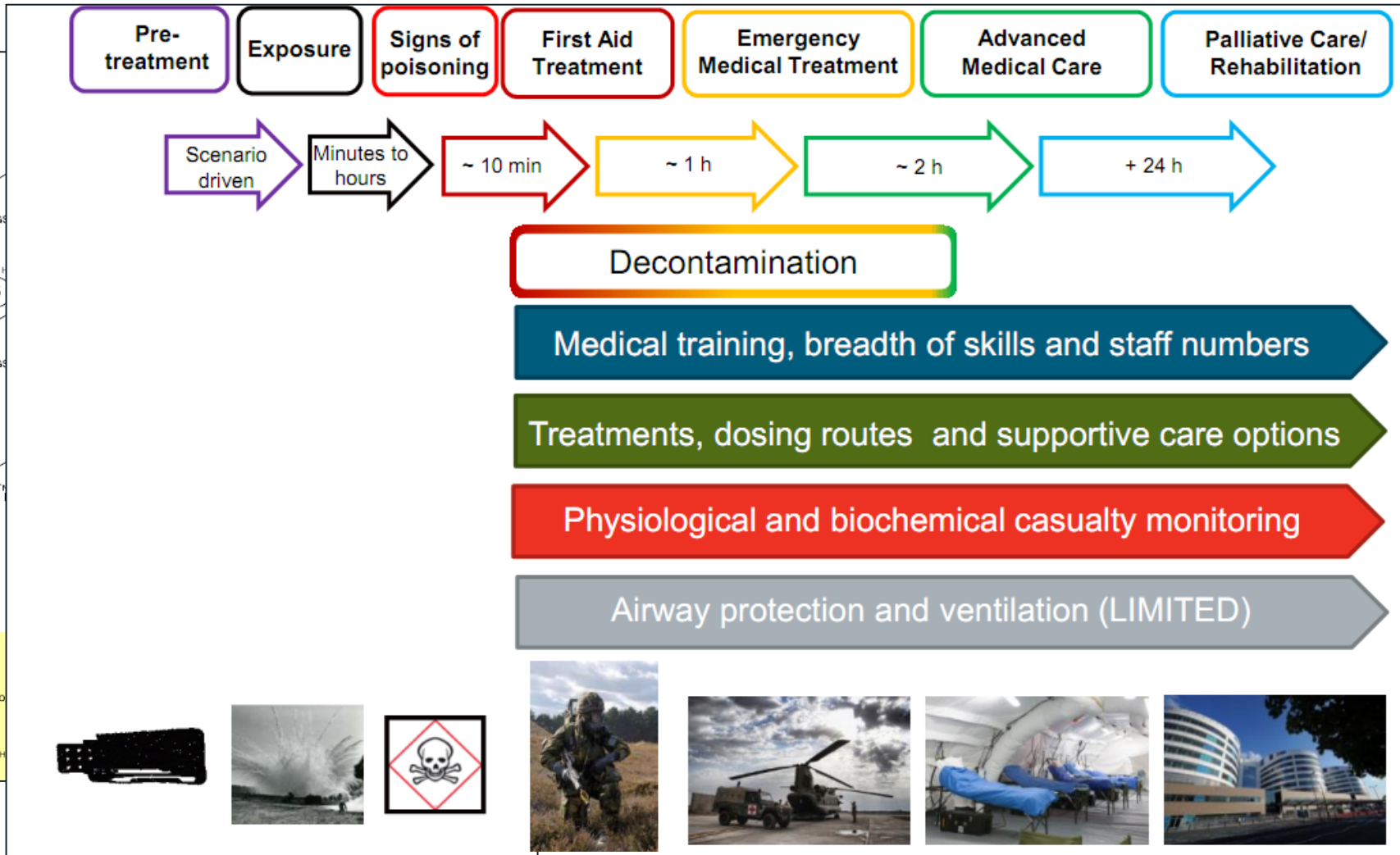
Mechanisms of Toxicity



Mechanisms of Toxicity



Mechanisms of Toxicity



Medical Countermeasures

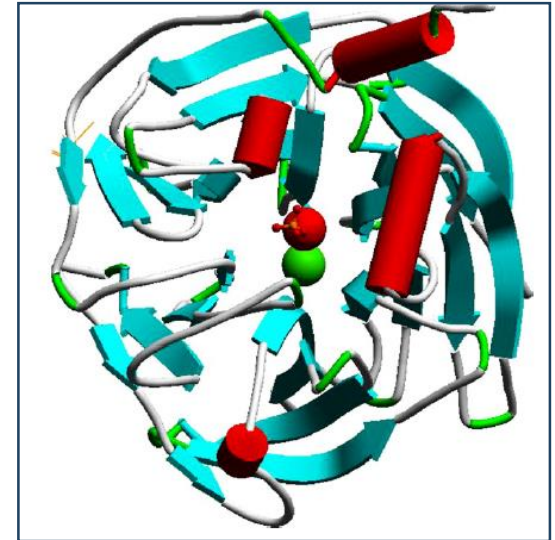
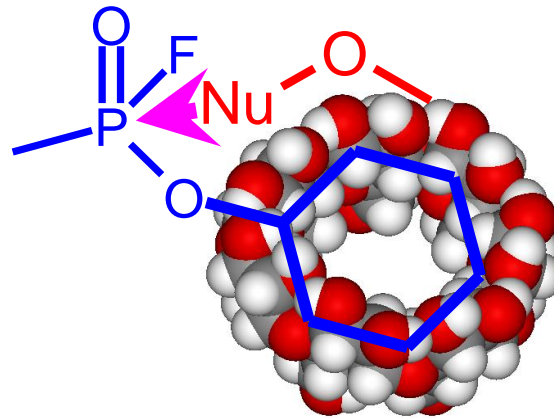


Meridian Medical Technologies; firstaid.about.com

2016

Oximes in use or in advanced development

2-PAM	1955
TMB-4	1958
MMB-4	1959
Obidoxime	1959
HI-6	1968



H. Thiermann



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There is Still Much to Learn...

Acute Gene Expression Profile of Lung Tissue Following Sulfur Mustard Inhalation Exposure in Large Anesthetized Swine

Bronwen J. A. Jugg[†], Heidi Hoard-Fruchey[‡], Cristin Rothwell[‡], James F. Dillman[‡], Jonathan David[†], John Jenner[†], and Alfred M. Sciuto[‡]

[†] CBR Division, Dstl Porton Down, Salisbury, Wiltshire SP4 0JQ, U.K.

[‡] US Army Medical Research Institute of Chemical Defense, 2900 Ricketts Point Road, Aberdeen Proving Ground, Maryland 21010, United States

Chem. Res. Toxicol., 2016, 29 (10), pp 1602–1610

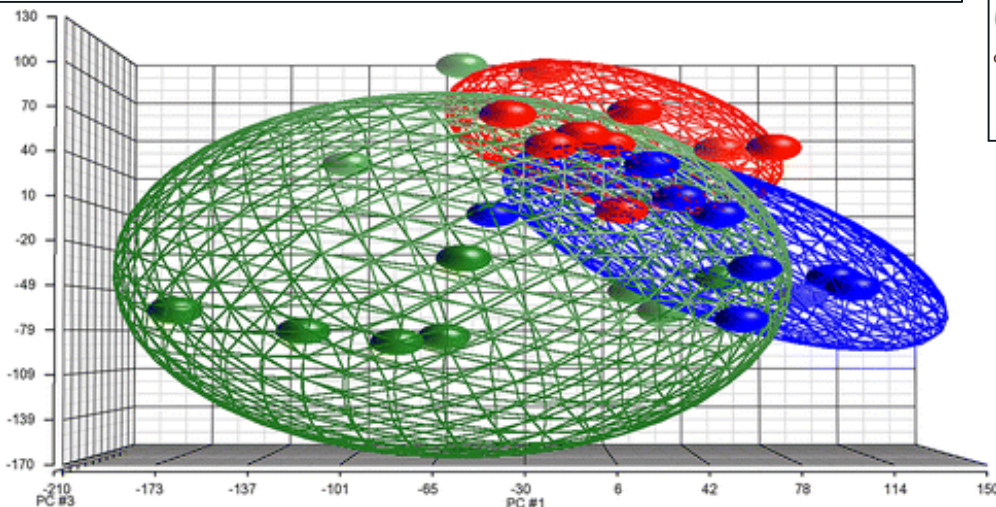
DOI: 10.1021/acs.chemrestox.6b00069

Publication Date (Web): September 12, 2016

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*E-mail: heidi.m.hoard-fruchey.civ@mail.mil.

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Toxicology Research



PAPER

View Article Online
View Journal



Cite this: DOI: 10.1039/c5tx00305a

Dynamic cytotoxic profiles of sulfur mustard in human dermal cells determined by multiparametric high-content analysis[†]

Long Long,^{a,b} Wei Li,^{a,b} Wei Chen,^{a,b} Fei-Fei Li,^{a,b} Hua Li^{*a,b} and Li-Li Wang^{*a,b}

	HEKf								HDFa							
Cell Count	0	0	0	0	0	1	3	3	0	0	0	0	0	0	2	3
Nuclear	1	0	0	0	0	0	1	2	0	0	0	0	0	0	1	3
Total Cell	/	/	/	/	/	0	0	1	1	0	0	0	0	0	1	2
Morphology																
F-Actin	/	/	/	/	/	0	1	2	2	1	0	1	1	1	1	3
α-Tubulin	/	/	/	/	/	0	0	1	0	0	0	0	0	1	2	3
Membrane Damage	/	/	/	/	/	0	0	3	/	/	/	/	/	0	0	1
Oxidative Stress	/	/	/	/	/	/	/	/	2	3	3	3	3	/	/	/
MMP Damage	/	/	/	/	/	0	0	3	/	/	/	/	/	0	2	3
DNA Damage	/	0	1	2	3	2	2	/	/	3	3	3	3	3	1	/
Lysosome Damage	/	2	1	1	0	0	3	/	/	2	3	2	2	3	3	/
Autophagy	/	0	0	0	1	1	2	/	/	2	2	3	3	2	0	/
Apoptosis	/	/	/	/	/	/	2	3	/	/	/	/	/	0	2	
Cell Cycle G2	/	/	/	/	/	0	2	3	/	/	/	/	/	0	1	2
Cell Cycle M	/	/	/	/	/	0	1	1	/	/	/	/	/	0	0	0
	0.25	0.5	2	4	6	8	24	48(h)	0.25	0.5	2	4	6	8	24	48(h)



OPCW

There is Still Much to Learn...

Acute Gene Expression Profile of Lung Tissue Following Sulfur Mustard Inhalation Exposure in Large Anesthetized Swine

Bronwen J. A. Jugg[†], Heidi Hoard-Fruchey[‡], Cristin Rothwell[‡], James F. Dillman[‡], Jonathan David[†], John Jenner[†], and Alfred M. Sciuto[‡]

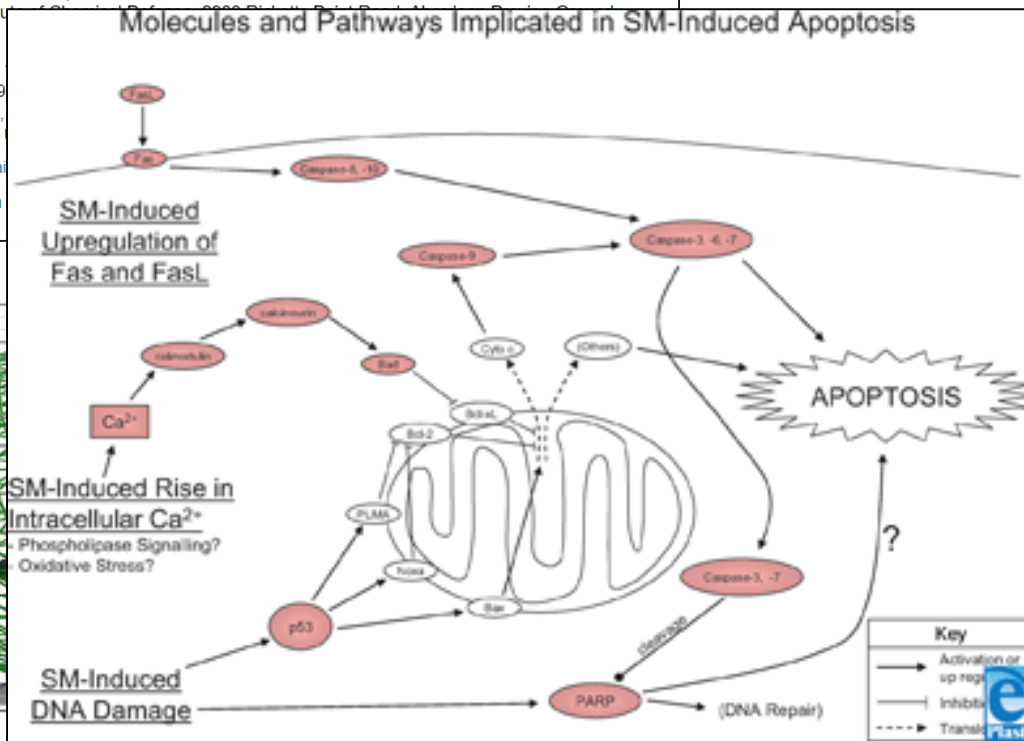
[†] CBR Division, Dstl Porton Down, Salisbury, Wiltshire SP4 0JQ, U.K.

[‡] US Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, Maryland 21010, United States

Chem. Res. Toxicol., 2016, 29 (10), pp
 DOI: 10.1021/acs.chemrestox.6b00069
 Publication Date (Web): September 12, 2016
 Copyright This article not subject to

*E-mail: heidi.m.hoard-fruchey.civ@ma

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Cytotoxic profiles of sulfur mustard in dermal cells determined by parametric high-content analysis†

Wei Li,^{a,b} Wei Chen,^{a,b} Fei-Fei Li,^{a,b} Hua Li^{*a,b} and Li-Li Wang^{*a,b}

	EKf						HDFa							
	0	1	3	3	0	0	0	0	0	0	0	2	3	
	0	0	1	2	0	0	0	0	0	0	0	1	3	
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	/	0	1	2	2	1	0	1	1	1	1	1	3	
	/	0	0	1	0	0	0	0	0	0	1	2	3	
	/	0	0	3	/	/	/	/	/	/	0	0	1	
	/	/	/	/	2	3	3	3	3	3	/	/	/	
	/	0	0	3	/	/	/	/	/	/	0	2	3	
	3	2	2	/	/	/	3	3	3	3	3	1	/	
	0	0	3	/	/	/	2	3	2	2	3	3	/	
	1	1	2	/	/	/	2	2	3	3	2	0	/	
Apoptosis	/	/	/	/	/	/	/	/	/	/	/	0	2	
Cell Cycle G2	/	/	/	/	/	0	2	3	/	/	/	0	1	2
Cell Cycle M	/	/	/	/	/	0	1	1	/	/	/	0	0	0
	0.25 0.5 2 4 6 8 24 48 (h)						0.25 0.5 2 4 6 8 24 48 (h)							

There is Still Much to Learn...

Toxicology Letters 244 (2016) 44–48

Acute C
Inhalati

Bronwen J
Jenner†, ar
† CBR Divis
‡ US Army
Maryland 2

Chem. Res.
DOI: 10.102
Publication D
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*E-mail: heid

ACS A



Contents lists available at ScienceDirect

Toxicology Letters

journal homepage: www.elsevier.com/locate/toxlet



Development of the sulfur mustard resistant keratinocyte cell line HaCaT/SM

Annette Schmidt^{a,c,*}, Dirk Steinritz^{a,b}, Horst Thiermann^a

^aBundeswehr Institute of Pharmacology and Toxicology, Neuherbergstraße 11, 80937 Munich, Germany

^bWalther Straub Institute of Pharmacology and Toxicology, University of Munich, Goethestr. 33, 80336 Munich, Germany

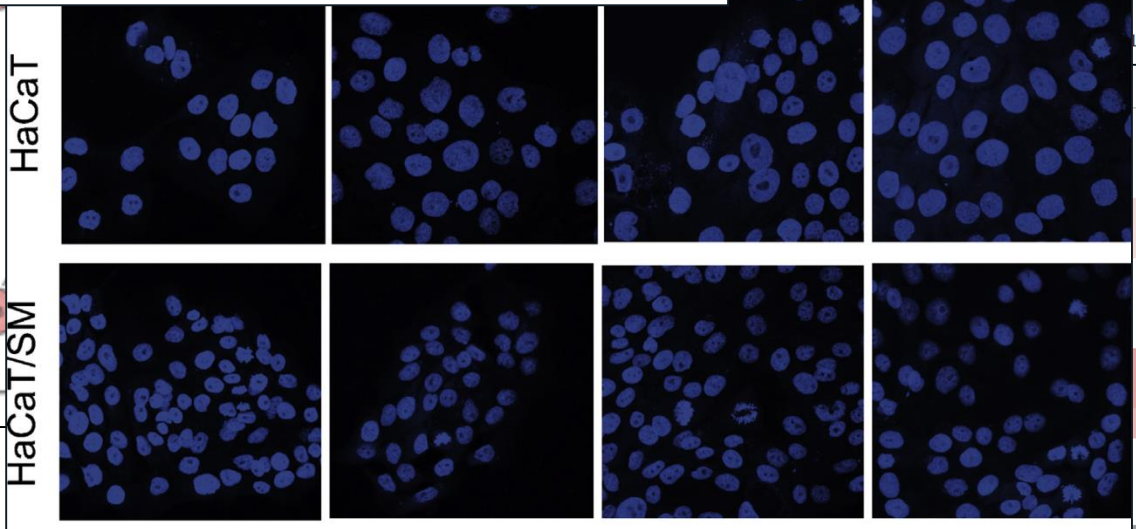
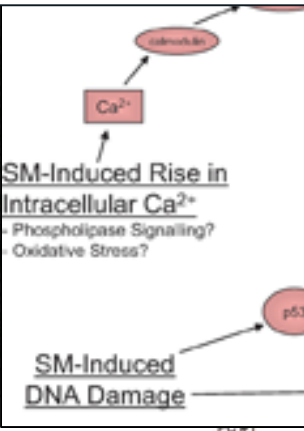
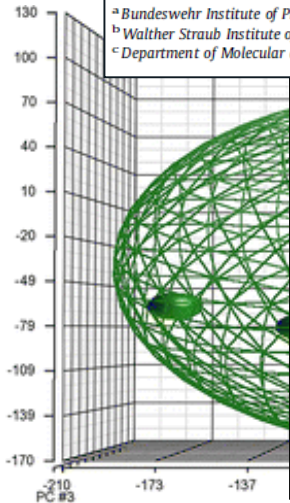
^cDepartment of Molecular and Cellular Sports Medicine, German Sports University, Am Sportpark Müngersdorf 6, 50933 Cologne, Germany



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cytotoxic profile of sulfur mustard in
M SM 7.2 μM SM

Li Wang^{*a,b}



0.25 0.5 2 4 6 8 24 48(h) 0.25 0.5 2 4 6 8 24 48(h)

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There is Still Much to Learn...

Toxicology Letters 244 (2016) 44–48

Acute C
Inhalati

Bronwen J
Jenner†, ar
† CBR Divis
‡ US Army
Maryland 2

Chem. Res.
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*E-mail: heid

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Toxicology Letters

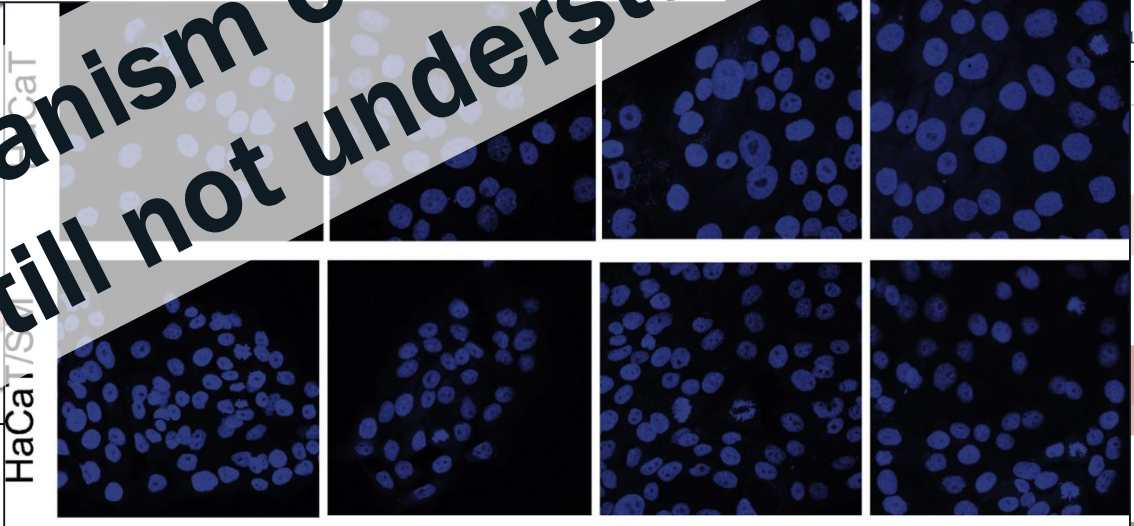
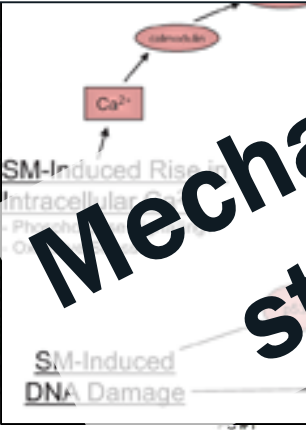
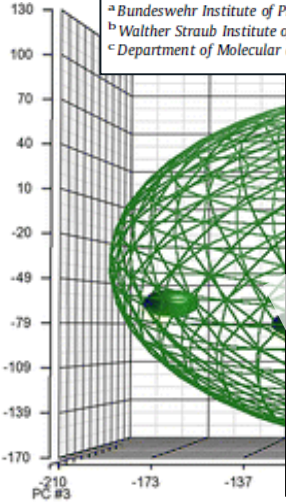
journal homepage: www.elsevier.com/locate/toxlet



Development of the sulfur mustard resistant keratinocyte cell line HaCaT/SM

Annette Schmidt^{a,c,*}, Dirk Steinritz^{a,b}, Horst Thiermann^a

^aBundeswehr Institute of Pharmacology and Toxicology, Neuherbergstraße 11, 80937 Munich, Germany
^bWalther Straub Institute of Pharmacology and Toxicology, University of Munich, Goethestr. 33, 80336 Munich, Germany
^cDepartment of Molecular and Cellular Sports Medicine, German Sports University, Am Sportpark Müngersdorf 6, 50948 Cologne, Germany



0.25 0.5 2 4 6 8 24 48(h) 0.25 0.5 2 4 6 8 24 48(h)



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View Journal

Genotoxic profile of sulfur mustard in HaCaT/SM cells

Li Wang^{a,b}

0	2	3
0	1	3
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0	0	1
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Mechanism of blistering is still not understood!

