Science, Industry and the Chemical Weapons Convention

An Organisation for the Prohibition of Chemical Weapons Side Event on

SCIENTIFIC REVIEW & KEY STAKEHOLDER ENGAGEMENT

Tuesday 5 December

09:00 - 10:00

Biological Weapons Convention 2017 Meeting of States Parties

Salle XXV, Palais des Nations

OPCW

Organisation for the Prohibition of Chemical Weapons

1997–2017 OPCW 20 YEARS

Science, Technology and the Fourth Review Conference of the Chemical Weapons Convention

2017 Biological Weapons Convention Meeting of States Parties
5 December 2017

Jonathan E. Forman, Ph.D.
Science Policy Adviser and Secretary to the Scientific Advisory Board
Jonathan.forman@opcw.org

21-30 November 2018: A Time to Review

Scientific Advisory Board Report:

Overview of scientific and technological changes during review period

Advice on relevant and emerging areas of science and technology

Recommendations for moving forward

The OPCW Scientific Advisory Board in 2017

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

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

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

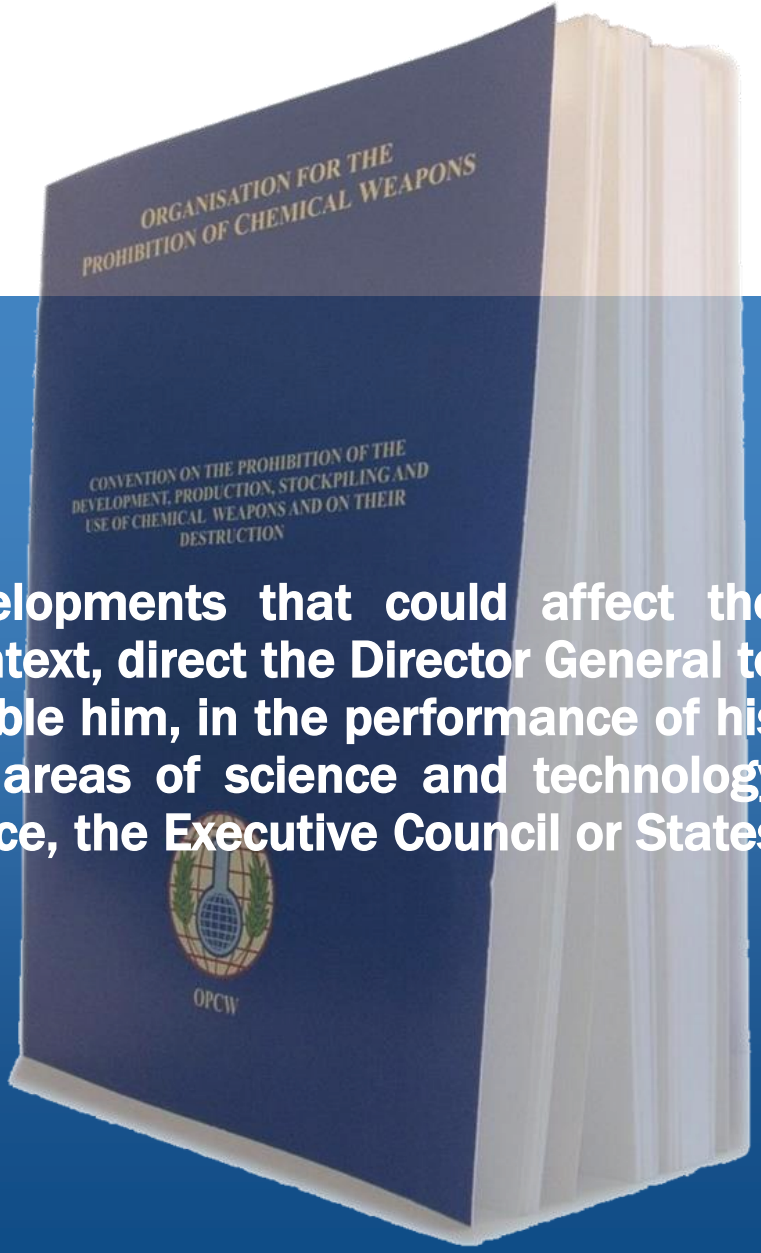
Response to the Director-General's Request to the Scientific Advisory Board to Provide Consideration on which Riot Control Agents are Subject to Declaration under the Chemical Weapons Convention
(SAB-25/WP.1, dated 27 March 2017)
URL: https://q-r.to/bap1Li

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

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

OPCW 1997-2017 OPCW 20 YEARS

Science and Technology in the Convention



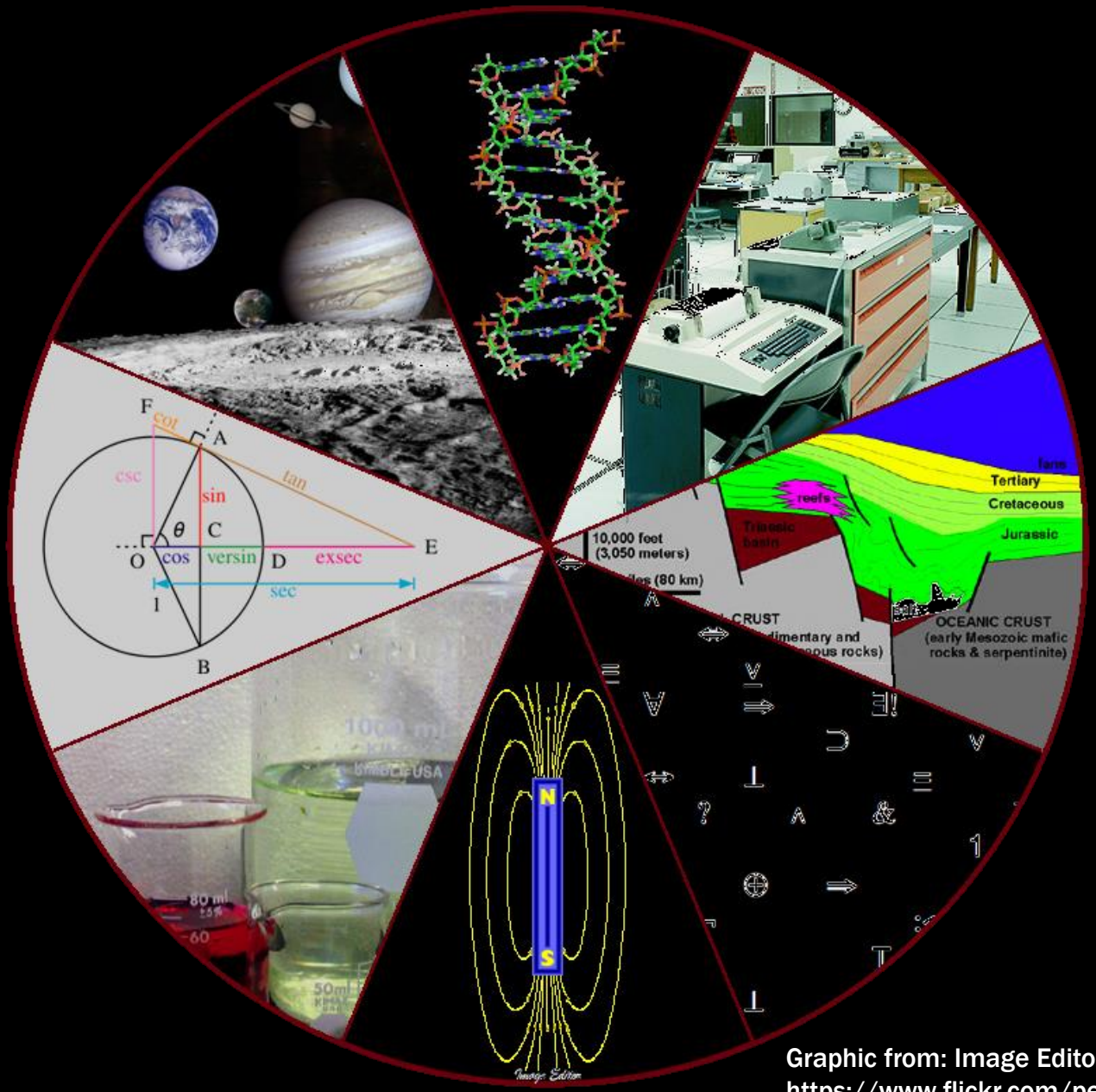
The Conference of States Parties Shall:

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

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

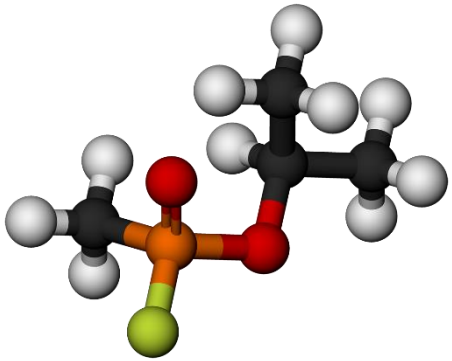
OPCW | 1997-2017 OPCW 20 YEARS

Which Field of Science Matters?



Graphic from: Image Editor
https://www.flickr.com/people/11304375@N07/

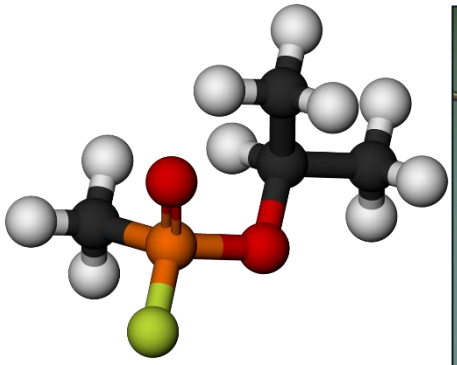
The Science of Chemical Weapons?