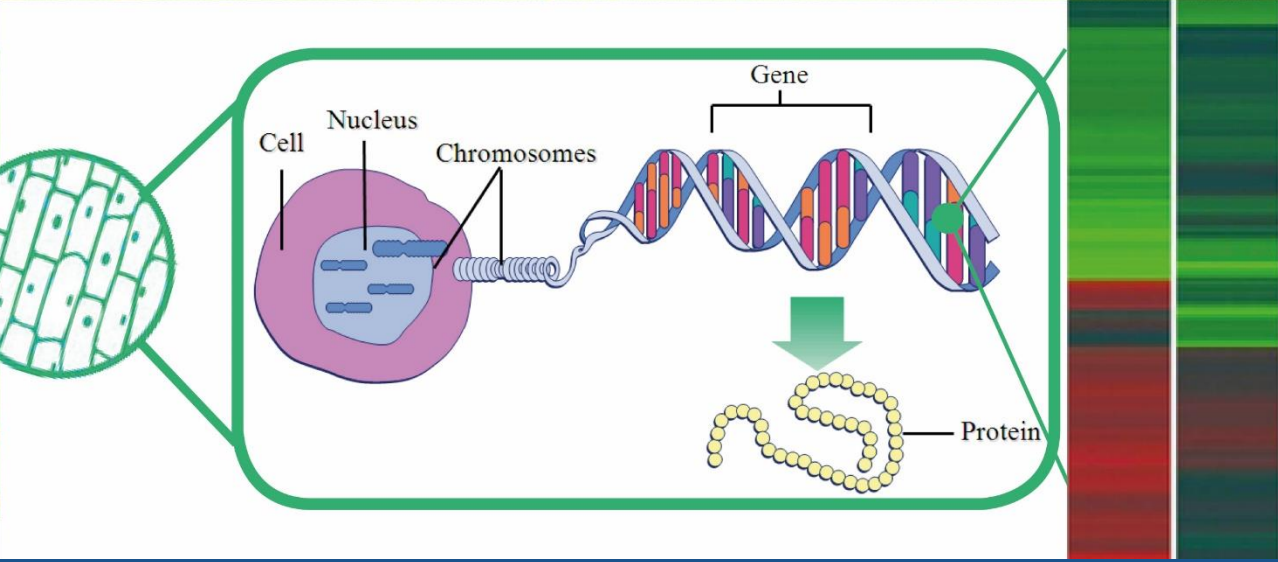
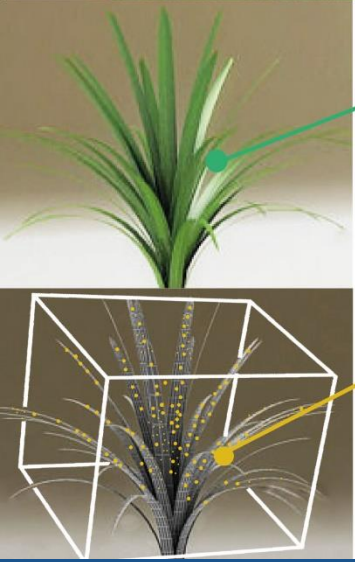


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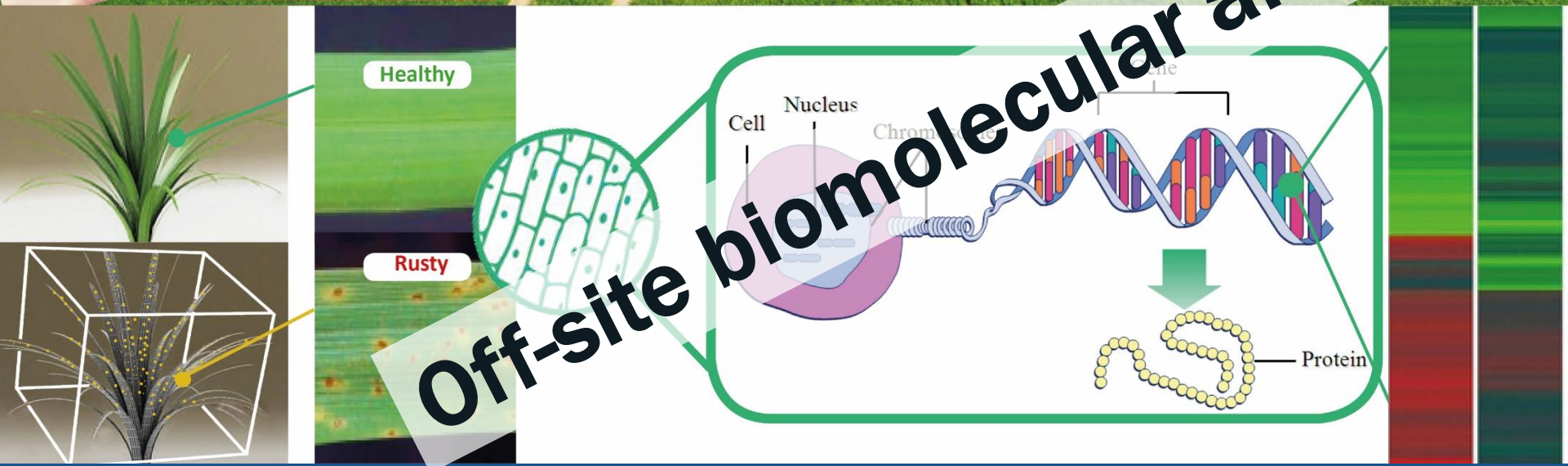
*The National
Academies of*
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ENGINEERING
MEDICINE**







Real-time on-site analysis



Off-site biomolecular analysis



Analysis

28 June 1994



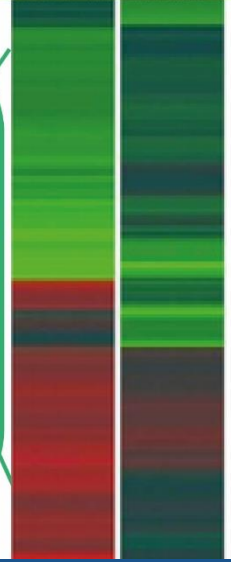
5 July 1994



Analysis



Office



Mobile Sensors

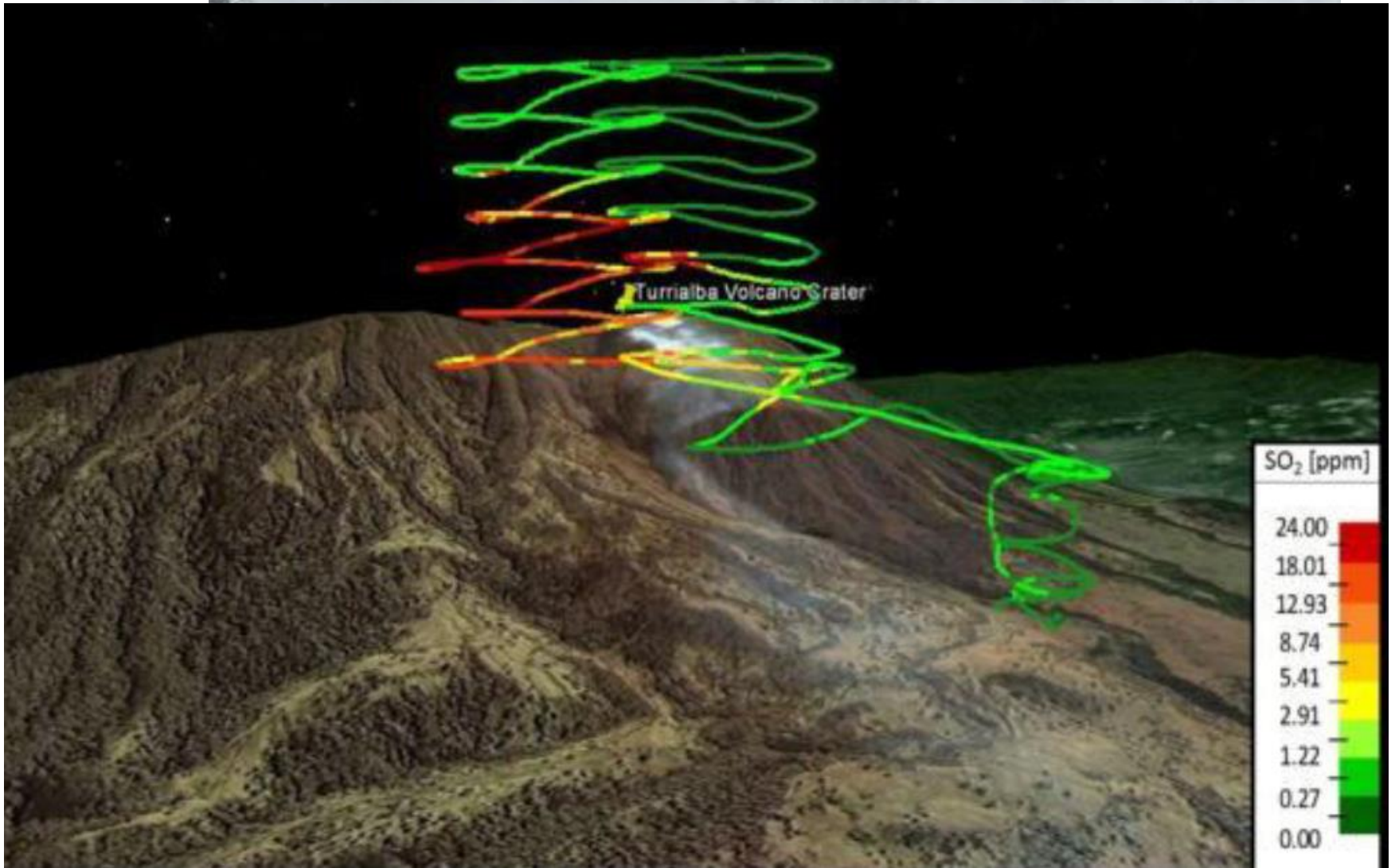
Poas, Costa Rica



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Dr Jorge Diaz, University of Costa Rica

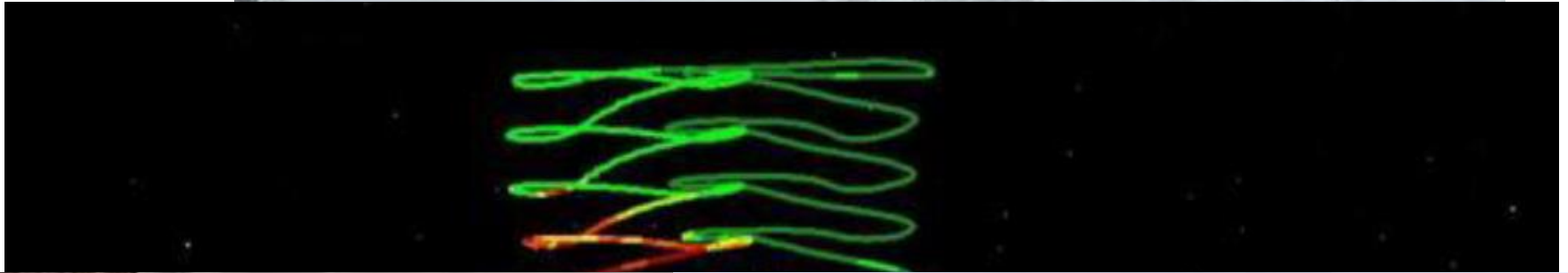
Mobile Sensors



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Dr Jorge Diaz, University of Costa Rica

Mobile Sensors



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Dr Jorge Diaz, University of Costa Rica

Mobile Sensors

DR1000

AVAILABLE SENSORS

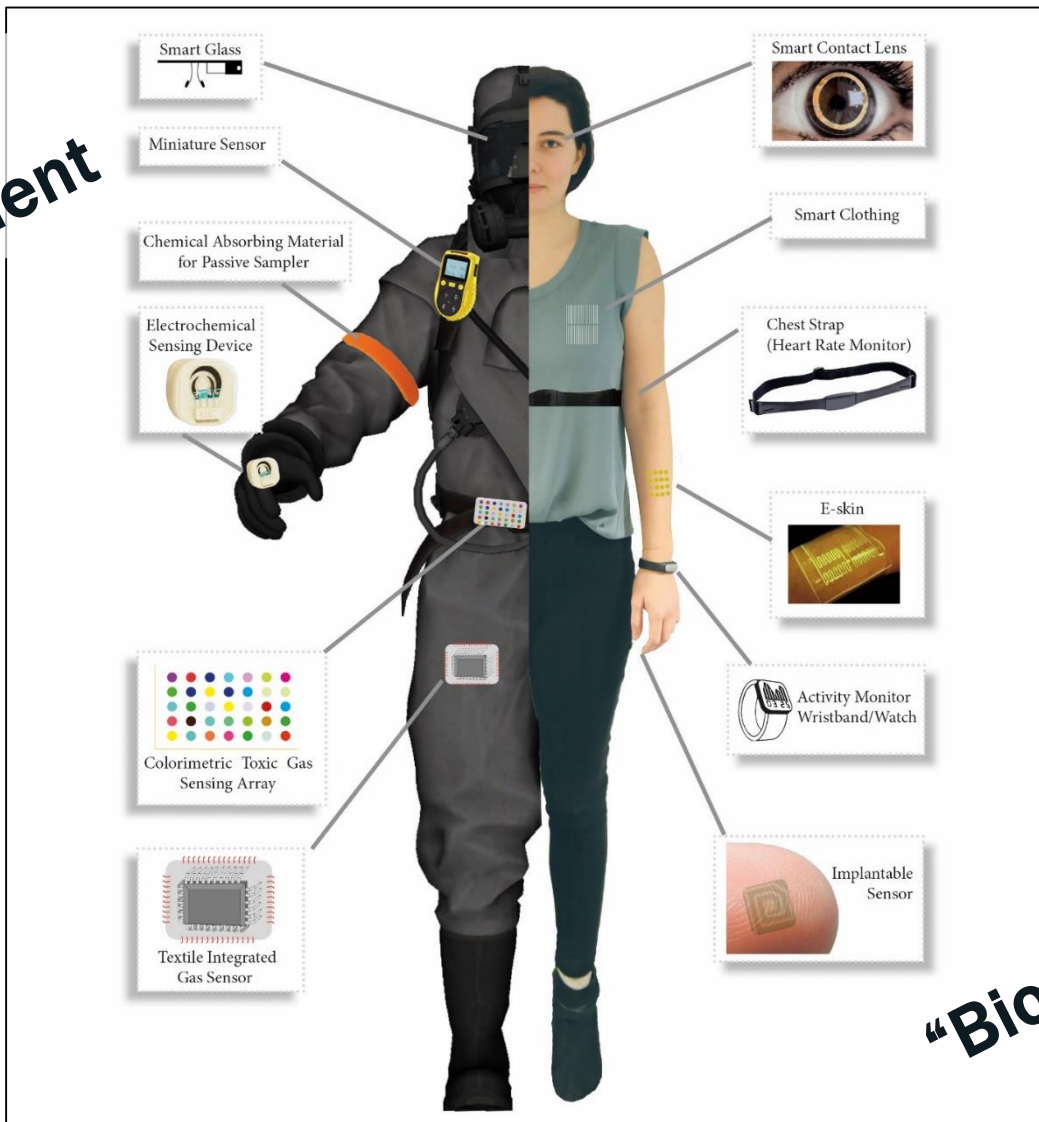
Sensor ID	Chemical	Range	Lowest Detection	Resolution (ppm)
CD1	Carbon Dioxide - High Concentration	5,000 to 900,000 ppm	5000 ppm	100 ppm
CD2	Carbon Dioxide - Low Concentration	0-5000ppm	0 ppm	15 ppm
CO1	Carbon Monoxide (low Concentration)	500 ppm	15 ppm	5 ppm
CO2	Carbon Monoxide (high concentration)	10000 ppm	250 ppm	20 ppm
C11	Chlorine	20 ppm	200 ppb	20 ppb
E1	Ethylene Oxide	0-100 ppm	1 ppm	0.1 ppm
H1	Hydrogen	0-5000 ppm	1 ppm	0.8 ppm
HCL1	Hydrogen Chloride	100 ppm	0.1 ppm	0.1 ppm
HCY1	Hydrogen Cyanide	100 ppm	0.1 ppm	0.1 ppm
AM1	Ammonia	100 ppm	0 ppm	1 ppm
ON1	Ozone and Nitrogen Dioxide	O3- 20; NO2- 20 ppm	0 ppb	15 ppb
PH1	Phosphine (low Concentration)	10 ppm	0 ppm	30 ppb
PH2	Phosphine (high Concentration)	2000 ppm	5 ppm	2 ppm
HS1	Hydrogen Sulfide (low Concentration - ppb)	1 ppm	3 ppb	1 ppb
HS2	Hydrogen Sulfide (high Concentration - ppm)	2000 ppm	1 ppm	1 ppm
NO1	Nitrogen Oxide	100	0 ppm	0.1 ppm
CH1	Carbon Monoxide and Hydrogen Sulfide	CO 0-1000, H2S 0 - 100 ppm	0 ppm	CO 1, H2S 0.25 ppm
E2	Ethanol	0-500 ppm	0 ppm	1 ppm
MT1	Methane (LEL)	0-100% LEL	0 ppm	1% LEL
NC1	Nitric Oxide (low Concentration)	20 ppm	0 ppm	80 ppb
NC2	Nitric Oxide (High Concentration)	5000 ppm	0 ppm	1 ppm
ND1	Nitrogen Dioxide (Low Concentration)	20 ppm	0 ppm	0.02 ppm
ND2	Nitrogen Dioxide (high Concentration)	200 ppm	0 ppm	0.1 ppm
O1	Oxygen	0-20%	0 ppm	0.10%
O2	Oxygen	0-100%	0 ppm	1%
PD1	Total VOCs (ppb) - PID	50 ppm (isobutylene)	0 ppm	1 (ppb isobutylene)
PD2	Total VOCs (ppm) - PID	300 ppm (isobutylene)	1 ppm	0.1 (ppm isobutylene)
SD1	Sulfur Dioxide (high Concentration)	2000 ppm	0 ppm	2 ppm
SD2	Sulfur Dioxide (low Concentration)	20 ppm	0 ppb	20 ppb
FM1	Formaldehyde	10 ppm	0.01 ppm	0.01 ppm
PM 1-10	Particulate PM 1, 2.5, 10	0-10,000 Particles/Sec	PM 1	N/A



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Humans as Sensors

**Chemicals
in Environment**



“Biomarkers”



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Institute for Medical
Research and
Occupational
Health



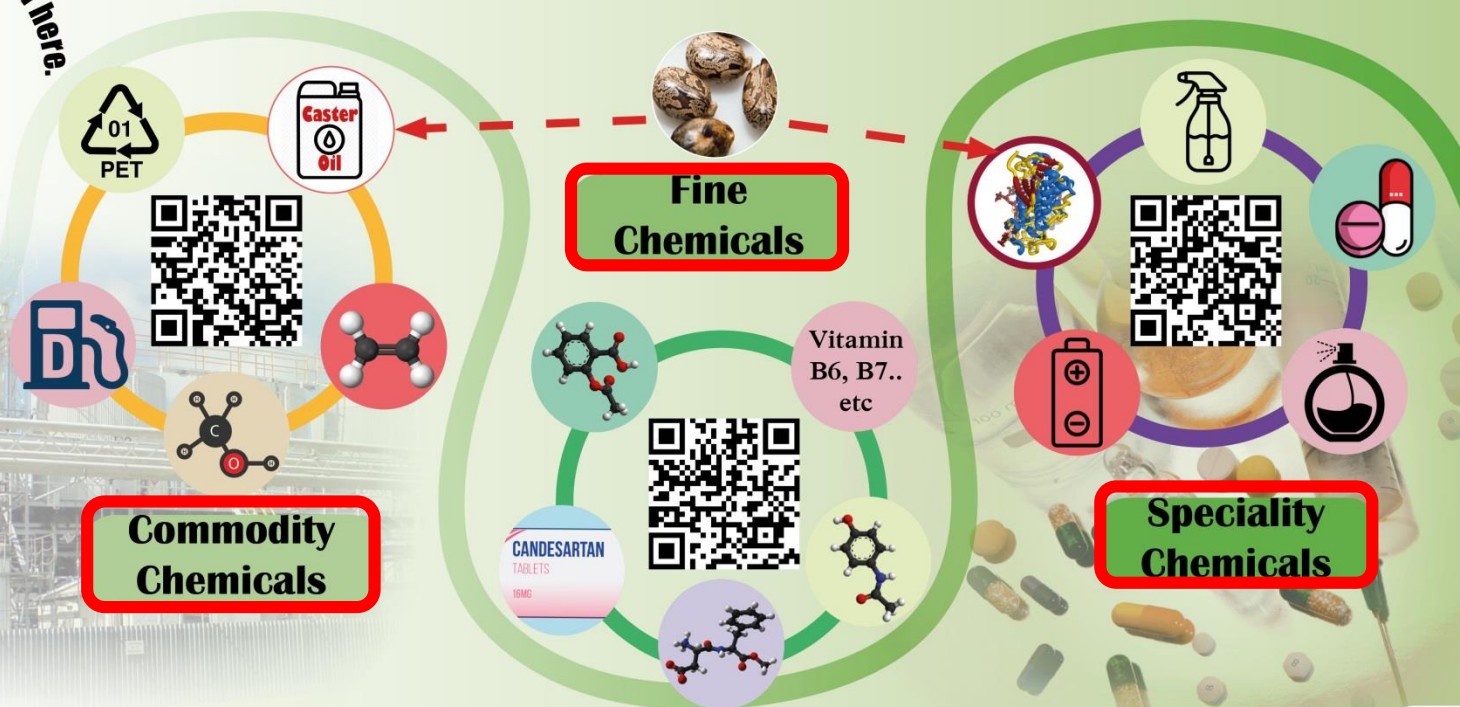
Chemical Synthesis From Small to Large



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Chemical Production

For more information, scan here.



Refinery



Chemicals



Fermenter



Biomass

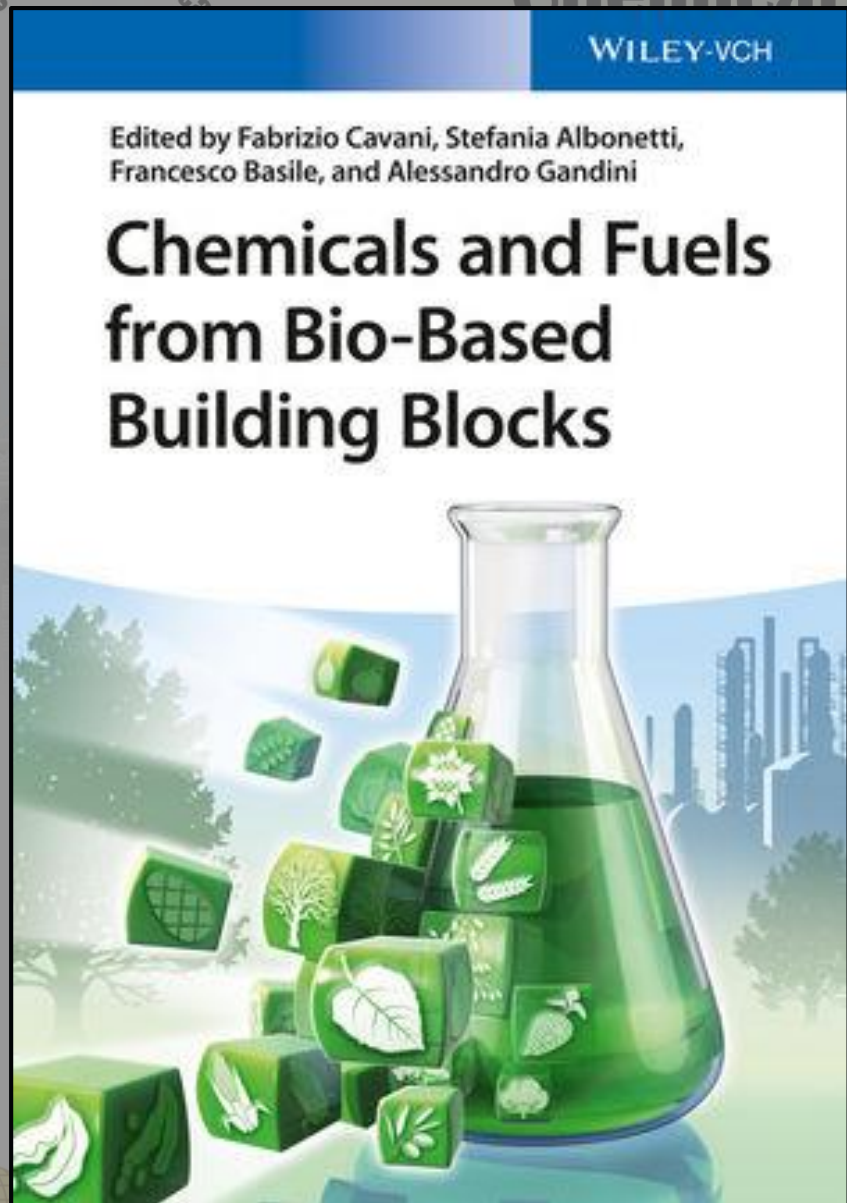


Photosynthesis



For more information, see

Chemical Production



Fine chemicals

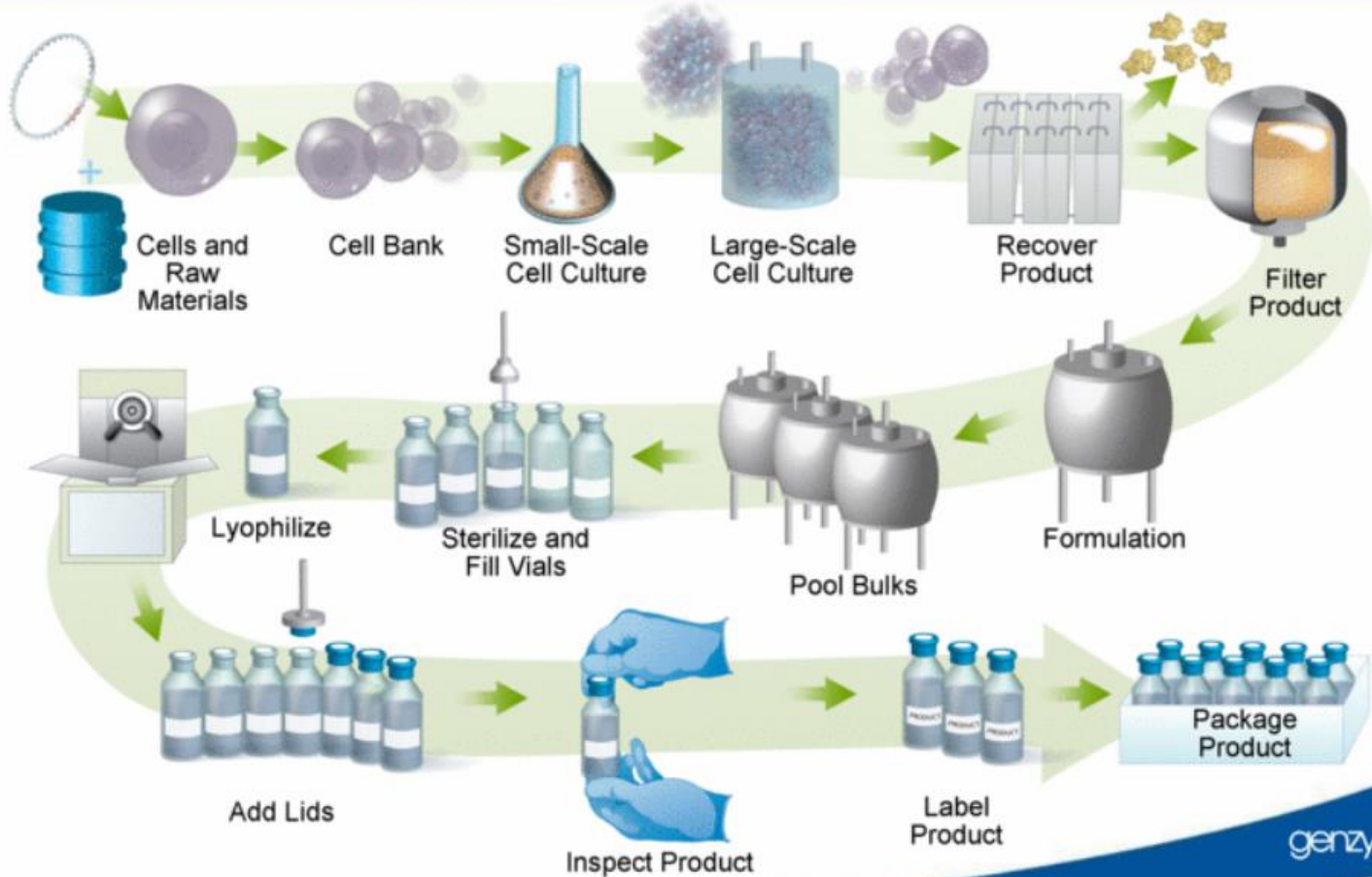
Vitamin B6, B7.. etc

Greatest levels of adoption of biobased production methods seen here



Industrial Biology

Biopharmaceutical Manufacturing Is Inherently Complex



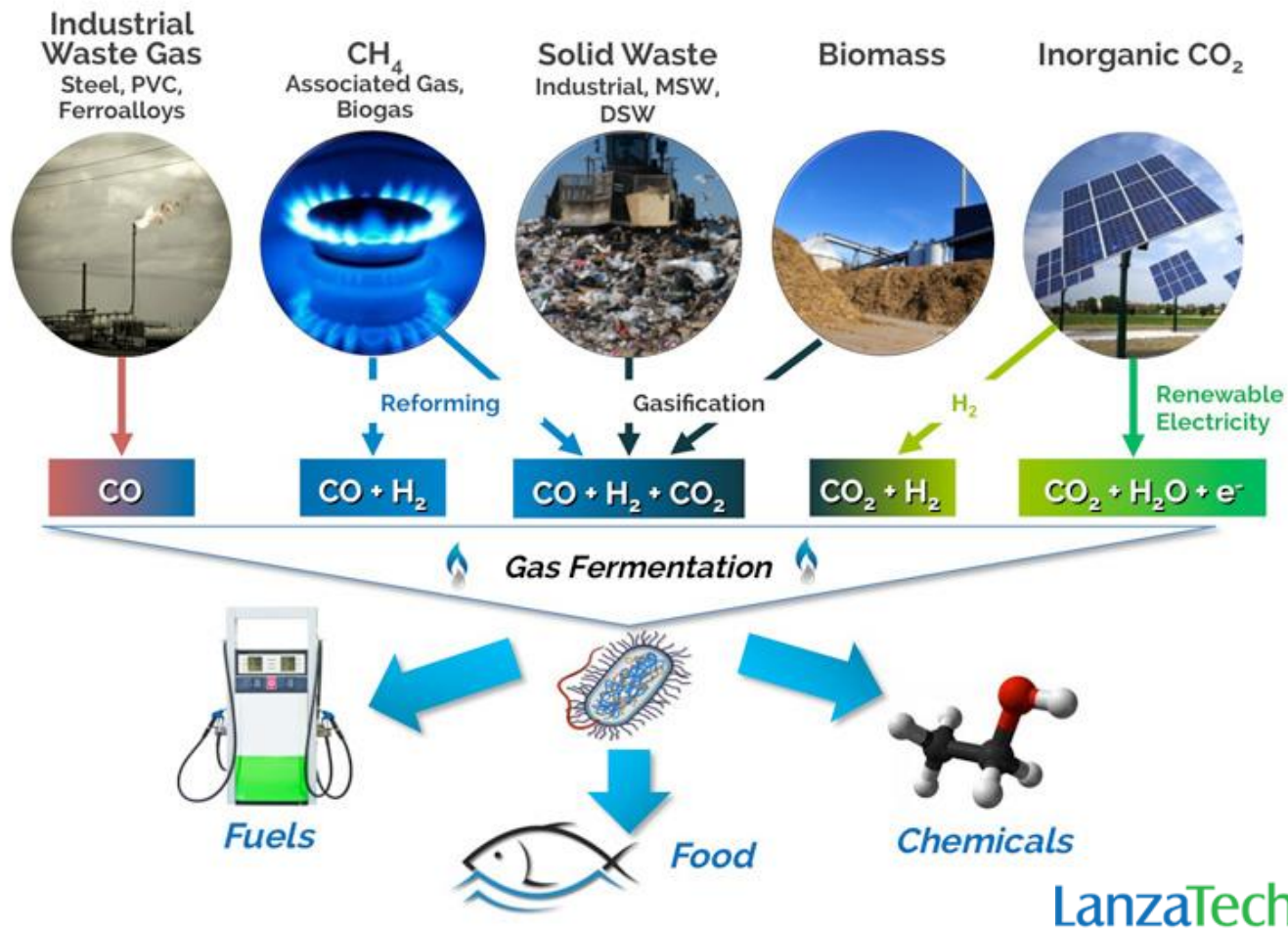
Dr D. Leake



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Decentralised Chemical production?

Waste Carbon as a Resource for Product Synthesis




Inputs for the Scientific Advisory Board's Report

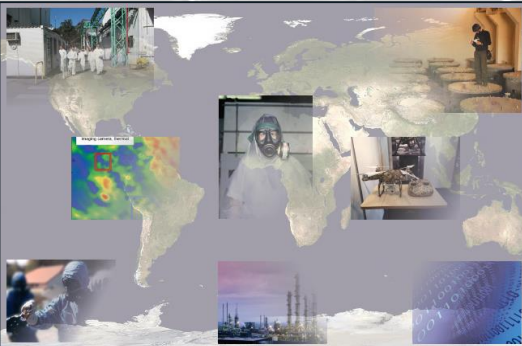
CONVERGENCE OF CHEMISTRY AND BIOLOGY

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



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Inputs for the Scientific Advisory Board's Report



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons

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.

CONVERGENCE OF CHEMISTRY AND BIOLOGY

REPORT OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS



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MANAGEMENT:
Analytical Chemistry

SCIENTIFIC ADVISORY
BOARD'S TEMPORARY WORKING GROUP

NOVEMBER 2014

PROHIBITION



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Inputs for the Scientific Advisory Board's Report



RESPONSIBLE SCIENTIFIC

EXECUTIVE

1. Respo
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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:

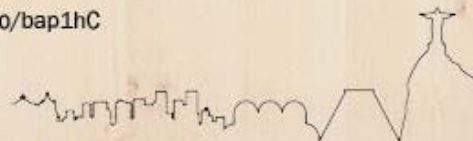


Innovative Technologies for Chemical Security

Rio de Janeiro, Brazil. 3 to 5 July 2017
SAB-26/WP.1, dated 21 July 2017, URL: <http://q-r.to/bap1hC>
Coorganizers:



The National Academies of
SCIENCES
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MEDICINE



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:



REPUBLIC OF CROATIA
MINISTRY OF ECONOMY



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(b) ...
CS-2016-978(E) distributed 26/05/2016

1.4 The list of ...
point of reference ...
1 May 2014). The addition ...
(Appendix 5) might also be provided ...
the criteria of an RCA (and thus should not ...
been considered for use as an RCA.

1.5 This original list of 59 has been reviewed and an additional chemical ... (pipetime) 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/fileadmin/OPCW_serve/2016/06/117-2014_e.pdf

Inputs for the Scientific Advisory Board's Report



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



27 Events

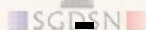


Chemical Weapons Agents: Toxicity, Emergency Response, and Medical Countermeasures

Paris, France. 21 to 23 September 2016

SAB-24/WP.2, dated 14 October 2016, URL: <http://q-r.to/bap1gy>

Coorganizer:



- 289 individuals



- 58 Nationalities



Innovative Technologies in Chemical Forensics

Rio de Janeiro, Brazil. 3 to 5 July 2017

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

Coorganizers:



453 Speakers

- 201 individuals



International Workshop on Chemical Products

Zagreb, the Republic of Croatia. 13 to 15 October 2017

SAB-26/WP.2, dated 19 October 2017, URL: <http://q-r.to/bap1hD>

Coorganizers:



32 Reports



Engagement in Scientific Communities



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Twenty-first Session
23 - 27 June 2014

RESPONSE
SCIENTIFIC

ENEMY

1. Resp

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CS-2016-978(E) distributed 20/05/2016

1.4 The list of 11 points of reference (Appendix 5) dated 1 May 2014 is being reviewed and the SAB (Appendix 5) might also be provided as an RCA (and used should not be considered for use 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/fileadmin/OPCW_sab/2016/05/17-2014_e.pdf



OPCW

Organisation for the Prohibition of Chemical Weapons

What Happens After the Science Review? Connecting Science Advice with Decision Makers

*Disarmament and Technological Change
Biological Weapons Convention Meeting of Experts MX2
10 August 2018*

Jonathan E. Forman, Ph.D.

Science Policy Adviser and Secretary to the Scientific Advisory Board

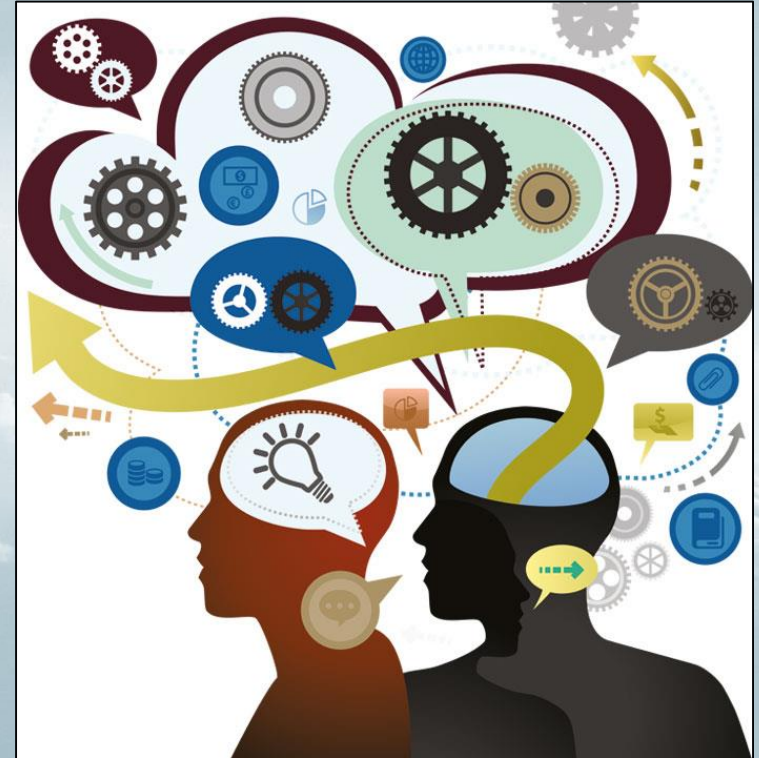
Jonathan.forman@opcw.org

What is the Purpose of a Science Review/Advice Mechanism?

Foresight and horizon scanning?



Policy and/or oversight for science?



Science to inform decision making and/or policy?



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What is the Purpose of a Science Review/Advice Mechanism?



Who is the advice for ? **What** do they want and need from it?

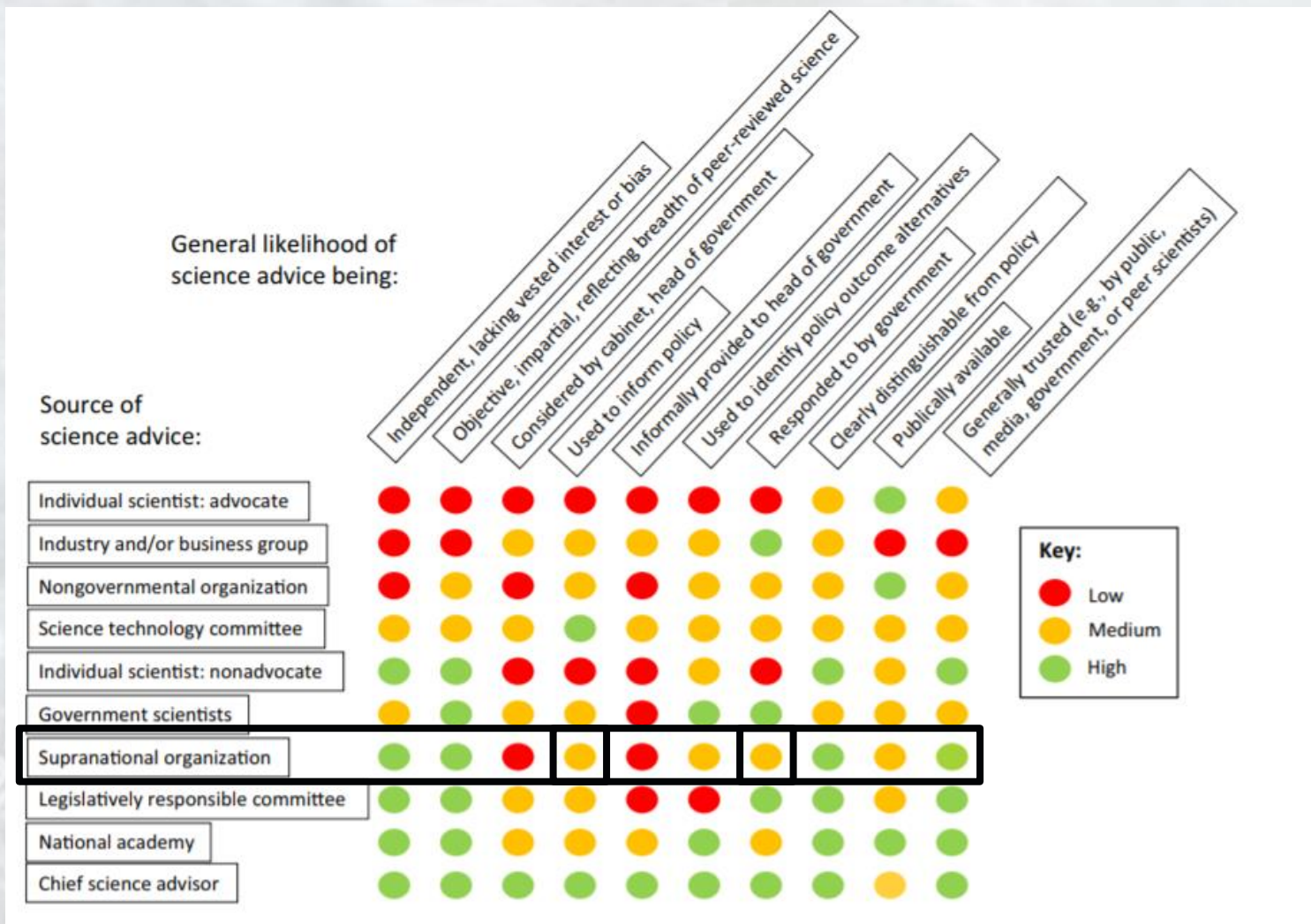


making and/or policy?



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Impact and Effectiveness of Science Advice Mechanisms: Structure, Placement and Intended Recipients Matter!