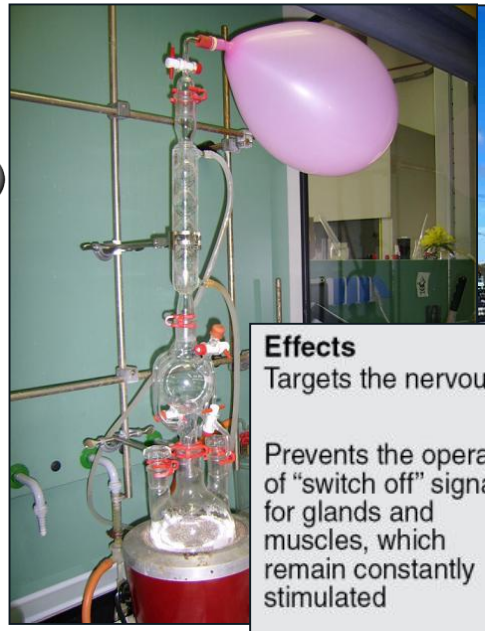


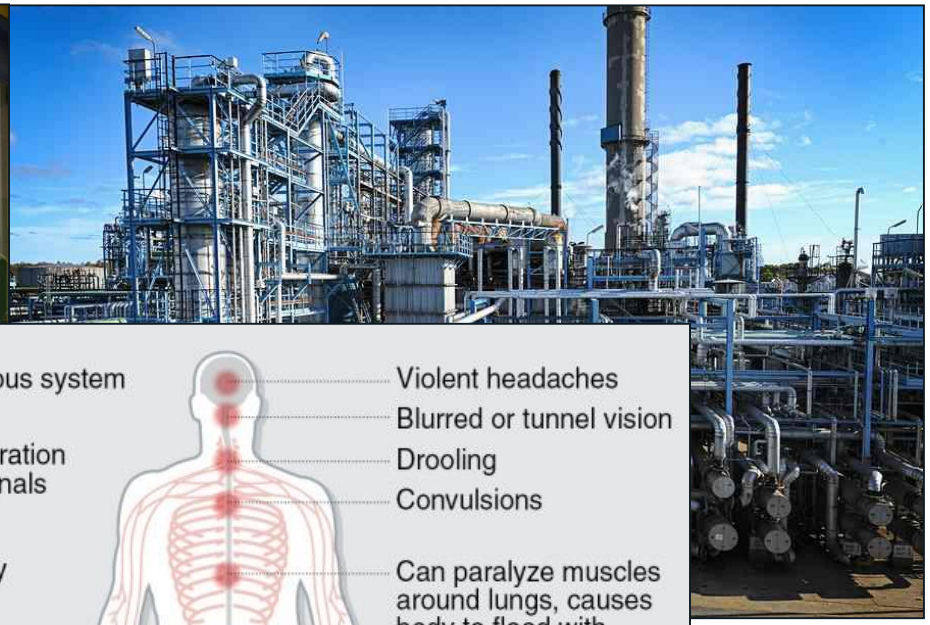
Chemistry

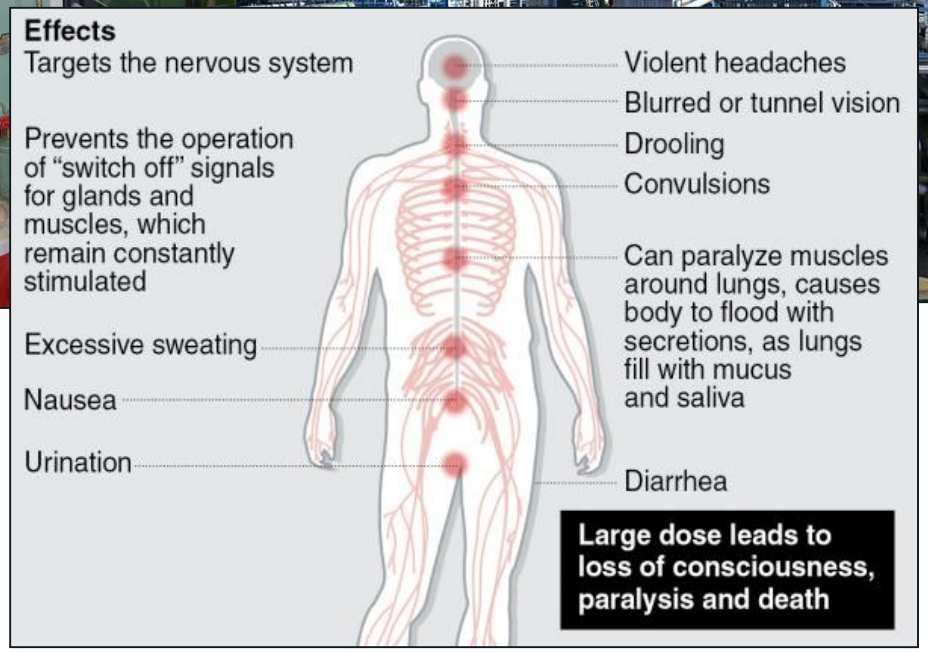
and Chemical Engineering

The Science of Chemical Weapons?

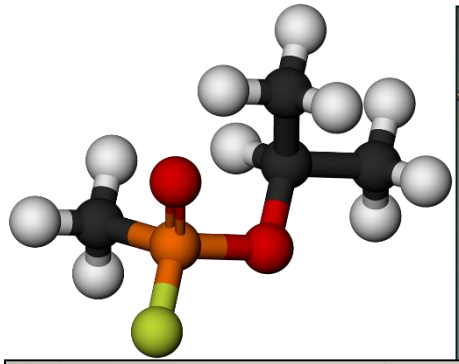


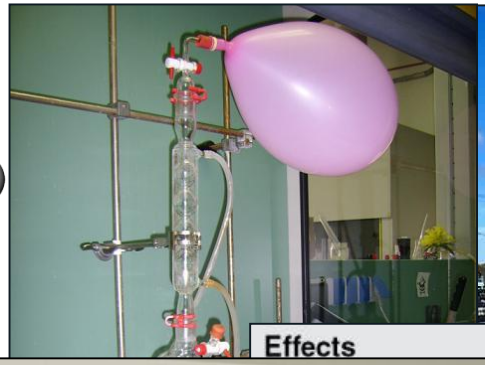


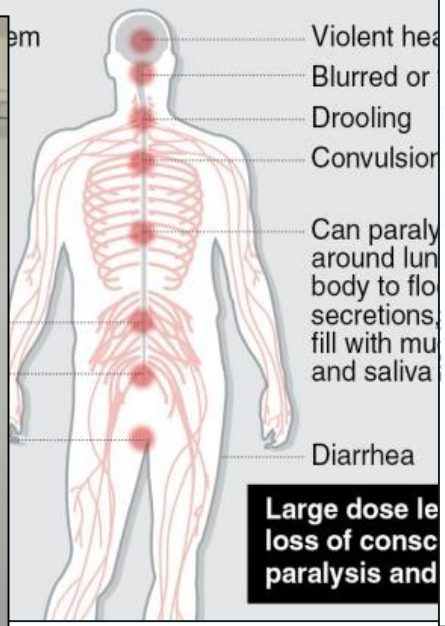


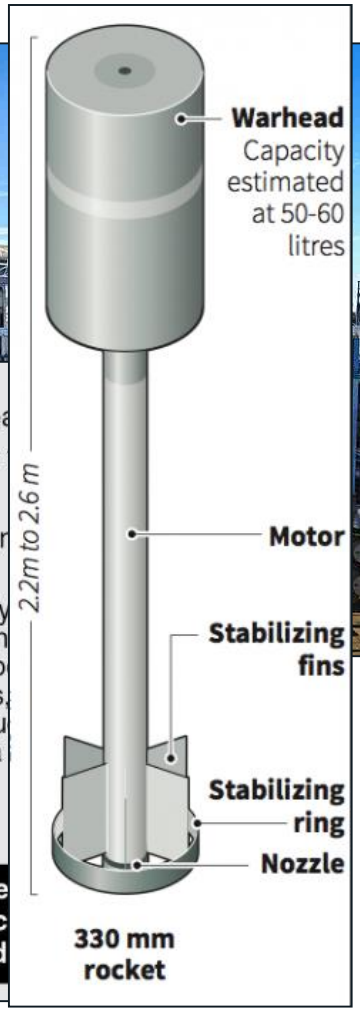


The Science of Chemical Weapons?



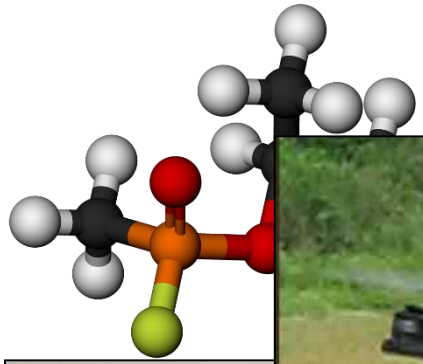


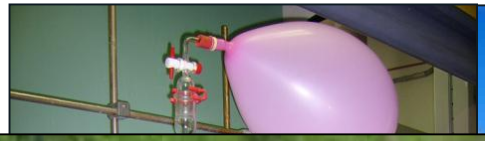




Physics and Engineering

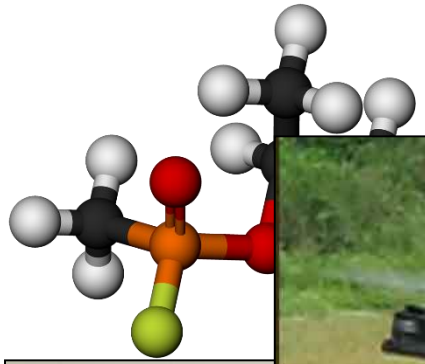
The Science of Chemical Weapons?