Obligations: International Treaty Compliance: National Implementation



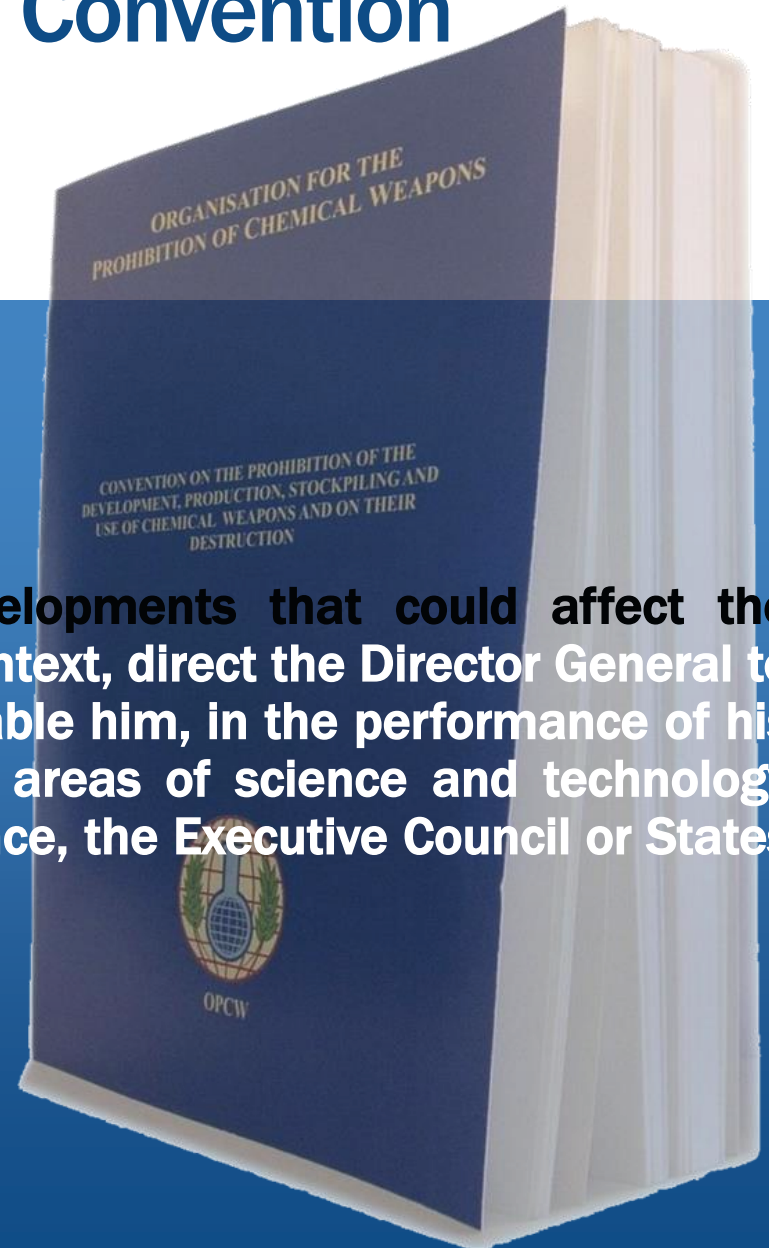
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Science and Technology in the Chemical Weapons Convention

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)



Science and Technology in the Chemical Weapons Convention



Advice for the States Parties!

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the Organization for the Prohibition of Chemical Weapons.
Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

The Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

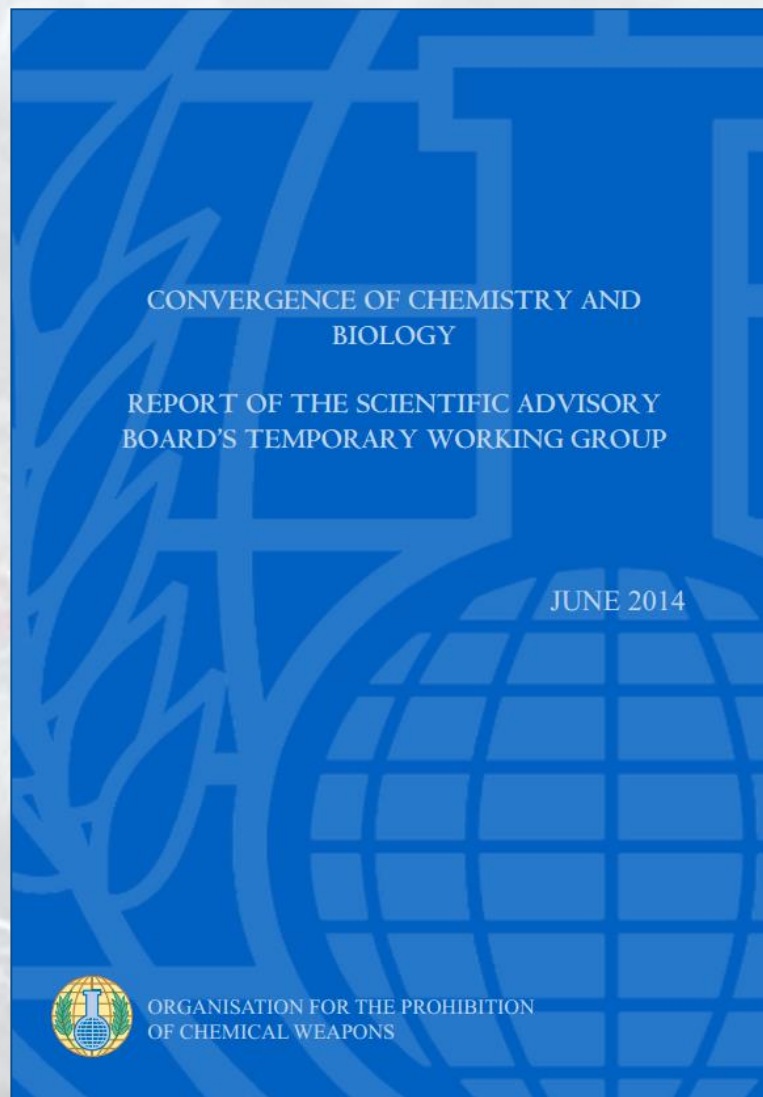


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States Parties on Science and Technology



Policy for Science: Advice on Science of “Concern”



www.opcw.org/fileadmin/OPCW/SAB/en/TWG_Scientific_Advisory_Group_Final_Report.pdf



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ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons

Recommendations From The OPCW Scientific Advisory Board's Report on Convergence of Chemistry & Biology

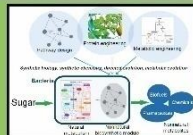
Recommendation 1

The SAB, or a suitable TWG, and the TS should continue to monitor advances in production facilities and technologies, and related trends such as outsourcing and modularisation of equipment. Assessments should be made on a periodic basis to determine their relevance to verification under the CWC. Regular engagement with subject matter experts, e.g. from the biotechnology industry, will be required.



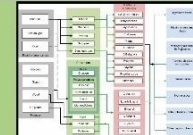
Recommendation 2

The SAB should monitor developments in biological and biologically-mediated chemical production processes, such as metabolic engineering, synthetic biology and associated enabling technologies. Regular engagement with subject matter experts will be required.



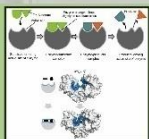
Recommendation 3

The SAB should continue to monitor the range of chemicals being studied and produced using biological or biologically-mediated processes.



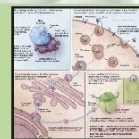
Recommendation 4

The SAB, or a suitable TWG, should review advances in rational enzyme design prior to the next review conference.



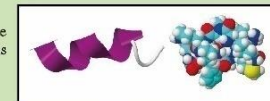
Recommendation 5

The SAB, or a suitable TWG, should review the feasibility of using metabolic engineering or synthetic biology to obtain toxins prior to the next review conference.



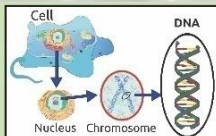
Recommendation 6

The TS should increase and maintain in-house knowledge of bioregulators, and possible applications of new developments in drug delivery.



Recommendation 7

The SAB, or a suitable TWG, should review the synthesis of replicating organisms prior to the next review conference.



Recommendation 8

The SAB, or a suitable TWG, should review progress in the use of enzymes for decontamination prior to the next review conference.



Recommendation 9

The OPCW should monitor advances in protective equipment and possible applications for OPCW personnel as they become commercially available.



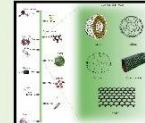
Recommendation 10

The OPCW should consider possible applications of diagnostic devices to on-site activities as they become commercially available.



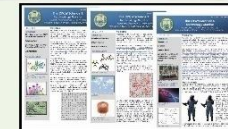
Recommendation 11

The SAB should monitor advances in nanotechnology prior to the next review conference. Regular engagement with subject matter experts will be required.



Recommendation 12

The SAB and TS should examine ways to increase and maintain in-house, high level knowledge of a broader range of scientific disciplines.



<https://www.opcw.org/special-revision/science-technology/biotechnology>

Recommendation 13

A venue like the TWG on convergence of chemistry and biology should continue to exist, possibly as a temporary working group or a standing arrangement under the SAB.



Recommendation 14

National Authorities could be encouraged to engage more actively on convergence issues, including interacting with relevant biological and chemical scientific communities and hosting relevant events. A standing item on science and technology at National Authority Days might provide an opportunity to promote and report back on such an activity. Adopting convergence as a major theme for a future National Authority Day would help draw attention to this issue.



Recommendations 15 & 16

The SAB and TS should continue to work across areas of overlap between the CWC and the BWC. The Director-General might ask States to consider knowledge of the biological sciences when considering nominating experts to the SAB.



The TS, supported by the SAB, should continue to participate in such meetings and continue to address convergence.

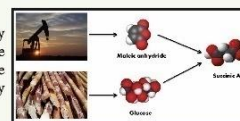
Recommendation 17

The Director-General might consider meeting with the Chair of the BWC and heads of relevant international scientific bodies to explore issues around convergence.



Recommendation 18

Taking into consideration the convergence of chemistry and biology as it relates to the synthesis of chemicals, the TWG was of the view that any process designed for the formation of a chemical substance should be covered by the term "produced by synthesis".



Recommendation 19

The TS should review the technical feasibility of converting a bio-based chemical processing facility to produce chemicals of concern to the CWC.



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/opcw



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons

Recommendations From The OPCW Scientific Advisory Board's Report on Convergence of Chemistry & Biology

Recommendation 1

The SAB, or a suitable TWG, and the TS should continue to monitor advances in production facilities and technologies, and related trends such as outsourcing and modularisation of equipment. Assessments should be made on a periodic basis to determine their relevance to verification under the CWC. Regular engagement with subject matter experts, e.g. from the biotechnology industry, will be required.



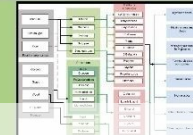
Recommendation 2

The SAB should monitor developments in biological and biologically-mediated chemical production processes, such as metabolic engineering, synthetic biology and associated enabling technologies. Regular engagement with subject matter experts will be required.



Recommendation 3

The SAB should continue to monitor the range of chemicals being studied and produced using biological or biologically-mediated processes.



Recommendation 4

The SAB, or a suitable TWG, should review advances in rational enzyme design prior to the next review conference.



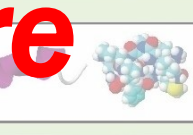
Recommendation 5

The SAB or suitable TWG, should review the feasibility of using naturally occurring or genetically modified organisms to produce toxins prior to the next review conference.



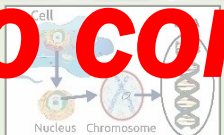
Recommendation 6

The SAB should continue to monitor the range of chemicals being studied and produced using biological or biologically-mediated processes.



Recommendation 7

The SAB, or a suitable TWG, should review the synthesis of replicating organisms prior to the next review conference.



Recommendation 8

The SAB or suitable TWG, should review progress in the synthesis of chemical weapons prior to the next review conference.



Recommendation 9

The SAB should continue to monitor the range of chemicals being studied and produced using biological or biologically-mediated processes.



Recommendation 10

The OPCW should continue to monitor possible applications of diagnostic devices to CWC activities as they become commercially available.



Recommendation 11

The SAB or suitable TWG, should review progress in the synthesis of chemical weapons prior to the next review conference. Regular engagement with subject matter experts will be required.



Recommendation 12

The SAB should continue to monitor the range of chemicals being studied and produced using biological or biologically-mediated processes.



Recommendation 13

A venue like the TWG on convergence of chemistry and biology should continue to exist, possibly as a temporary working group or a standing arrangement under the SAB.



Recommendation 14

National Authority Days should be encouraged as a more active convergence is being sought. A standing arrangement between chemical scientific communities and related relevant events. A standing item on science and technology at National Authority Days might provide an opportunity to promote and report back on such an activity. Adopting convergence as a major theme for a future National Authority Day would help draw attention to this issue.



Recommendation 15

The SAB should continue to monitor the range of chemicals being studied and produced using biological or biologically-mediated processes.



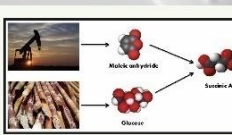
Recommendation 17

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Recommendation 18

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Recommendation 19

The TS should review the technical feasibility of converting a bio-based chemical processing facility to produce chemicals of concern to the CWC.



13/19 Recommendations are "to continue monitoring" and 4/19 Recommendations are to "engage" with stakeholders





ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS



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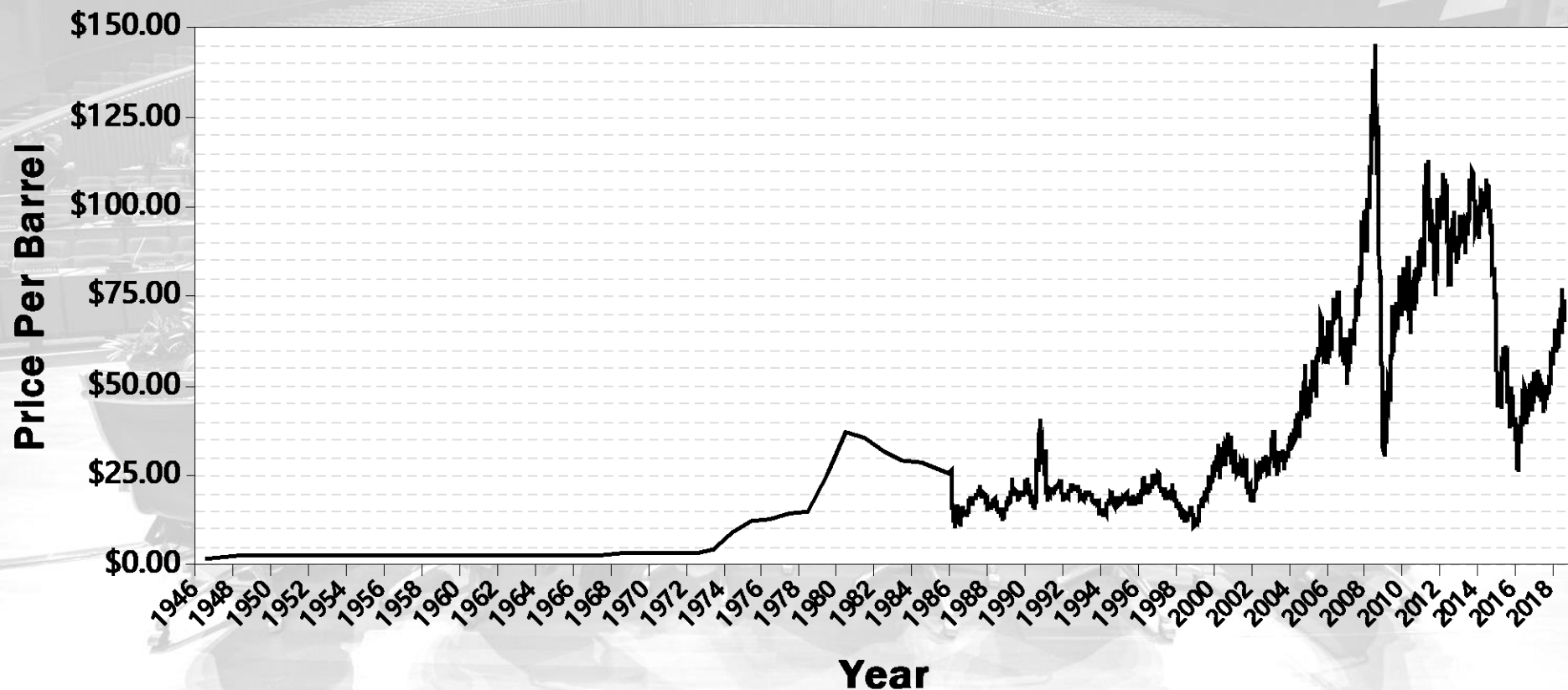
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Policy for Science is Driven by More than Chemical Security

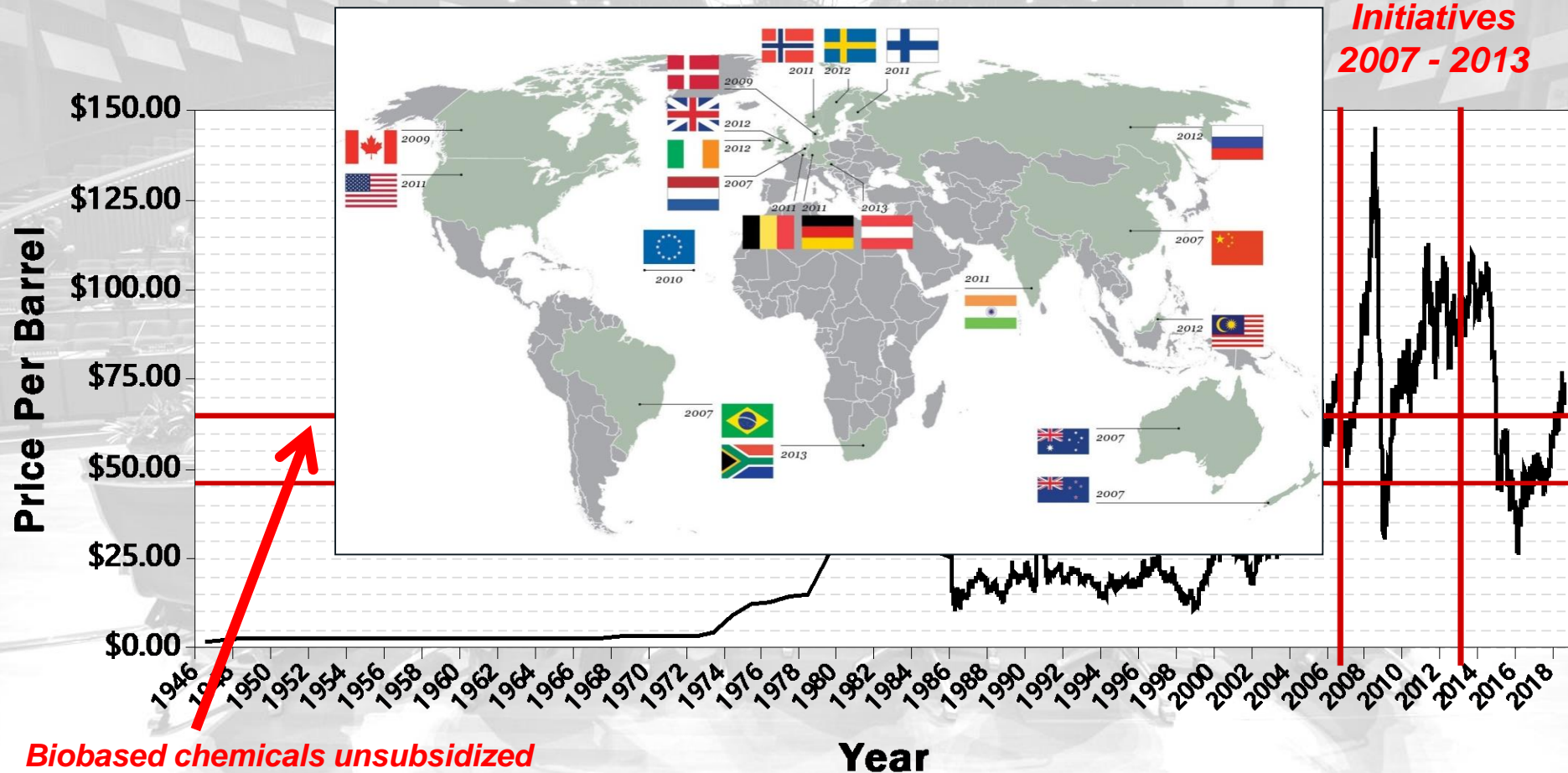
(Oil prices 1947 to 26 July 2018)



OPCW

Policy for Science is Driven by More than Chemical Security (Oil prices 1947 to 26 July 2018)

**Bioeconomic
Initiatives
2007 - 2013**



OPCW

Policy for Science is Driven by More than Chemical Security (Oil prices 1947 to 26 July 2018)

Volume 87 Issue 50 | pp. 23-25
Issue Date: December 14, 2009



Big Plans For Succinic Acid

Against the odds, five ventures are pursuing the biobased chemical across the globe

By Michael McCoy

[+]Enlarge



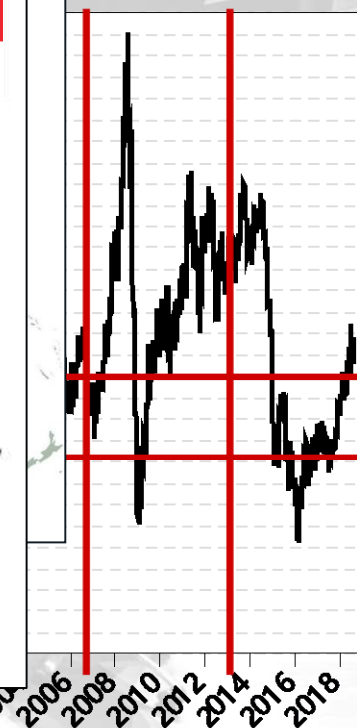
FINISHING TOUCHES

Bioamber's demonstration plant in northeastern France was almost

Earlier this month in rural northeastern France, a venture between a U.S. company and a French farming cooperative started manufacturing succinic acid from agricultural rather than petrochemical feedstocks. Built at a cost of \$27 million, the demonstration facility is the first of its kind in the world—but almost certainly not the last.