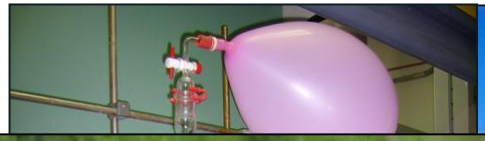




Physics and Engineering

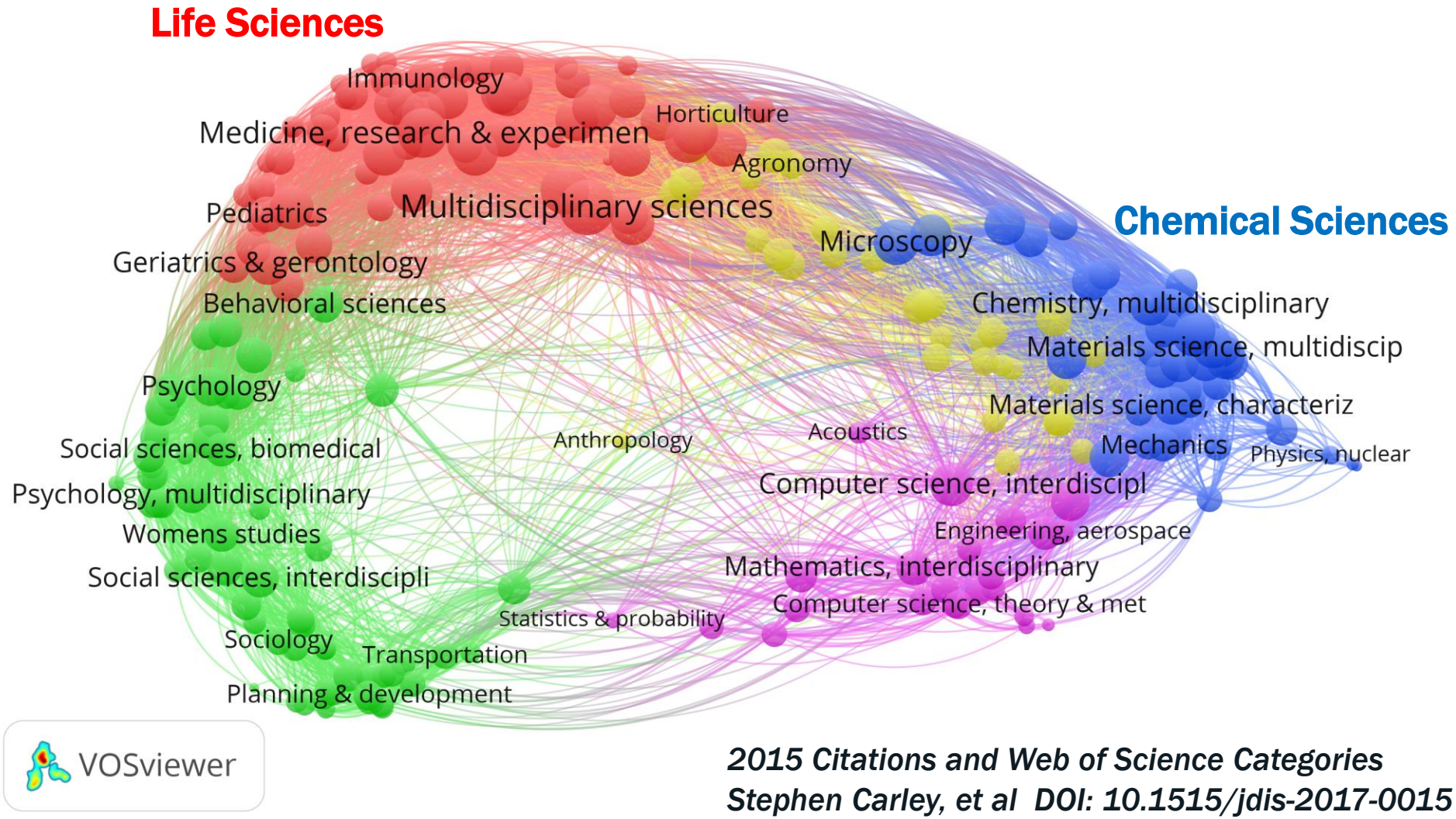
The Science of Chemical Weapons?





Physics and Engineering

A Multi-Disciplinary Scientific Landscape



2015 Citations and Web of Science Categories
Stephen Carley, et al DOI: 10.1515/jdis-2017-0015

A Convergent Convention?

Chemical Weapon

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

Toxic Chemical

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

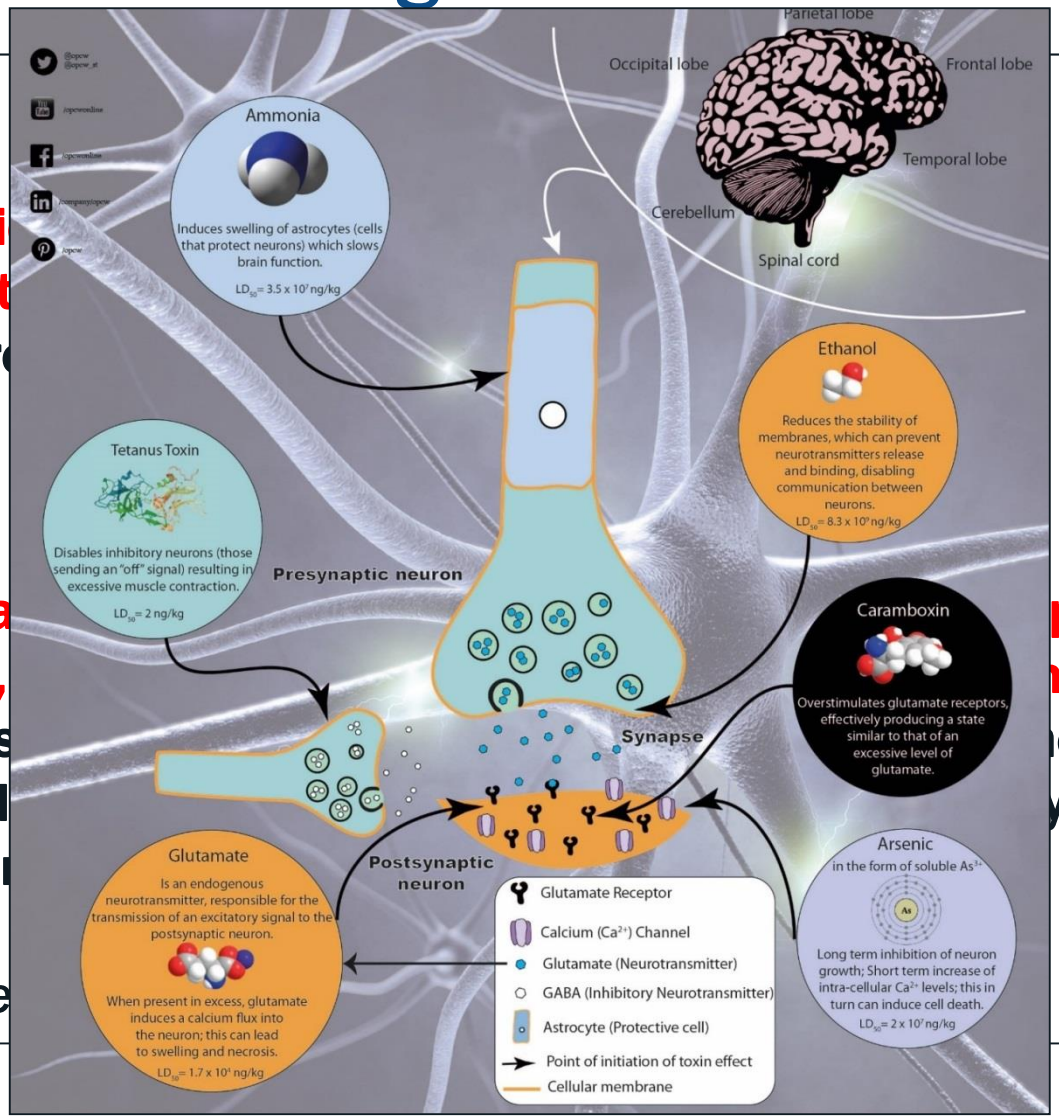
Chemical Weapons Convention Article II

A Convergent Convention?

Toxic chemi **intended for**
purposes not the types and
quantities ar

Any chemica **processes can**
cause death, **to humans or**
animals. This **eir origin or of**
their method **y are produced**
in facilities, i