Four other succinic acid projects are in development across

Bioeconomic
Initiatives
2007 - 2013



1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

**Biobased chemicals unsubsidized
cost equivalent range to be competitive**

Year



OPCW

Policy for Science is Driven by More than Chemical Security (Oil prices 1947 to 26 July 2018)

Bioeconomic
Initiatives
2007 - 2013

Volume 87 Issue 50 | pp. 23-25
Issue Date: December 14, 2009



Big Plans For Succinic Acid

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FINISHI
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BIOBASED CHEMICALS

Succinic acid maker BioAmber is bankrupt

by *Michael McCoy*

MAY 13, 2018 | APPEARED IN **VOLUME 96, ISSUE 20**

BioAmber, a pioneer in the manufacture of succinic acid from renewable resources, has declared bankruptcy. "This process will provide BioAmber with the time and stability to restructure its finances," says CEO Richard Eno. Like other producers of biobased chemicals, BioAmber has struggled in an environment of low energy and raw material costs for traditional chemical products. It had close to \$12 million in succinic acid sales last year, an 81% increase over 2016, but a heavy debt load from building its plant in Sarnia, Ontario.

Chemical & Engineering News

ISSN 0009-2347

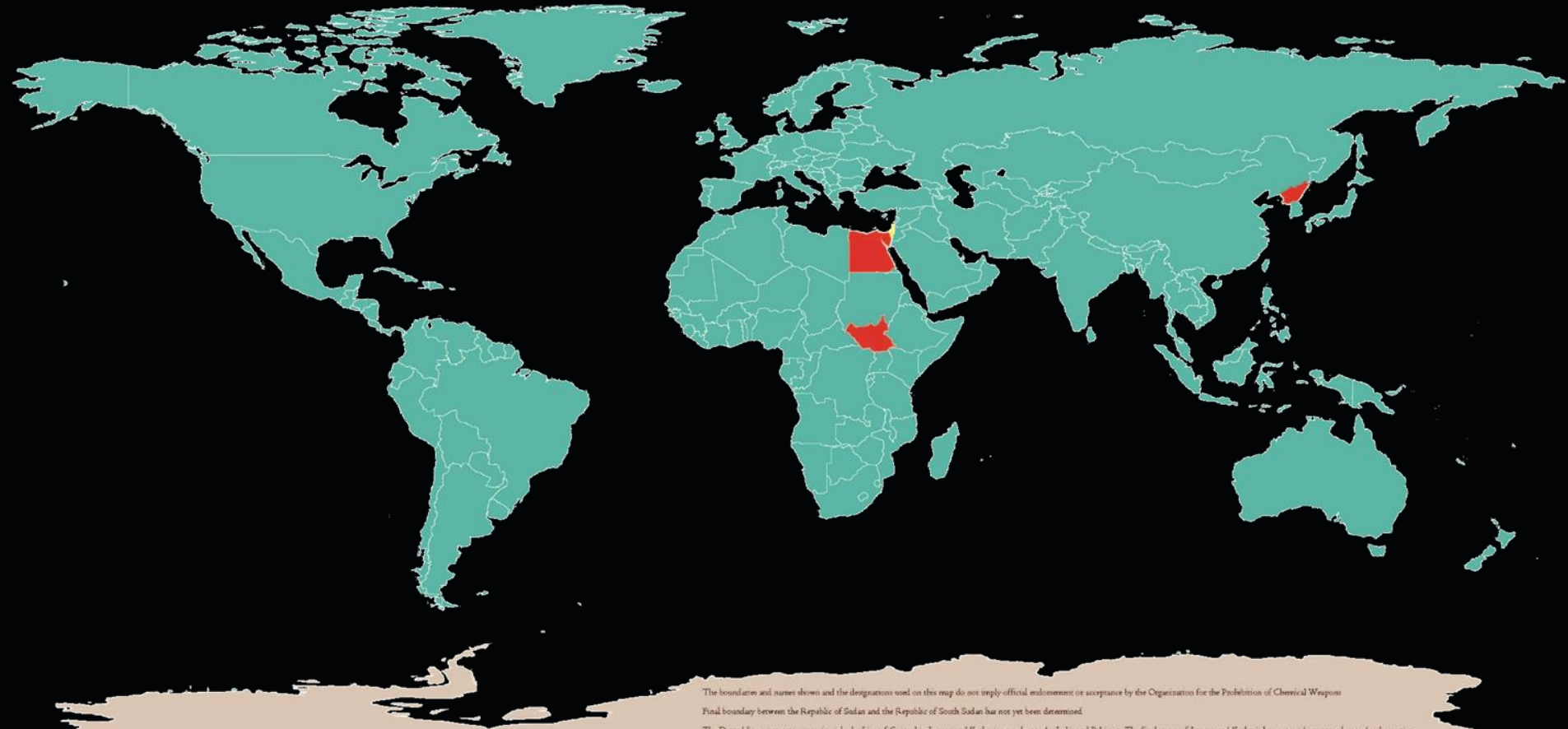
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OPCW

Biobased
cost equivalent

Consulting with States Parties on a Recommendation that Challenges National Policies: Production by Synthesis



193 States Parties

Signed Without Ratification

Non-Signatory

Consulting with States Parties on a Recommendation that Challenges National Policies: Production by Synthesis



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the Organisation for the Prohibition of Chemical Weapons
Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined
The Demilitarized Zone between the State of Palestine and the State of Israel is shown for information only. The final status of this zone remains to be determined.

193 States Parties

Signed Without Ratification

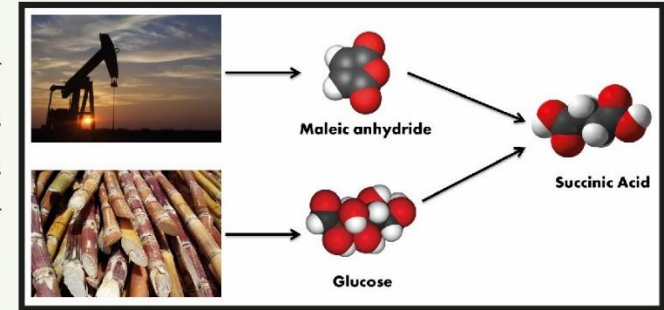
Non-Signatory

Consulting with States Parties on a Recommendation that Challenges National Policies: Production by Synthesis

Discussed since 1999!

Recommendation 18

Taking into consideration the convergence of chemistry and biology as it relates to the synthesis of chemicals, the TWG was of the view that any process designed for the formation of a chemical substance should be covered by the term “produced by synthesis”.



Considered further in TWG on verification in 2015

Recommendation 19

The TS should review the technical feasibility of converting a bio-based chemical processing facility to produce chemicals of concern to the CWC.



Risk assessment?

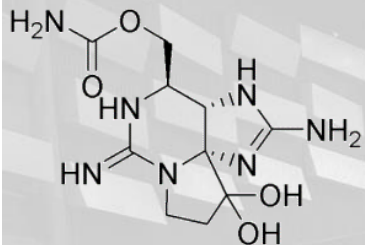
**Recommendations 18 and 19:
Evaluate Existing Science and Technology**

193 States Parties

Signed Without Ratification

Non-Signatory

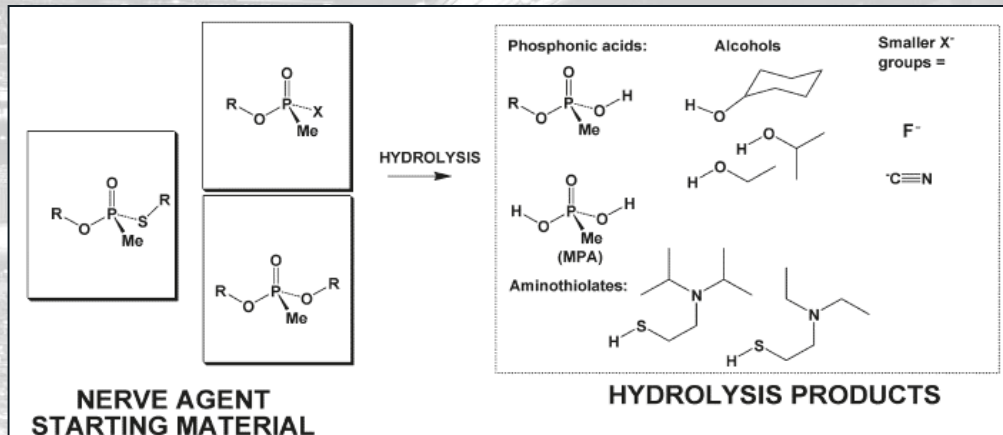
Science and Technology Underpin the Convention



Article II



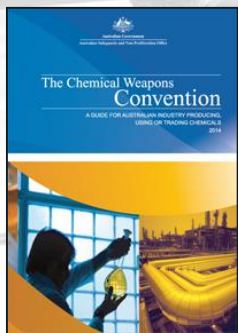
Article III



Articles IV and V



Article VI



Article VII



Article VIII



Articles IX and X



Article XI

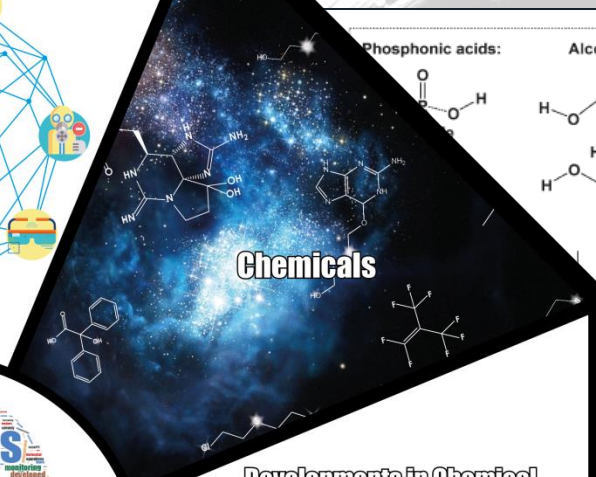
Advances in Science and Technology



Scientific Literacy and Science Advice



Chemicals



Developments in Chemical Production and Chemical Discovery



Technologies for the Delivery of Toxic Chemicals and Drugs



Article XI



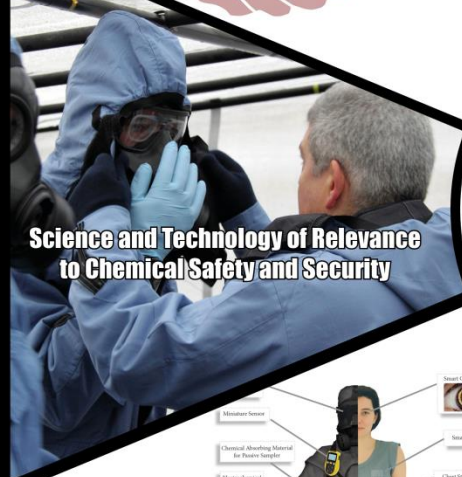
Science and Technology of Relevance to Verification



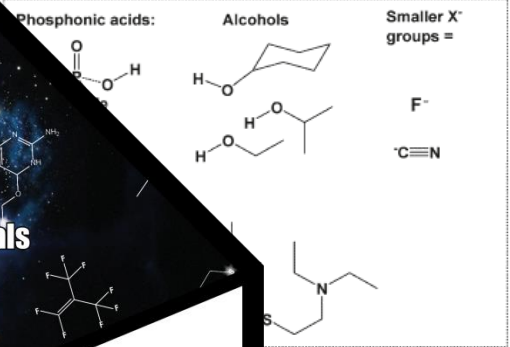
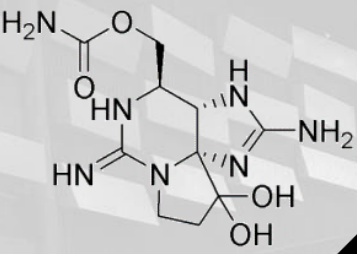
Assistance and Protection



Science and Technology of Relevance to Chemical Safety and Security



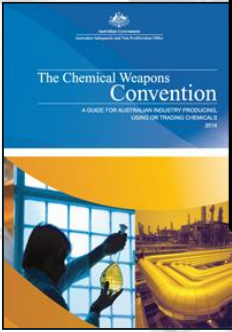
Article II



Article VI



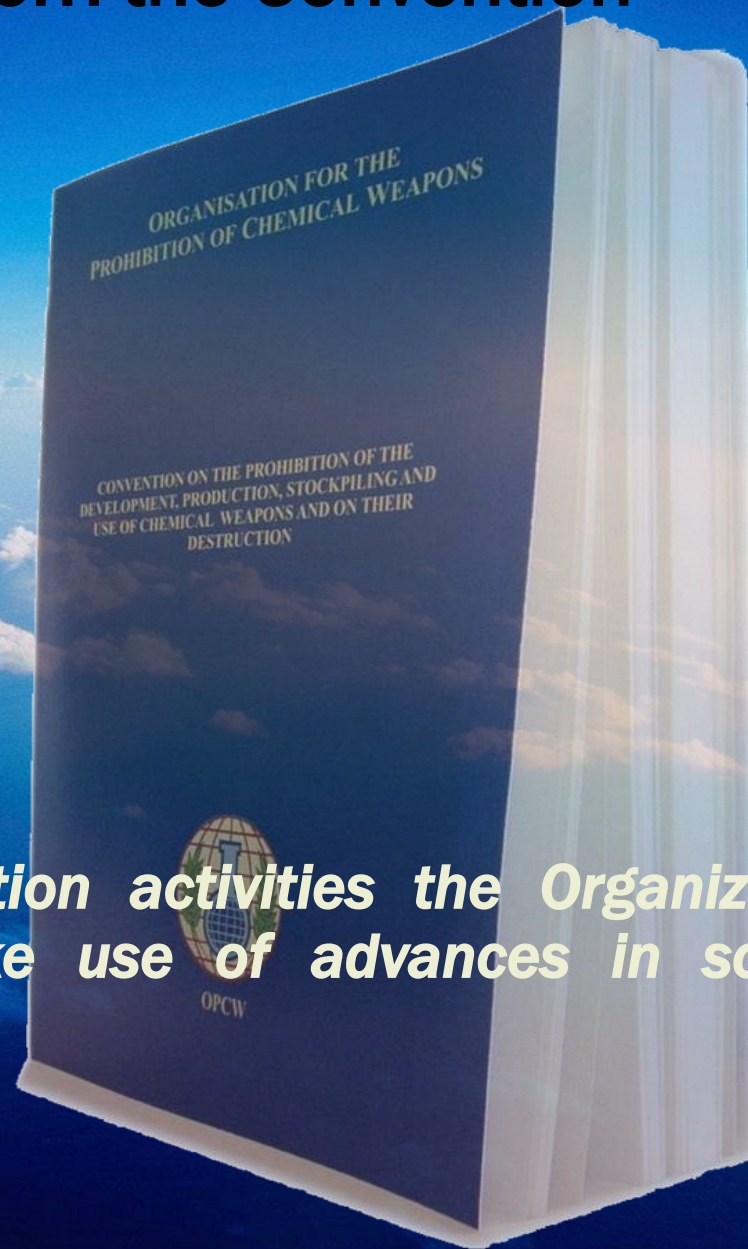
Article VII



We Cannot Afford to Fear Science

Disarmament and preventing re-emergence requires science advice for policy and decision making. Effective implementation demands scientific literacy

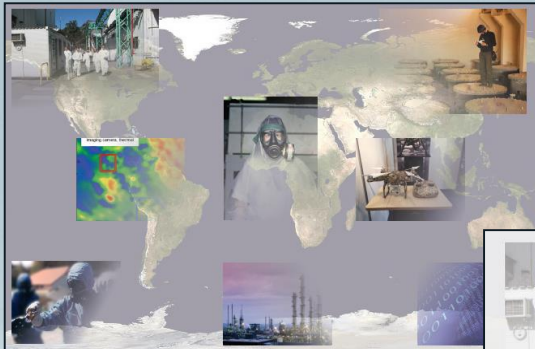
Guidance from the Convention



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

- ***CWC Article VIII, paragraph 6***

Verification Relevant Considerations are Continually Addressed



VERIFICATION

REPORT OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP

June 2015



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons

Recommendations From The OPCW Scientific Advisory Board's Report on Verification

Recommendation 1

The Secretariat should consider adopting a comprehensive, more analytical approach to verification utilising all available and verifiable information.



Recommendation 2

The Secretariat should acquire the capability to use open-source information on a routine basis.



Recommendation 3

The Secretariat should put in place an information management structure that can provide the support required for the verification process.



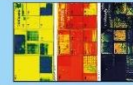
Recommendation 4

Remote/automated monitoring technologies should be added to the list of approved inspection equipment.



Recommendation 5

The Secretariat should look into the option of using satellite imagery for the planning of non-routine missions, in particular for IAU and CI.



Recommendation 6

The Secretariat should visit the National Authorities to obtain assurance on the accuracy and completeness of declarations. The outcome of such visits may impact on the inspection frequency.



Recommendation 7

The Secretariat must commission an independent review of all activities pertaining to the missions carried out in the Syrian Arab Republic.



Recommendation 8

The list of declarable CCPs submitted by States Parties should include all facilities which fall under the definition/requirement of paragraph 1 of Part IX of the Verification Annex, regardless of the purity level of a DOC or DOC mixtures produced.



Recommendation 9

Not all facilities that fall under Part IX of the Verification Annex should be considered of the same relevance to the object and purpose of the Convention. The TWG recommends a practical approach for enhancing the utilisation of verification resources for OCFE declaration and on-site inspection processes.



Recommendation 10

The verification thresholds for OCFEs producing highly relevant chemicals, and the possibility of revision of the product group codes, should be addressed by the SAB as well as the industry cluster.



Recommendation 11

The OPCW should increase the staff of the OPCW Laboratory to cope with various aspects of IAL, biomedical samples, trace environmental analysis, toxins, and on-site analysis. Establishing a network of DLs for biomedical sample analysis should be a high priority.



Recommendation 12

Lessons on chemical sampling and analysis from the OPCW's support to the 2013 United Nations Mission to Investigate the Use of Chemical Weapons in the Syrian Arab Republic, and all subsequent OPCW activities in relation to the Syrian Arab Republic must be identified and implemented.



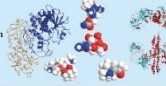
Recommendation 13

FTs should incorporate a broader range of chemicals, and at a wider range of concentrations, to prepare laboratories for IAU-type scenarios.



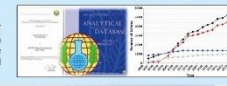
Recommendation 14

The Secretariat should expedite toxin identification exercises.



Recommendation 15

Continuous additions to the OPCW Central Analytical Database (OCAD) are recommended to allow the OPCW to meet all its mandated inspection aims, including IAU.



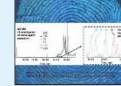
Recommendation 16

Developments in analytical instrument portability, maintenance and disposable biosensors should be periodically reviewed by the Secretariat and the SAB for potential applicability to on-site analysis.



Recommendation 17

The Secretariat should monitor developments in analytical analysis/chemical forensics.



Recommendation 18

The Secretariat should augment its capability to monitor and forecast developments in science and technology of relevance to the Convention and its verification regime.



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Report available at: https://www.opcw.org/fileadmin/OPCW/SAB/en/Final_Report_of_SAB_TWG_on_Verification_-_as_presented_to_SAB.pdf



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Verification Relevant Considerations are Continually Addressed



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons

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.



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Verification Relevant Considerations are Continually Addressed



ORGANISATION FOR PROHIBITION OF CHEMICAL WEAPONS

Working Group

Temporary Working Group

Reporting to the Scientific Advisory Board

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 4:

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

Question 7:

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

Question 10:

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

REPORTING BOARD



OPCW



OPCW

Fourth Special Session
26 – 28 June 2018

Conference of the States Parties

C-SS-4/DEC.3
27 June 2018
Original: ENGLISH

ADDRESSING THE THREAT FROM CHEMICAL WEAPONS USE

The Conference of the States Parties,
Reaffirming the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (hereinafter "the Convention");

Determined for the sake of all mankind to exclude completely the possibility of the use of chemical weapons through the implementation of the provisions of the Convention;
Recalling that the United Nations Security Council bears primary responsibility for the maintenance of international peace and security;

Recalling that United Nations Security Council Resolution 2235 (2015) established the OPCW-UN Joint Investigative Mechanism to identify perpetrators of chemical weapons attacks in Syria, and **regretting** that its mandate has not been renewed;

Reaffirming that those responsible for the use of chemical weapons should be held accountable;

Recalling paragraph 19 of Article VIII of the Convention that the Conference of the States Parties (hereinafter "the Conference") shall consider any questions, matters or issues within the scope of the Convention, and may make recommendations and take decisions on any questions, matters or issues related to the Convention raised by a State Party or brought to its attention by the Executive Council (hereinafter "the Council"), and **recalling** paragraph 20 of Article VIII of the Convention that the Conference shall oversee the implementation of the Convention and act in order to promote its object and purpose, and review compliance;

Recalling paragraph 37 of Article VIII of the Convention that the Technical Secretariat (hereinafter "the Secretariat") shall carry out the verification measures provided for in the Convention;

Recalling paragraph 40 of Article VIII of the Convention that the Secretariat shall inform the Council of any doubts, ambiguities or uncertainties about compliance with the Convention that have come to its notice in the performance of its verification activities and that it has been unable to resolve or clarify through its consultations with the State Party concerned, and **further recalling** paragraph 26 of Part XI(D) of the Verification Annex to the Convention;

CS-2018-1161(E) distributed 27/06/2018

Questions:

management of data including compilation,

and methodologies (whether can be used in the provenancing of material samples collected in an

technologies and methodologies (whether or new) can be used to ensure the integrity of a site?