Chemical We



A Need for Practical Science Advice

- **All this advanced science and…**

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

A Need for Practical Science Advice

- **All this advanced science and…**

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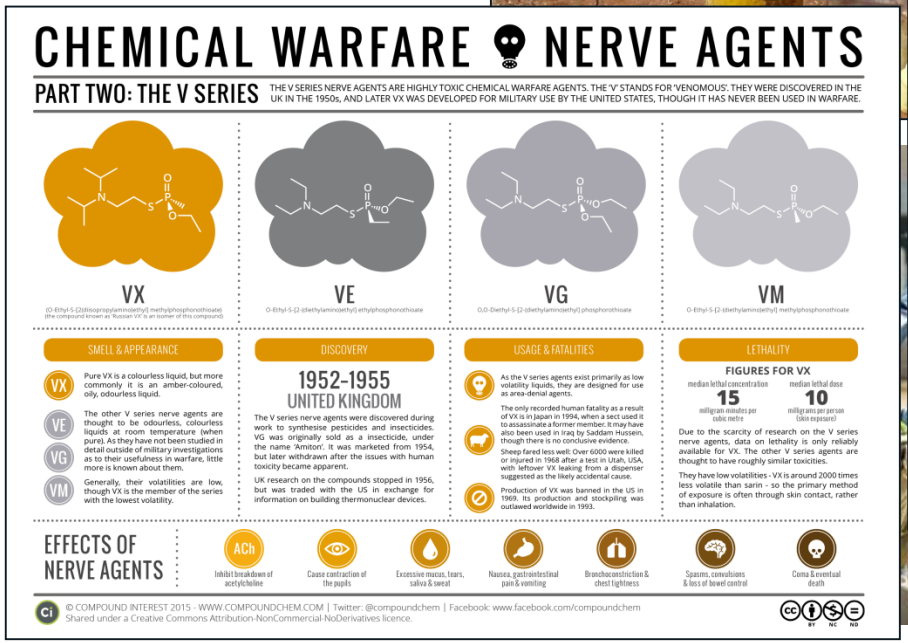
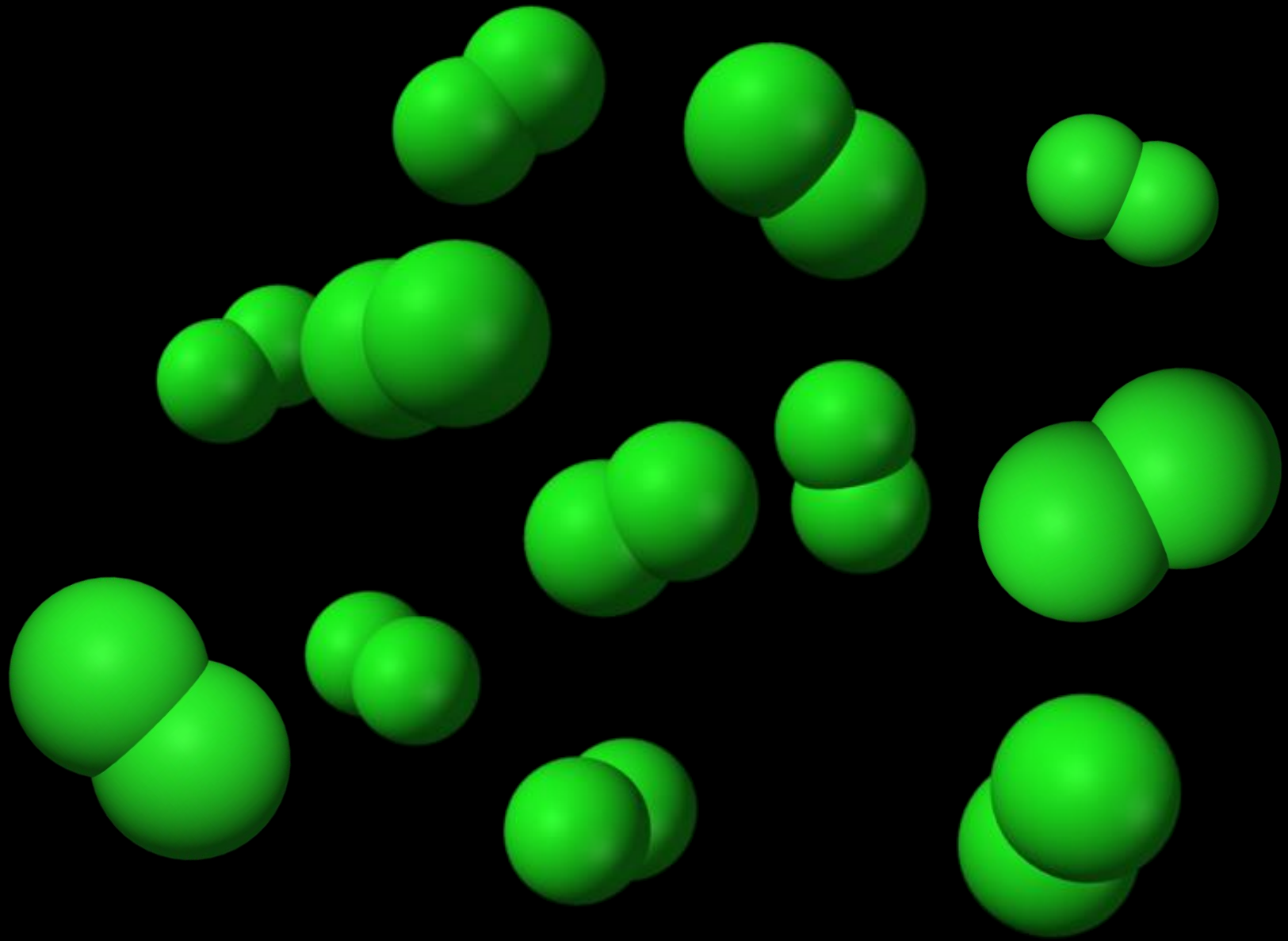