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



Some Issues Require More Immediate Consideration

Six interessional responses to requests for advice from June 2013 to July 2018



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OPCW

Twenty-First Session
23 - 27 June 2014

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

EXECUTIVE SUMMARY

Scientific Advisory Board

SAB-21/WP.7
29 April 2014
ENGLISH only



OPCW

Twenty-Third Session
18 - 22 April 2016

RESPONSE TO THE DIRECTOR-GENERAL'S REQUEST TO THE SCIENTIFIC ADVISORY BOARD TO PROVIDE FURTHER ADVICE ON CHEMICAL WEAPONS SAMPLE STABILITY AND STORAGE

Scientific Advisory Board

SAB-23/WP.2
25 May 2016
ENGLISH only



OPCW

Twenty-Second Session
8 - 12 June 2015

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

Scientific Advisory Board

SAB-22/WP.2Rev.1
10 June 2015
ENGLISH only



OPCW

Twenty-First Session
18 - 22 April 2016

RESPONSE TO THE DIRECTOR-GENERAL'S REQUEST TO THE SCIENTIFIC ADVISORY BOARD TO PROVIDE FURTHER ADVICE ON SCHEDULED CHEMICALS

Scientific Advisory Board

SAB-21/WP.8
28 April 2016
ENGLISH only



OPCW

Scientific Advisory Board

RESPONSE TO THE DIRECTOR-GENERAL'S REQUEST TO THE SCIENTIFIC ADVISORY BOARD TO PROVIDE CONSIDERATION ON WHICH TO THE SCIENTIFIC ADVISORY BOARD TO PROVIDE FURTHER ADVICE ON RIOT CONTROL AGENTS ARE SUBJECT TO DECLARATION UNDER THE CHEMICAL WEAPONS CONVENTION



OPCW

Twenty-Eighth Session
3 - 7 June 2018

RESPONSE TO THE DIRECTOR-GENERAL'S REQUEST TO THE SCIENTIFIC ADVISORY BOARD TO PROVIDE ADVICE ON NEW TYPES OF NERVE AGENTS

Scientific Advisory Board

SAB-28/WP.1
3 July 2018
ENGLISH only



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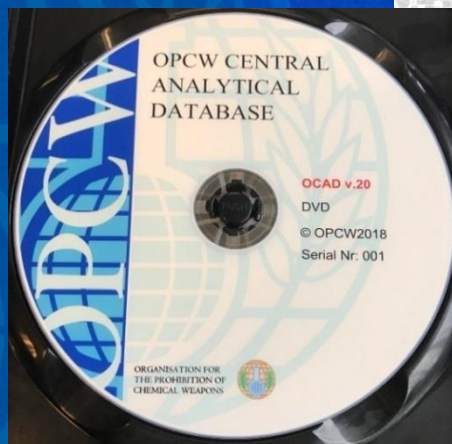
Timing is Everything...

Recommendations to include relevant non-scheduled chemicals in OCAD have been forthcoming since 2007

OPCW CENTRAL ANALYTICAL DATABASE

OCAD v.20_2018

January 2018



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Johan de Wittlaan 32, 2517 JR, The Hague, The Netherlands



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Degradation and Environmental Fate of Sulfur Mustard

Darcy van Eerten

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

• $\text{SCl}_2 + \text{H}_2\text{C}=\text{CH}_2$ (HMD Process)
 • $\text{S}_2\text{Cl}_2 + \text{H}_2\text{C}=\text{CH}_2$ (Levinstein Process)

Chlorinating Agent (Meyer Process)
 Common chlorinating agents:

$\text{H}_2\text{S} \rightarrow \text{Thiolglycidol}$
 $\text{Cl}-\text{CH}_2-\text{CH}_2-\text{S}-\text{CH}_2-\text{CH}_2-\text{Cl}$

Bis G
 GSH-SM Guanine
 AuSH SBSNAE

Oxidation
 FDC

Present in ton containers
 Levinstein mustards

Environmental fate in:

Environmental fate in: Cement & Soil | Sea Water | Synthesis Routes | Toxicology | Reported Impurities | Decontamination | Scheduled Chemical

Other Recommendations Move Forward More Quickly



EDUCATION AND ENGAGEMENT:
Promoting a Culture of Responsible Chemistry

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

NOVEMBER 2014



ORGANISATION FOR THE PROHIBITION
OF CHEMICAL WEAPONS



www.opcw.org/documents-reports/subsidiary-bodies/advisory-board-on-education-and-outreach/



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Recommendations Can Have Impact Without Formal Decisions



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Riot Control Agents

Fauzia Nurul Izzati, Jonathan E. Forman and Christopher M. Timperley

What is the definition of a Riot Control Agent (RCA)?

From paragraph 7, Article II of the Chemical Weapons Convention:

"Any chemical not listed in a Schedule, which can produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure."

What are Riot Control Agents?

Chemicals that meet the criteria of an RCA include the following:

 2-Chloroacetophenone (CN) Synonyms: Mace, CN, RM CN (10% CN, 43% benzene, 40% carbon tetrachloride), CN (10% CN, 70% chloroform), and CN (23% CN, 38.4% chloroform, 38.4% chloroform). Physical states: White solid with odour of apple blossom. Melting Point 54-56 °C; Boiling Point 245 °C	 2-Chlorobenzylidene malonitrile (CS) Synonyms: 2-Chlorobenzaldehyde malonitrile, α -chlorobenzylidene malonitrile, R62 CS (pure), CS (15% CS, 5% allylaerogel), CS (CS and allylaerogel), CSX (1 g CS, 99 g α -n-octyl phosphate), CS dissolved in methyl ethyl ketone (used in spray device). Physical states: White solid with pungent peppery odour. Melting Point 93-95 °C; Boiling Point 310-315 °C dec.	 Dibenz(b,f)(1,4)oxazepine (CR) Synonyms: CR Physical states: Yellow stable powder. Melting Point 72 °C; Boiling Point 335 °C	 2'-Chloroacetophenone Synonyms: α -chloroacetophenone Physical states: Colourless liquid. Boiling Point 220 °C	 4-Nonanoylmorpholine Synonyms: MPA, MFK, palargenic acid morpholide Physical states: Liquid. Boiling Point 310 °C
 3'-Chloroacetophenone Synonyms: m -chloroacetophenone Physical states: Colourless liquid. Boiling Point 228 °C	 α-Chlorobenzylidene malonitrile Synonyms: none Physical states: White solid. Melting Point 58-70 °C; Boiling Point 126 °C/0.1 mmHg	 N,N'-Bis(isopropylethylene)diamine Synonyms: Diisole Physical states: Viscous tan-coloured solid. Melting Point 48-50 °C	 N,N'-Bis(tert-butylethylene)diamine Synonyms: none Physical states: White solid. Melting Point 39-43 °C	 Cis-4-Acetylaminodicyclohexylmethane Synonyms: none Physical states: White solid. Melting Point 112 °C
 8-Methyl-N-vanillyl-trans-6-nonenamide Synonyms: C, capsaicin, Maltin, Zacin Physical states: White solid. Melting Point 62-65 °C; Boiling Point 210-220 °C at 0.01 mmHg	 8-Methyl-N-vanillyl-nonanamide Synonyms: Dihydrocapsaicin, DNC Physical states: White solid. Physical data unavailable	 N-Vanillylnonanamide Synonyms: N-(8-hydroxy-3-methoxy-benzylidene)nonanamide, nonivamide, pseudo-capsaicin, palargenic acid vanillylamide, PVA Physical states: White solid with strong odour. Melting Point 57 °C	 N-Vanillyl-7-methyloctanamide Synonyms: norhydrocapsaicin Physical states: Lipophilic, colourless odourless crystalline or waxy solid	 Oleoresin capsiicum (OC) This is a mixture containing > 8% capsaicin, capsaicin, dihydrocapsaicin, and nordihydrocapsaicin dissolved in an organic solvent.
 N-Vanillyl-9-methyldec-7-OD-enamide Synonyms: homocapsaicin Physical states: Lipophilic, colourless odourless crystalline or waxy solid	 N-Vanillyl-9-methyldodecanamide Synonyms: homodihydrocapsaicin Physical states: Lipophilic, colourless odourless crystalline or waxy solid	 N-Vanillyl-7-methyloctanamide Synonyms: norhydrocapsaicin Physical states: Lipophilic, colourless odourless crystalline or waxy solid	 N-Vanillyl-9-methyldodecanamide Synonyms: homodihydrocapsaicin Physical states: Lipophilic, colourless odourless crystalline or waxy solid	 N-Vanillyl-9-methyldodecanamide Synonyms: homodihydrocapsaicin Physical states: Lipophilic, colourless odourless crystalline or waxy solid

17 chemicals identified that meet Convention criteria of riot-control agent

How do Riot Control Agents work?

RCA's irritate through binding to TRP (Transient Receptor Potential) receptors. This activates some of the same biochemical pathways that are triggered by eating horseradish or hot peppers.

What are TRP Receptors?

TRP receptors are a family of ion channel receptors mainly located on cell membranes of multicellular organisms. TRP receptors are classified into seven subfamilies: TRPC (canonical or classical), TRPV (vanilloid), TRPM (melastatin), TRPA (ANKTM1 homologues), TRPP (polycystin), TRPML (mucolipin), and TRPN (NOMP-C homologues).

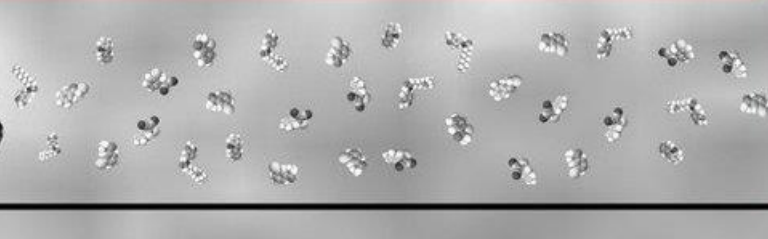
TRP receptor functions are diverse; the receptors serve as versatile sensors that allow individual cells and entire organisms to detect changes in their environment. This includes experiencing changes in temperature, touch, taste and other stimuli (including pain).

TRPA1

CS and isothiocyanate compounds bind to the TRPA1 receptor. Allyl isothiocyanate is the main pungent ingredient in wasabi, horseradish, and mustard oil - this chemical also binds to the TRPA1 receptor.

TRPV1

Capsaicin, homocapsaicin, and other related compounds bind to the TRPV1 receptor. These chemicals are naturally found in hot chili peppers.



Making it Work

Lessons Learned from 21 Years of Scientist – Policymaker Engagement



1923 *Chemical & Engineering News* begins as the News Edition of *Industrial & Engineering Chemistry*.

1930s Sulfonamides (sulfa drugs) are introduced. They are the first antibiotics commercialized.

1941 To show that his chlorofluorocarbon (CFC) coolant,

1953 Stanley L. Miller and Harold C. Urey make a

1962 Neil Bartlett proves that noble gases can form chemical compounds by preparing XePtF₆.

INDIA AND INDEPENDENCE NEWS

1980 In large part because of Love Canal, Congress passes the Comprehensive Environmental

1986 The Chernobyl nuclear power plant in the Soviet Union has a reactor core meltdown, releasing

1992 Robert A. Holton patents a route to Taxol that begins with a

▲ 1923 Acids and bases get refined definitions—one from Johannes N. Brønsted and Thomas M. Lowry, another from Gilbert N. Lewis.

▲ 1923 Tetraethyllead, an antiknock additive to gasoline, earns its discoverer, Thomas Midgley Jr., an ACS award.

1925 Six German firms merge to form the IG Farben conglomerate. It soon becomes the world's biggest chemical company.

1925–27 Work from Werner Heisenberg, Wolfgang E. Pauli, and Erwin Schrödinger ushers in the era of quantum mechanics.

1926 Four U.K. chemical companies merge to form Imperial Chemical Industries (ICI). In its heyday it will become the British Empire's largest manufacturing firm.

90 C&EN
CELEBRATES 90 YEARS OF
Stronger be

▼ 1928–29 Examining mold, Alexander Fleming discovers penicillin.

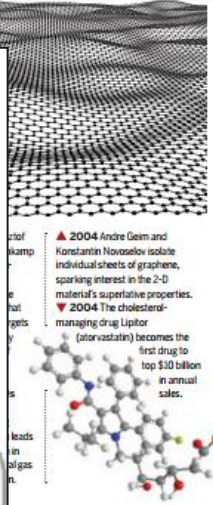
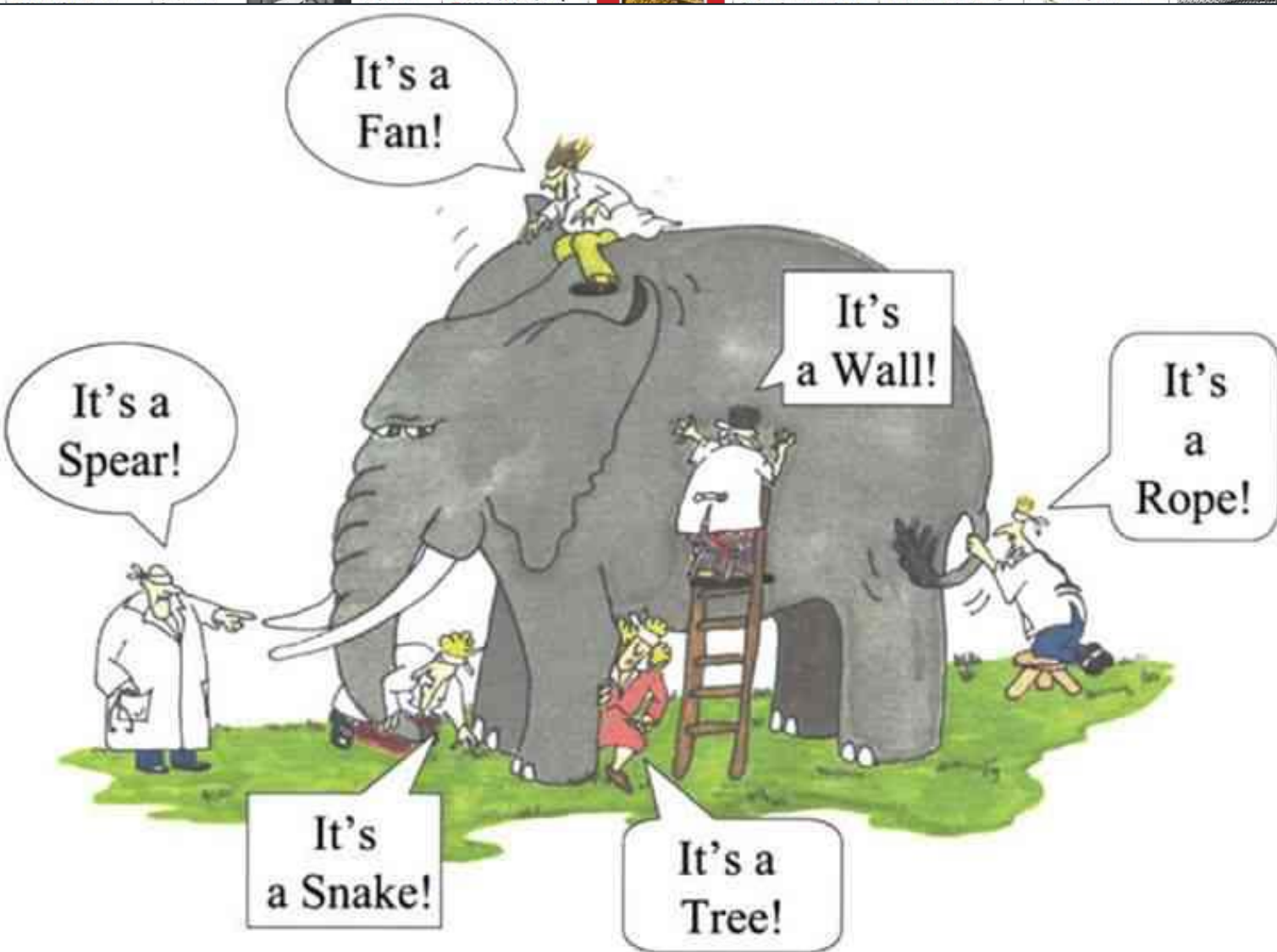


1928 C. V. Raman reports a light-scattering effect, which he observed after musing on the Mediterranean Sea's deep blue color. Adolf Smekal predicted this phenomenon in 1923.

1930 U.S. Congress formally establishes the National Institute of Health, precursor to the National Institutes of Health.

1930 Franz Fischer and Hans Tropsch patent their process for producing synthetic fuels from hydrogen and carbon monoxide.

1930s Arnold Ö. Beckman commercializes the pH meter.



▲ 2004 Andre Geim and Konstantin Novoselov isolate individual sheets of graphene, sparking interest in the 2-D material's superlative properties.

▼ 2004 The cholesterol-managing drug Lipitor (atorvastatin) becomes the first drug to top \$10 billion in annual sales.

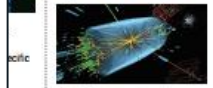
tor of C&EN's 90th anniversary
IMADZU
ence in Science

2009 FDA approves first human clinical trial of an embryonic stem-cell-based therapy. The trial is halted two years later.

2009 NASA scientists definitively detect water on the moon.

2009 IBM researchers improve the resolution of atomic force microscopy so much that they are able to visualize all of the atom positions and bonds of a single molecule for the first time.

2011 Brian K. Kobilka and Roger Tsien determine the first structure of a G protein-coupled receptor with its G protein partner.



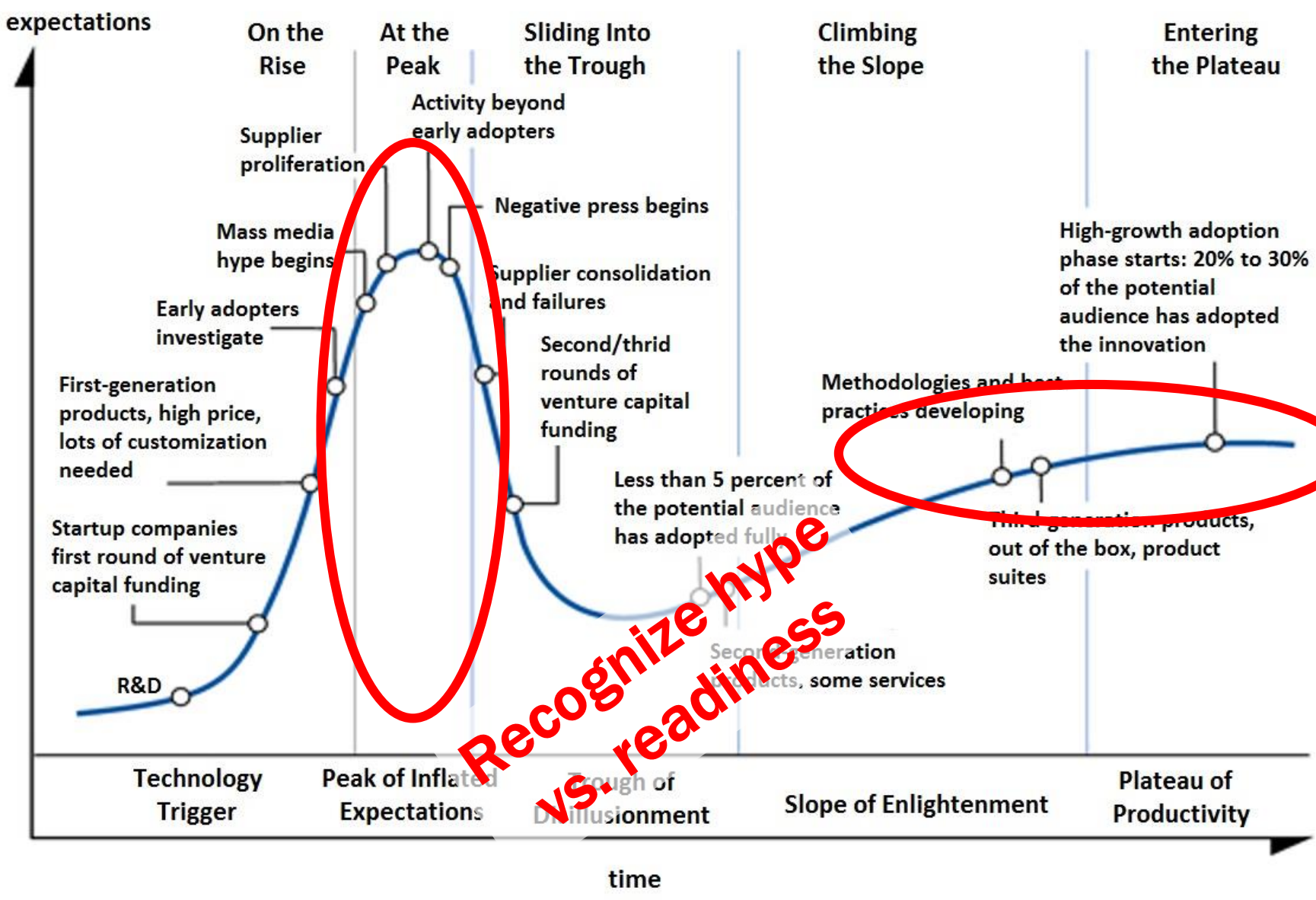
▲ 2012 An international team discovers a new particle that they think is the Higgs boson—a long-sought particle that imbues matter with mass.

2013 The U.S. Supreme Court rules that human genes cannot be patented.

2013 C&EN turns 90.

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Volume 406 · Number 21 · August 2014

ANALYTICAL & BIOANALYTICAL CHEMISTRY

GDCh SFC SFOA Q ASAC

Analysis of Chemicals Relevant to the Chemical Weapons Convention
 Guest Editors Marc-Michael Blum · R. V. S. Murty Mamidanna



Trigger Expectations

Climbing the Slope

Entering the Plateau

Talanta 188 (2018) 808–832

Contents lists available at ScienceDirect

Talanta

journal homepage: www.elsevier.com/locate/atalanta

Advice on chemical weapons sample stability and storage provided by the Scientific Advisory Board of the Organisation for the Prohibition of Chemical Weapons to increase investigative capabilities worldwide

Christopher M. Timperley^{a,*}, Jonathan E. Forman^{b,c,d,e}, Mohammad Abdollahi^b, Abdullah Saeed Al-Amri^f, Isel Pascual Alonso^g, Augustin Baulig^h, Veronica Borrettⁱ, Florida A. Cariño^j, Christophe Curty^k, David González Berrutti^l, Zrinka Kovarik^m, Roberto Martínez-Álvarezⁿ, Robert Mikulak^o, Nicia Maria Fusaro Mourão^o, Ramasami Ponnadurai^o, Slawomir Neffe^o, Syed K. Raza^p, Valentín Rubaylo^q, Koji Takeuchi^r, Cheng Tang^s, Ferruccio Trifirò^t, Francois Mauritz van Straten^u, Paula S. Vanninen^v, Volodymyr Zaitsev^w, Farhat Waqar^x, Mongia Saïd Zina^y, Marc-Michael Blum^z, Hugh Gregg^z, Elena Fischer^{aa}, Siqing Sun^{ab}, Pei Yang^{ab}

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- ^b The Institute of Pharmaceutical Sciences, and the Department of Toxicology and Pharmacology, Faculty of Pharmacy, Tehran University of Medical Sciences, The Islamic Republic of Iran
- ^c Saudi Basic Industries Corporation (SABIC), Riyadh, Saudi Arabia
- ^d University of Havana, Havana, Cuba
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- ^g University of the Philippines, Quezon City, Philippines
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- ⁱ Facultad de Química, Universidad de la República, Montevideo, Uruguay
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- ^q State Scientific Research Institute of Organic Chemistry and Technology (GosNIIORT), Mirovo, Russian Federation
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- ^x Pakistan Atomic Energy Commission, Pakistan
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- ^{ab} Secretary to the Scientific Advisory Board and Science Policy Adviser, Organisation for the Prohibition of Chemical Weapons, The Hague, The Netherlands

ARTICLE INFO

KEYWORDS
 Chemical warfare agent
 Chemical forensics
 Organisation for the Prohibition of Chemical Weapons

ABSTRACT
 The Scientific Advisory Board (SAB) of the Organisation for the Prohibition of Chemical Weapons (OPCW) has provided advice on sample stability and storage to increase investigative capabilities worldwide. This information is beneficial to all laboratories that carry out

* Corresponding author.
 ** Correspondence to: The Organisation for the Prohibition of Chemical Weapons (OPCW), The Hague, The Netherlands.
 E-mail addresses: cm.timperley@dstl.gov.uk (C.M. Timperley), jonathan.forman@opcw.org (J.E. Forman).

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Need to be a part of the scientific community, not just an observer!

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acts,






ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons


Recommendations From The OPCW Scientific Advisory Board's Report on Verification

Calls For "Changing of Routine"

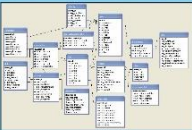
Recommendation 1
The Secretariat should consider adopting a comprehensive, more analytical approach to verification utilising all available and verifiable information.



Recommendation 2
The Secretariat should acquire the capability to use open-source information on a routine basis.



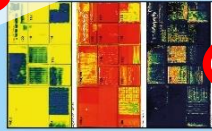
Recommendation 3
The Secretariat should put in place an information management structure that can provide the support required for the verification process.




Recommendation 4
Remote/automated monitoring technologies should be added to the list of approved inspection equipment.



Recommendation 5
The Secretariat should consider the option of using satellite-based monitoring for the detection of non-routine environmental changes in the IAU and CL.




Recommendation 6
The Secretariat should visit the National Authorities to obtain assurance on the accuracy and completeness of declarations. The outcome of such visits may impact on the inspection frequency.




Recommendation 7
The Secretariat must commission an independent review of all activities pertaining to the missions carried out in the Syrian Arab Republic.




Recommendation 8
The list of declarable OCPFs submitted by States Parties should include all facilities which fall under the definition/requirement of paragraph 1 of Part IX of the Verification Annex, regardless of the purity level of a DOC or DOC mixtures produced.




Recommendation 9
Not all facilities that fall under Part IX of the Verification Annex should be considered of the same relevance to the object and purpose of the Convention. The TWG recommends a practical approach for enhancing the utilisation of verification resources for OCPF declaration and on-site inspection processes.




Recommendation 10
The verification thresholds for OCPFs producing highly relevant chemicals, and the possibility of revision of the product group codes, should be addressed by the SAB as well as the industry cluster.




Recommendation 11
The OPCW should increase the staff of the OPCW Laboratory to cope with various aspects of IAU, biomedical samples, trace environmental analysis, toxins, and on-site analysis. Establishing a network of DLs for biomedical sample analysis should be a high priority.



Recommendation 12
Lessons on chemical sampling and analysis from the OPCW's support to the 2013 United Nations Mission to Investigate the Use of Chemical Weapons in the Syrian Arab Republic, and all subsequent OPCW activities in relation to the Syrian Arab Republic must be identified and implemented.



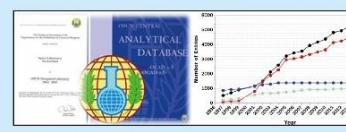
Recommendation 13
PTs should incorporate a broader range of chemicals, and at a wider range of concentrations, to prepare laboratories for IAU-type scenarios.




Recommendation 14
The Secretariat should expedite toxin identification exercises.



Recommendation 15
Continuous additions to the OPCW Central Analytical Database (OCAD) are recommended to allow the OPCW to meet all its mandated inspection aims, including IAU.



Recommendation 16
Developments in analytical instrument portability, miniaturisation and disposable biosensors should be periodically reviewed by the Secretariat and the SAB for potential applicability to on-site analysis.



Recommendation 17
The Secretariat should monitor developments in attribution analysis/chemical forensics.



Recommendation 18
The Secretariat should augment its capability to monitor and forecast developments in science and technology of relevance to the Convention and its verification regime.



<https://www.opcw.org/portal/science/sections/science-technology/science-technology-monitor/>





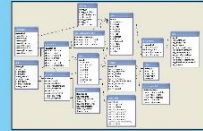
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Verification

Information management support



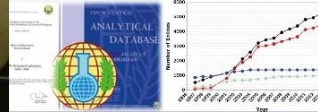
Authorities to obtain... impact on



Verification... on-site



from the OPCW's... implemented.



<http://www.opcw.org/portal/sections/science-technology/science-technology-monitor/>

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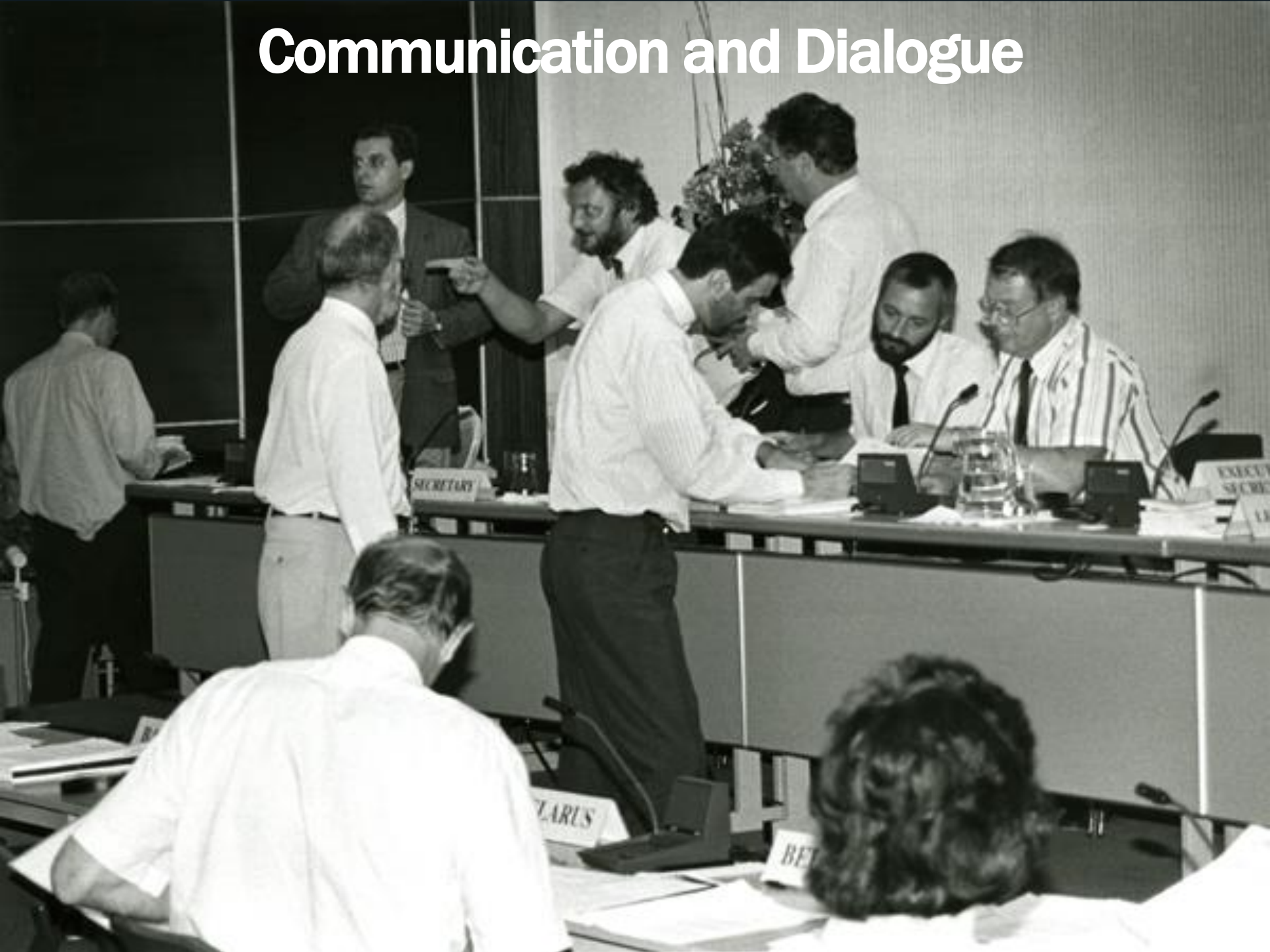
SAB's Assessment on Verification Issues
OEWG Future Priorities
31 January 2017
Cheng TANG
Vice Chairperson, Scientific Advisory Board
tang_cheng@hotmail.com

CHAIRPERSON

OEWG-FG, January 2017

Calls

Communication and Dialogue



Feedback from the Recipients of Advice is Critical



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Engage Policy Makers



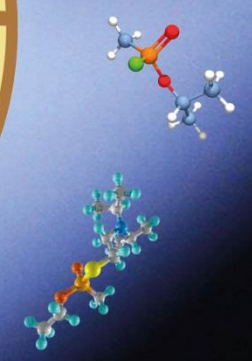
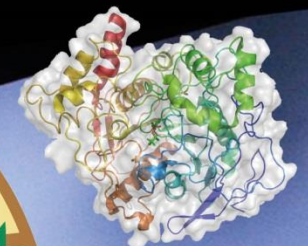
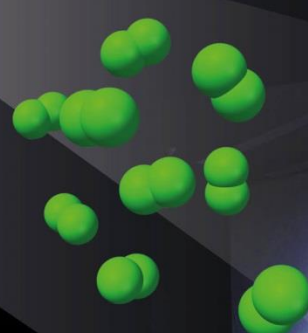
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OPCW Scientific Advisory Board Briefing to States Parties

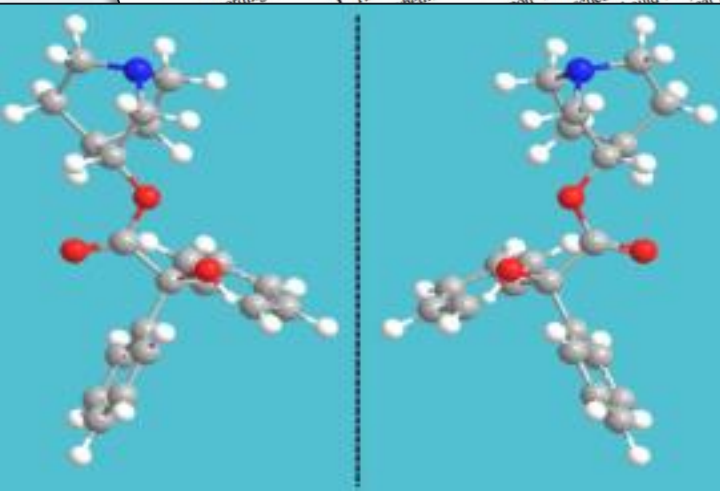
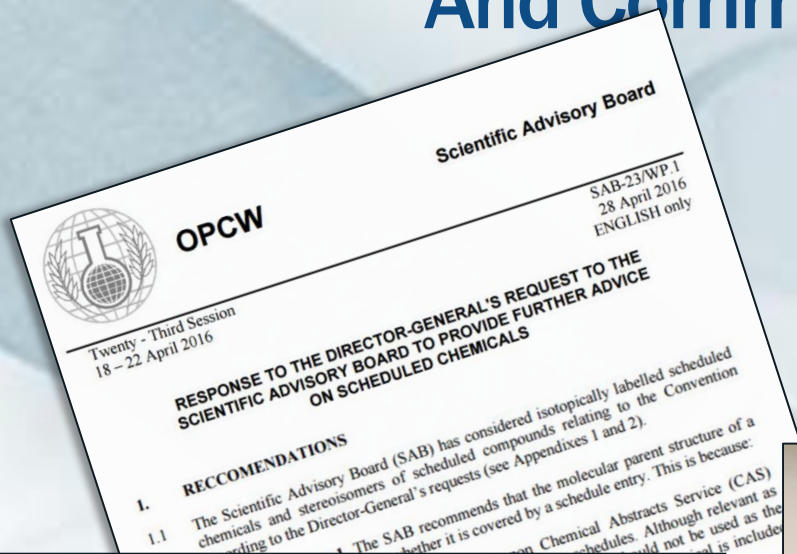
Thursday 22 March 2018

Jeper Room | 13:30-15:00

Light lunch served at 13:00



And Communicate the Science!



...the Technical...
...indexes 1 and 2) to...
Schedules 1, 2 and 3 should...
...in isotopic labels or can exist...
...the SAB's previous views

1 RG-2/DG.1, dated 28 February 2008, in paragraph 3.5 of its Annex.
2 Numbers in square brackets refer to the numbered references on pages 10 - 12.



And Communicate the Science!



Chemical Weapons Act 1996

CHAPTER 6

ARRANGEMENT OF SECTIONS

Introduction

- Section.
1. General interpretation.

Chemical weapons

2. Use etc. of chemical weapons.
3. Application of section 2.
4. Suspicious objects.
5. Power to remove or immobilise objects.
6. Power to destroy or remove objects.
7. Power to demolish premises and objects.
8. Compensation for damage to premises and objects.
9. Offences relating to premises and objects.
10. Offences relating to objects.

Premises for production etc.

11. Premises for production etc. of chemical weapons.
12. Premises for production etc. of chemical weapons.
13. Premises for production etc. of chemical weapons.
14. Premises for production etc. of chemical weapons.
15. Premises for production etc. of chemical weapons.
16. Premises for production etc. of chemical weapons.

Chemicals for permitted purposes

19. Restriction on use etc.
20. Licences.

Information and records

21. Information for purposes of Act.
22. Information and records for purposes of Convention.
23. Identifying persons who have information.

Scientific

OPCW



We have seen updates to guidance provided by National Authorities for declaration requirements following the 2016 advice and “science lesson”

on CAS registry

RG-2/DG.1, dated 2016
Numbers in square



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Science Communication is More than a Chemistry Lesson!



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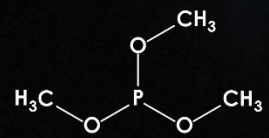
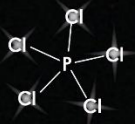
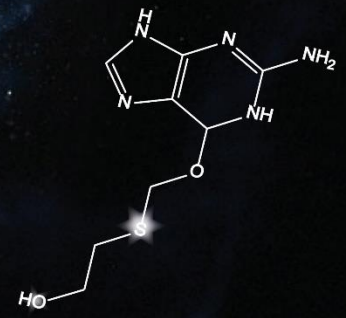
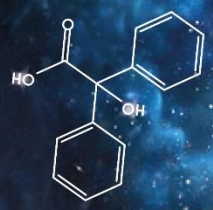
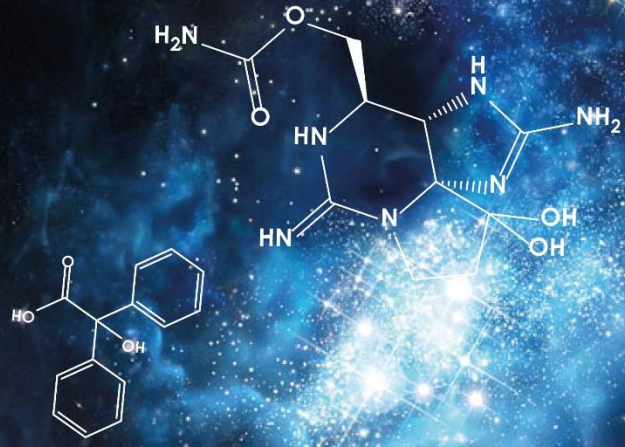
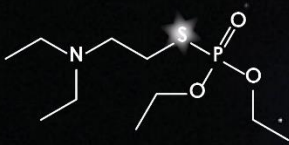
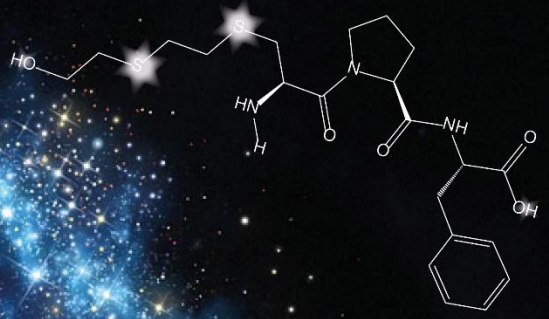
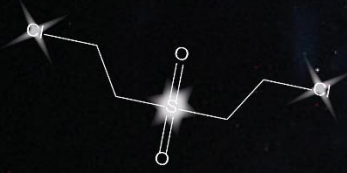
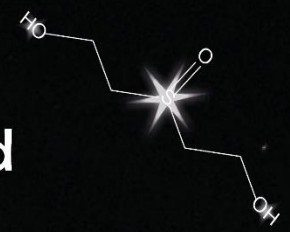
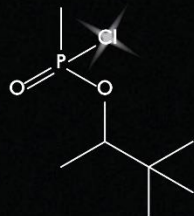
Science Communication is More than a Chemistry Lesson!



OPCW

Science for Diplomats at EC-88

The Chemical Universe: Scheduled and Unscheduled



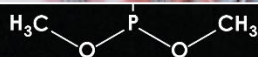
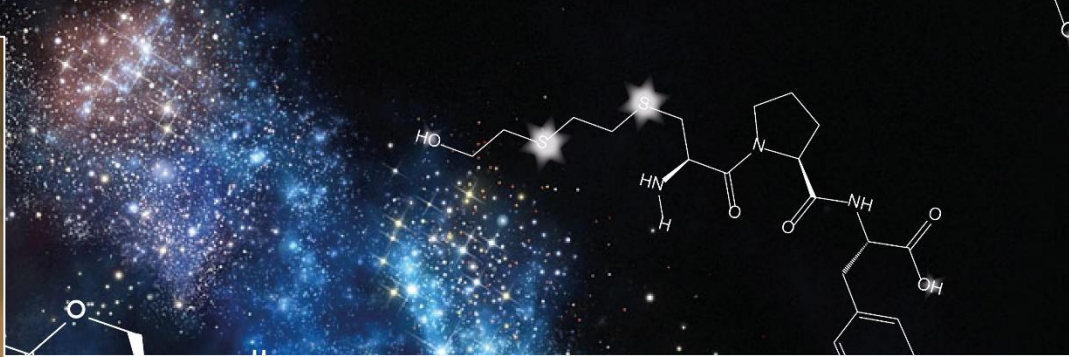
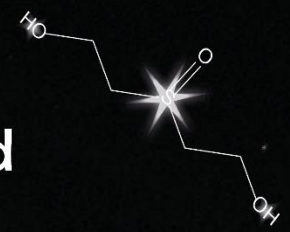
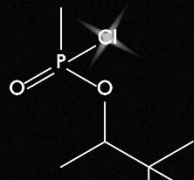
Tuesday, 10 July 2018
Ooms Room, OPCW

13:30 - 14:45

Light lunch served at 13:00

Science for Diplomats at EC-88

The Chemical Universe: Scheduled and Unscheduled



Science

The Chemistry

EC-88

Unscheduled

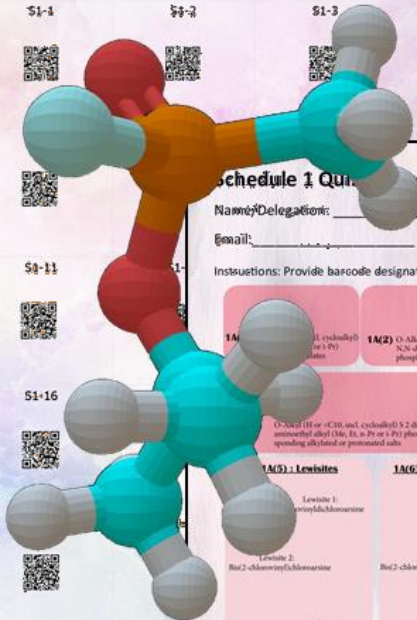
Test Your Chemical Weapons Convention Schedule 1 Knowledge



Using the Augment app, scan barcodes to view schedules 1 chemicals. Assign each to its corresponding schedule on the Schedule 1 answer sheet.



S1-1	S1-2	S1-3	S1-4	S1-5
S1-9	S1-10			



Schedule 1 Quiz Answer Sheet

Name/Delegation: _____
 Email: _____

Instructions: Provide barcode designations, e.g. 81-1, in the appropriate boxes.

1A(4) : Sulfur mustard 2-Chloroethylchloroethylsulfide Mustard gas: Bis(2-chloroethyl)sulfide Bis(2-chloroethyl)dimethylmethane Sesquimustard: 1,2-Bis(2-chloroethyl)ethane 1,3-Bis(2-chloroethyl)isopropane 1,4-Bis(2-chloroethyl)isobutane 1,5-Bis(2-chloroethyl)isopentane Bis(2-chloroethyl)dimethyl ether O-Mustard: Bis(2-chloroethyl)diethyl ether	1A(5) : Lewisites Lewisite 1: Bis(2-chloroethyl)phosphorine Lewisite 2: Bis(2-chloroethyl)phosphorine Lewisite 3: Tri(2-chloroethyl)amine	1A(6) : Nitrogen mustard HN1: Bis(2-chloroethyl)ethylenamine HN2: Bis(2-chloroethyl)urethane HN3: Tri(2-chloroethyl)amine HN4: Tri(2-chloroethyl)amine	1A(7) : Saxitoxin	1A(8) : Ricin
1B(9) Alkyl (H, or C, Cl, and S) substituted alkyl (Me, Et, n-Pr or i-Pr) phosphonothioates and corresponding silylated or protonated salts	1B(11) Chlorosarin O-isopropyl methylphosphorochloridate	1B(12) Chlorosoman O-pinacolyl methylphosphorochloridate		

Reading Molecular Structures in Augmented Reality

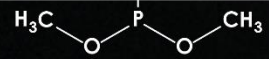
Atomic Color Code

C:	H:	S:	Tabular bonds
N:	P:	As:	Basic labels
Cl:	F:	O:	What

Reading Molecular Structures in Augmented Reality

Atomic Color Code

C:	H:	S:	Tabular bonds
N:	P:	As:	Basic labels
Cl:	F:	O:	What



Arsenic (As) 1	Fluorine (F) 2	Sulfur (S) 4	Hydrogen (H) 1
Carbon (C) 2	Chlorine (Cl) 1	Nitrogen (N) 1	Phosphorus (P) 1



Scheduled Chemicals under the Chemical Weapons Convention (CWC)

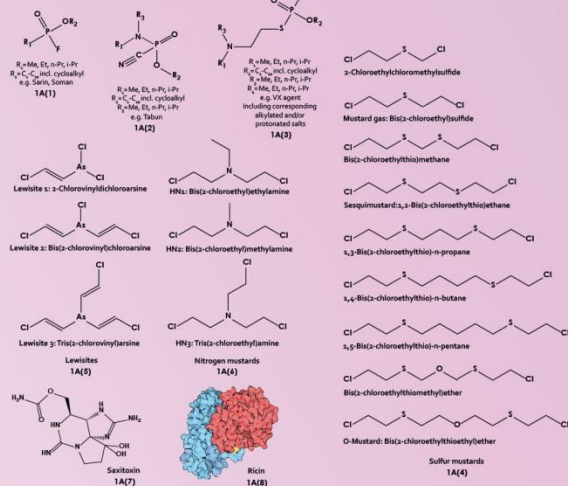
Schedule 1

Guidelines for Schedule 1

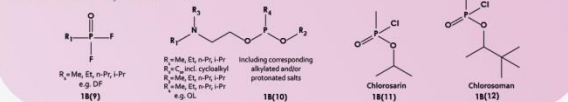
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

- 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 elsewhere;
 - It has little or no use for purposes not prohibited under this Convention.

Schedule 1 Part A. Toxic Chemicals



Schedule 1 Part B. Precursors



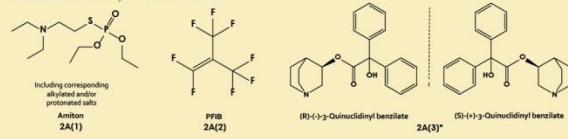
Schedule 2

Guidelines for Schedule 2

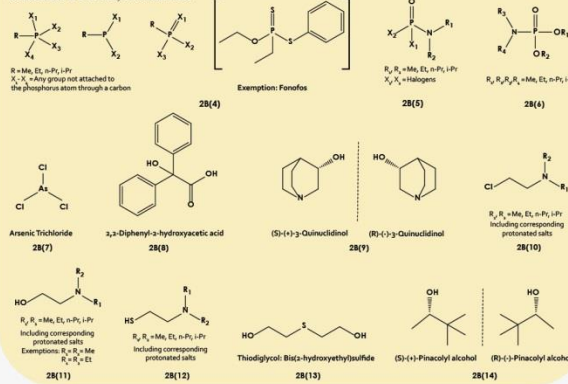
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:

- 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



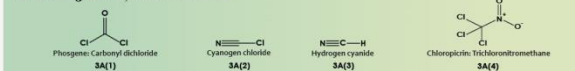
Schedule 3

Guidelines for Schedule 3

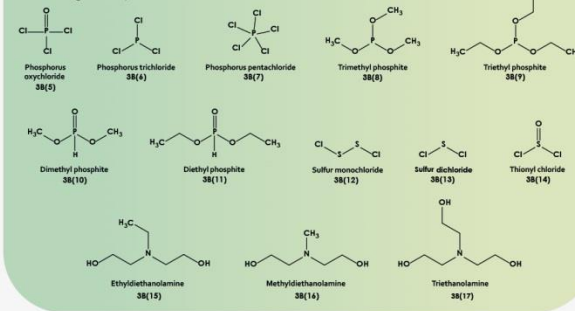
The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

- 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

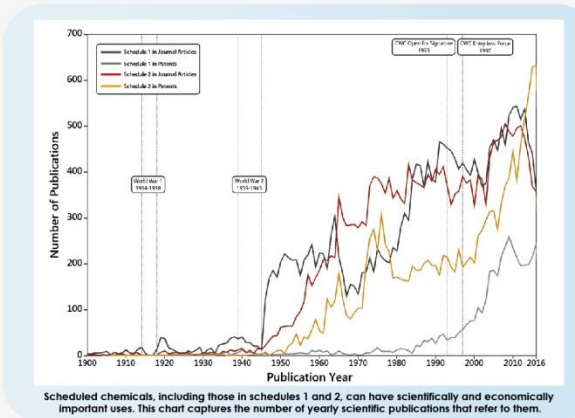
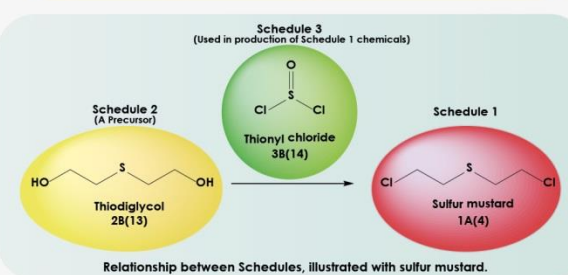


Schedule 3 Part B. Precursors



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons



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.

Scheduled Chemicals under the Chemical Weapons Convention (CWC)

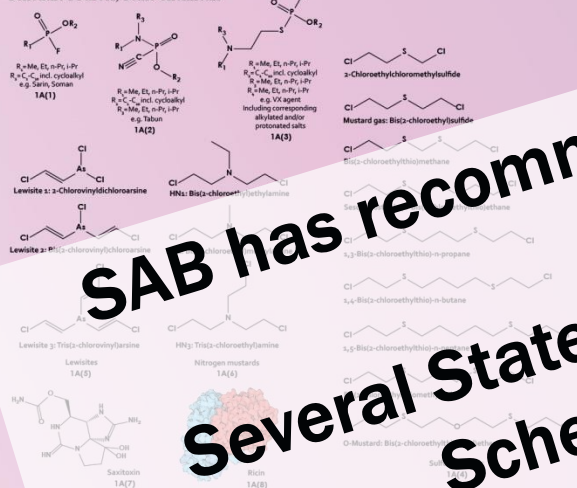
Schedule 1

Guidelines for Schedule 1

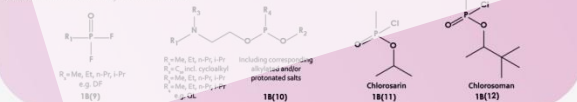
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

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



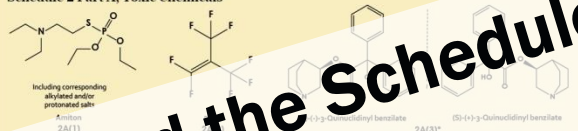
Schedule 2

Guidelines for Schedule 2

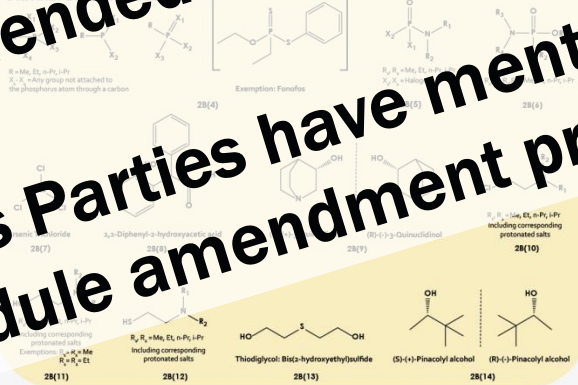
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:

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

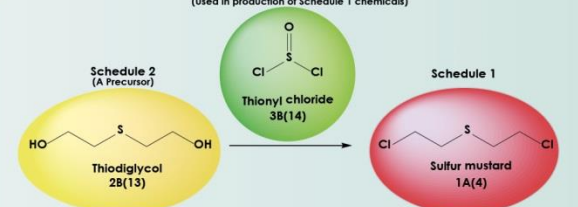
Schedule 2 Part A. Toxic Chemicals



Schedule 2 Part B. Precursors



Schedule 3 (Used in production of Schedule 1 chemicals)



Relationship between Schedules, illustrated with sulfur mustard.

Schedule 3

Guidelines for Schedule 3

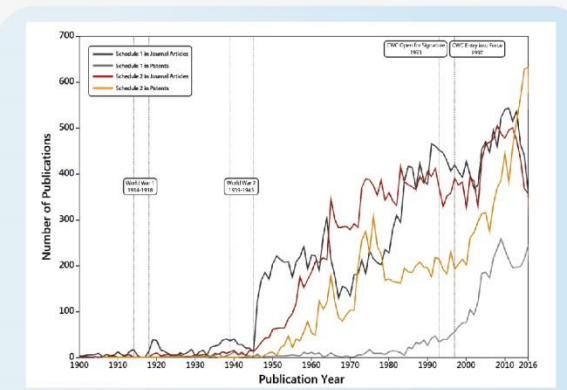
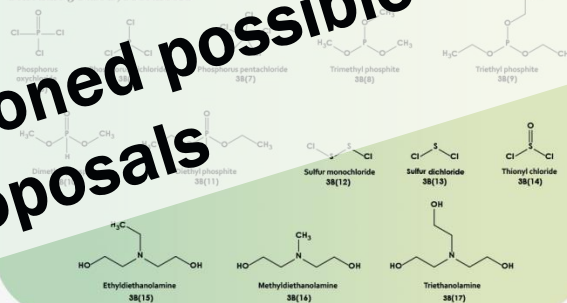
The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

- (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

[@opcw](https://twitter.com/opcw) [opcwline](https://www.facebook.com/opcwline) [opcwline](https://www.youtube.com/channel/UCpocwline) [company/opcw](https://www.linkedin.com/company/opcw) [opcw](https://www.pinterest.com/opcw)

What Else are States Parties Saying in the Lead Up to the Fourth Review Conference?



OPCW

Fourth Session
21 – 30 November 2018

Review Conference

RC-4/WP.1
16 July 2018
ENGLISH only

OPEN-ENDED WORKING GROUP ON FUTURE PRIORITIES OF THE OPCW RECOMMENDATIONS TO THE FOURTH SPECIAL SESSION OF THE CONFERENCE OF THE STATES PARTIES TO REVIEW THE OPERATION OF THE CHEMICAL WEAPONS CONVENTION

Introduction

The Open-Ended Working Group on the Future Priorities of the Organisation for the Prohibition of Chemical Weapons (OEWG-FP),

Pursuant to Executive Council decision EC-82/DEC.2, dated 14 July 2016 and in accordance with its mandate to act “as an informal mechanism for receiving, discussing, prioritising, elaborating, and integrating ideas and proposals from States Parties and the Secretariat on the future priorities of the OPCW on any aspect of the Convention or developments relevant to it with a view to supplying a holistic, coherent, forward-looking, and action-oriented document consisting of recommendations for consideration by the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention as a contribution to the full, effective, and non-discriminatory implementation of all provisions of the Convention”;

Pursuant to its Methods of Work, as agreed by participating States Parties (see Annex 1);

Taking note of the reports by the Technical Secretariat (“the Secretariat”) entitled “The OPCW in 2025: Ensuring a World Free of Chemical Weapons” (S/1252/2015, dated 6 March 2015) and the Permanent Representatives’ retreat on the future of the OPCW (S/1316/2015, dated 14 October 2015);

Taking note also of presentations and submissions made to the OEWG-FP by the Secretariat, subsidiary bodies of the OPCW and facilitators of other working groups, as well as by representatives of industry, other international organisation and civil society (see Annex 2);

Taking into account responses to and discussions of the above-mentioned presentations and submissions by States Parties, as well as oral and written submissions made by them (see Annex 3), in open-ended meetings of the OEWG-FP, as well as the work done by other facilitators, working groups and sub-working groups, in particular the outcome of the Sub-Working Group on Non-State Actors under the Open-Ended Working Group on Terrorism (EC-86/DEC.9, dated 13 October 2017),



Third Special Session of the
Conference of the States
Parties to Review the
Operation of the Chemical
Weapons Convention
18 – 19 April 2013



Science Advisory Mechanisms Must be Supported



- **Facilitator**
(“science officer”)
in ***organisationally relevant*** position

- **Funding**



Trust Fund
(voluntary
contributions from
States Parties)



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A Science Advisory Mechanism

- Independent and active in scientific communities
- Considers all relevant information
- Feedback mechanism to recipients and stakeholders of advice
- Science communication for scientific literacy
- Supported
- ***Science represents one of many dimensions of overall policy considerations – advice may not always move forward (be patient!)***



What is the “Right” Science Advice Mechanism

- **Who is the advice for?**
- **Why is the advice needed?**
- **How does advice go forward?**



OPCW

Science Advice, Science Diplomacy and Science Communication at the Organisation for the Prohibition of Chemical Weapons

Scientific Advisory Board

The Chemical Weapons Convention is built on a scientific foundation, requiring technical expertise for effective implementation, and scientific literacy for decision making.

Scientific principles provide the definitions for what is, and what is not a chemical weapon; ensure completeness of declarations; guarantee the robustness of sampling and analysis and other verification methodologies; guide the procedures and methods used for inspections, investigations and destruction; inform approaches to assistance and protection and benefits outreach to scientific communities.

The Scientific Advisory Board (SAB) is a subsidiary body of the OPCW serving as an independent science advisory mechanism to provide advice to inform the work and processes of the OPCW, and to bring scientific literacy into the policymaking process.

The SAB was established in accordance with the Chemical Weapons Convention to enable the Director-General to render specialist advice in areas of science and technology relevant to the Convention, its State Parties, the Conference of States Parties, and the Executive Council.

For the basis of the SAB in the Chemical Weapons Convention, see Article VIII Paragraph 21 (b).

Scientific Diplomacy in Support of the Convention

The SAB is made up of 25 experts from OPCW Member States. Members serve in their personal capacity (not as representatives of their respective States Parties) for up to two consecutive three-year terms. The SAB chair and Vice-chair are elected annually.

Scientists from more than 40 States Parties have served on the SAB and its working groups since its first session in 1997, providing the core of the Convention's international scientific and technical community and serving the SAB on a voluntary basis. The SAB members are experts in the fields of chemical and biological sciences, toxicology, medicine, and environmental science. They have provided scientific and technical advice to the OPCW, the Conference of States Parties, and the Executive Council. The SAB also provides scientific and technical advice to the Director-General, who provides responses and recommendations to States Parties through the Director-General.



★ OPCW Designated Laboratory network in April 2018

- Research with the Most Potential: Research, development and innovation in the field of chemical and biological sciences.
- Applied Technology: Research and development in the field of chemical and biological sciences.
- Chemical Analysis: Research and development in the field of chemical analysis.
- Biological Analysis: Research and development in the field of biological analysis.
- Medical Countermeasures: Research and development in the field of medical countermeasures.
- Response to the Director-General Request: Research and development in the field of response to the Director-General Request.

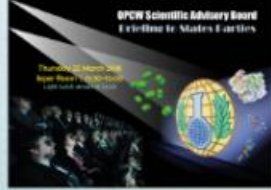
The SAB is a subsidiary body of the OPCW, which provides responses and recommendations to States Parties through the Director-General.

Find out more about the SAB Reports of SAB Other documents

Find infographics and resources here:

Science Communication and Engagement

OPCW actively promotes scientific literacy for policymaking and treaty implementation. This requires productive discourse between scientific experts and diplomats from OPCW's State Parties.

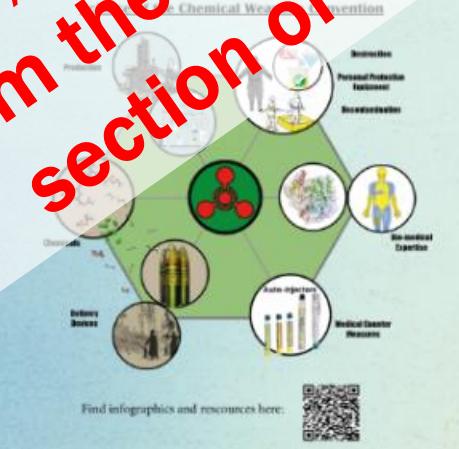


The SAB regularly briefs States Parties on its work and the OPCW's Science for Diplomats Initiative provides a forum for interactive engagement with diplomats involved in the implementation of the Chemical Weapons Convention.

Learn more about the "Science for Diplomats Initiative"

To ensure effectiveness, the work of the SAB must be visible; SAB reports and informative materials must be easily accessible to stakeholders, and the promotion of scientific literacy must be interactive and engaging.

Mobile apps, mobile device retrievable documents and augmented reality provide useful tools with a great degree of flexibility to aid in communication and dissemination of information.



Work of the SAB from January to July 2018

OPCW Organisation for the Prohibition of Chemical Weapons

Scientific Review for the Fourth Review Conference of the Chemical Weapons Convention

The Scientific Advisory Board serves as an independent body that assesses and reports to the Director-General on developments in scientific and technological fields relevant to the Convention. Recognising where technological change both benefits and challenges the implementation of the Convention is an important and continual aspect of this work (in particular for verification purposes).

To ensure the OPCW keeps pace with scientific and technological change, the SAB submits a report on developments in science and technology which includes recommendations for the content of the Convention to each 5-yearly Review Conference of the Chemical Weapons Convention. The upcoming fourth Review Conference (RC-4) is to be held from 21 - 28 November 2018.

The SAB took inputs for its report to RC-4 from previous consultations to the Director-General, conferences, engagement with scientific and technological communities, and a variety of new sources. See below.

A. The deliberations of the SAB during its eight regular sessions from 2010 to 2013 to March 2018 (SAB-20/1, SAB-21/1, SAB-22/1, SAB-23/1, SAB-24/1, SAB-25/1, SAB-26/1, SAB-27/1, SAB-28/1, SAB-29/1, SAB-30/1, SAB-31/1, SAB-32/1, SAB-33/1, SAB-34/1, SAB-35/1, SAB-36/1, SAB-37/1, SAB-38/1, SAB-39/1, SAB-40/1, SAB-41/1, SAB-42/1, SAB-43/1, SAB-44/1, SAB-45/1, SAB-46/1, SAB-47/1, SAB-48/1, SAB-49/1, SAB-50/1, SAB-51/1, SAB-52/1, SAB-53/1, SAB-54/1, SAB-55/1, SAB-56/1, SAB-57/1, SAB-58/1, SAB-59/1, SAB-60/1, SAB-61/1, SAB-62/1, SAB-63/1, SAB-64/1, SAB-65/1, SAB-66/1, SAB-67/1, SAB-68/1, SAB-69/1, SAB-70/1, SAB-71/1, SAB-72/1, SAB-73/1, SAB-74/1, SAB-75/1, SAB-76/1, SAB-77/1, SAB-78/1, SAB-79/1, SAB-80/1, SAB-81/1, SAB-82/1, SAB-83/1, SAB-84/1, SAB-85/1, SAB-86/1, SAB-87/1, SAB-88/1, SAB-89/1, SAB-90/1, SAB-91/1, SAB-92/1, SAB-93/1, SAB-94/1, SAB-95/1, SAB-96/1, SAB-97/1, SAB-98/1, SAB-99/1, SAB-100/1).

B. The deliberations of the SAB during its four Temporary Working Groups (SAB-20/1, SAB-21/1, SAB-22/1, SAB-23/1, SAB-24/1, SAB-25/1, SAB-26/1, SAB-27/1, SAB-28/1, SAB-29/1, SAB-30/1, SAB-31/1, SAB-32/1, SAB-33/1, SAB-34/1, SAB-35/1, SAB-36/1, SAB-37/1, SAB-38/1, SAB-39/1, SAB-40/1, SAB-41/1, SAB-42/1, SAB-43/1, SAB-44/1, SAB-45/1, SAB-46/1, SAB-47/1, SAB-48/1, SAB-49/1, SAB-50/1, SAB-51/1, SAB-52/1, SAB-53/1, SAB-54/1, SAB-55/1, SAB-56/1, SAB-57/1, SAB-58/1, SAB-59/1, SAB-60/1, SAB-61/1, SAB-62/1, SAB-63/1, SAB-64/1, SAB-65/1, SAB-66/1, SAB-67/1, SAB-68/1, SAB-69/1, SAB-70/1, SAB-71/1, SAB-72/1, SAB-73/1, SAB-74/1, SAB-75/1, SAB-76/1, SAB-77/1, SAB-78/1, SAB-79/1, SAB-80/1, SAB-81/1, SAB-82/1, SAB-83/1, SAB-84/1, SAB-85/1, SAB-86/1, SAB-87/1, SAB-88/1, SAB-89/1, SAB-90/1, SAB-91/1, SAB-92/1, SAB-93/1, SAB-94/1, SAB-95/1, SAB-96/1, SAB-97/1, SAB-98/1, SAB-99/1, SAB-100/1).

C. Interessional responses to requests for advice from the Director-General (2013 to 2017)

- Medical countermeasures and longer term treatment for victims of chemical agent exposure
- Isotopically labeled and stressors of scheduled chemicals
- Simple storage and stability
- Root control agents

D. A series of workshops, co-organised by external partners and kindly funded by the European Union

A European Union Funded Project

Chemical Process Capabilities assess the Field and the Potential Applications in Chemical Weapons Conventions Implementation

Chemical Warfare Agents: Toxicity, Emergency Response and Medical Countermeasures

Innovative Technologies for Chemical Security

International Workshop on Trends in Chemical Production

In the RC 4 Review Process, the SAB held 27 meetings and workshops with 747 Attendees (289 individuals of 58 Nationalities) and 453 Speakers (201 individuals of 58 Nationalities) producing a total of 33 Reports

Examples of the topics covered in the report include the convergence of the sciences, chemical production and technology to enhance capability. Download these graphics and explore with augmented reality!

Available from the "Science and Technology" section of OPCW.org

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/OPCW



/OPCW



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/OPCW



/OPCWONLINE



Sci
The SAB was estab
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Executive Council
For the basis of th
Nationalit
Work of the S

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DG response
RC-4/DG.2
1 June 2016
QR
led by external
European Union
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the SAB held
shops
es
nationalities)
nationalities)
Reports
QR



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