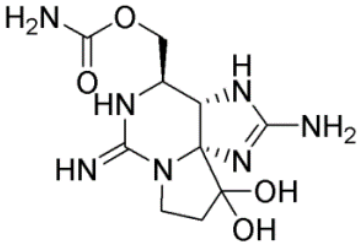
A Need for Practical Science Advice

- **All this advanced science and…**
- **Allegations of use of Chlorine Gas, Sulphur Mustard and Nerve Agents**
- **Diseases found in nature**
  - Nature does not sign or honour treaties!



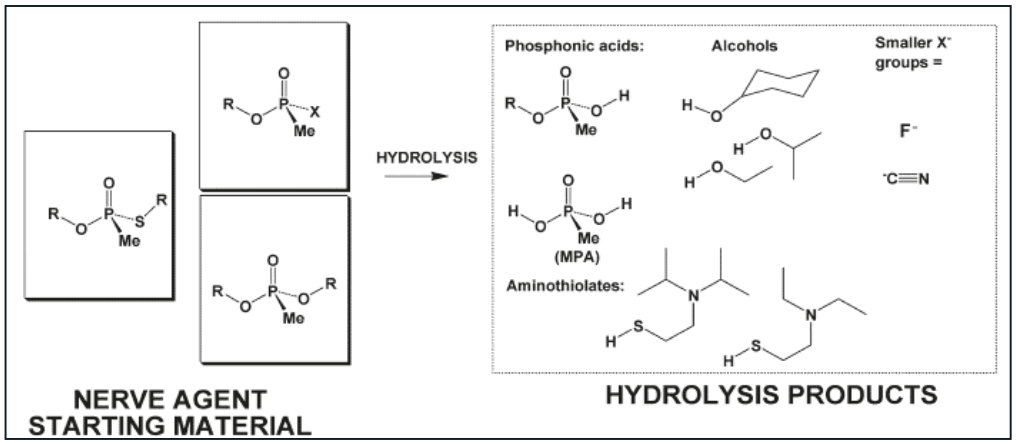

Chemical analysis to verify
chlorine gas exposure?

The Bigger Challenge of Science and Technology



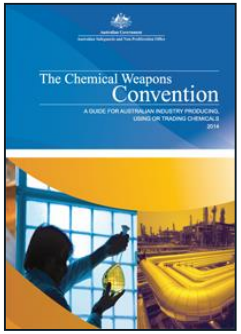
Article II

Article III



Articles IV and V

Article VI



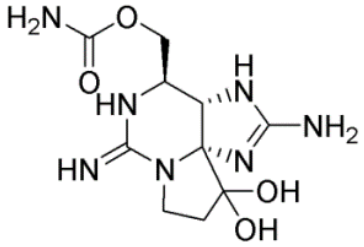
Article VII

Article VIII

Articles IX and X

Article XI

The Bigger Challenge of Science and Technology



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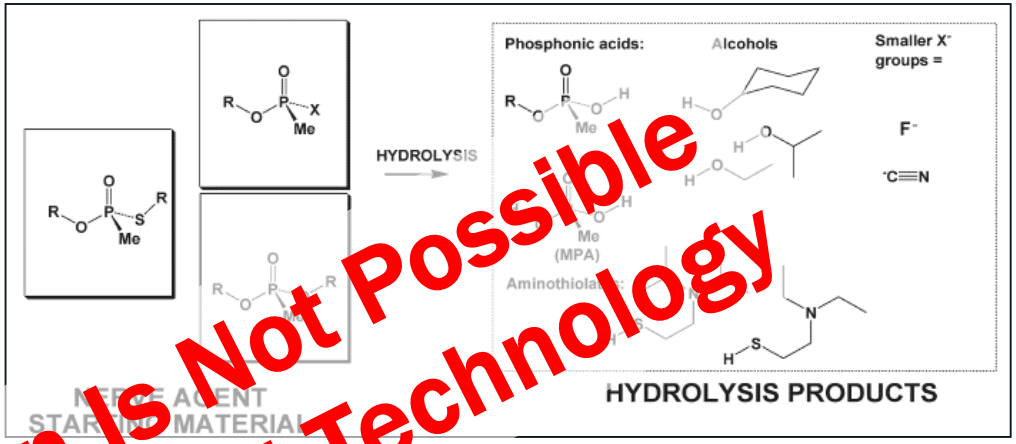
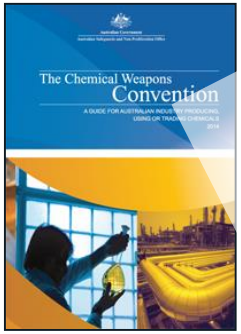


Articles IV and V

Article VI



Article VII

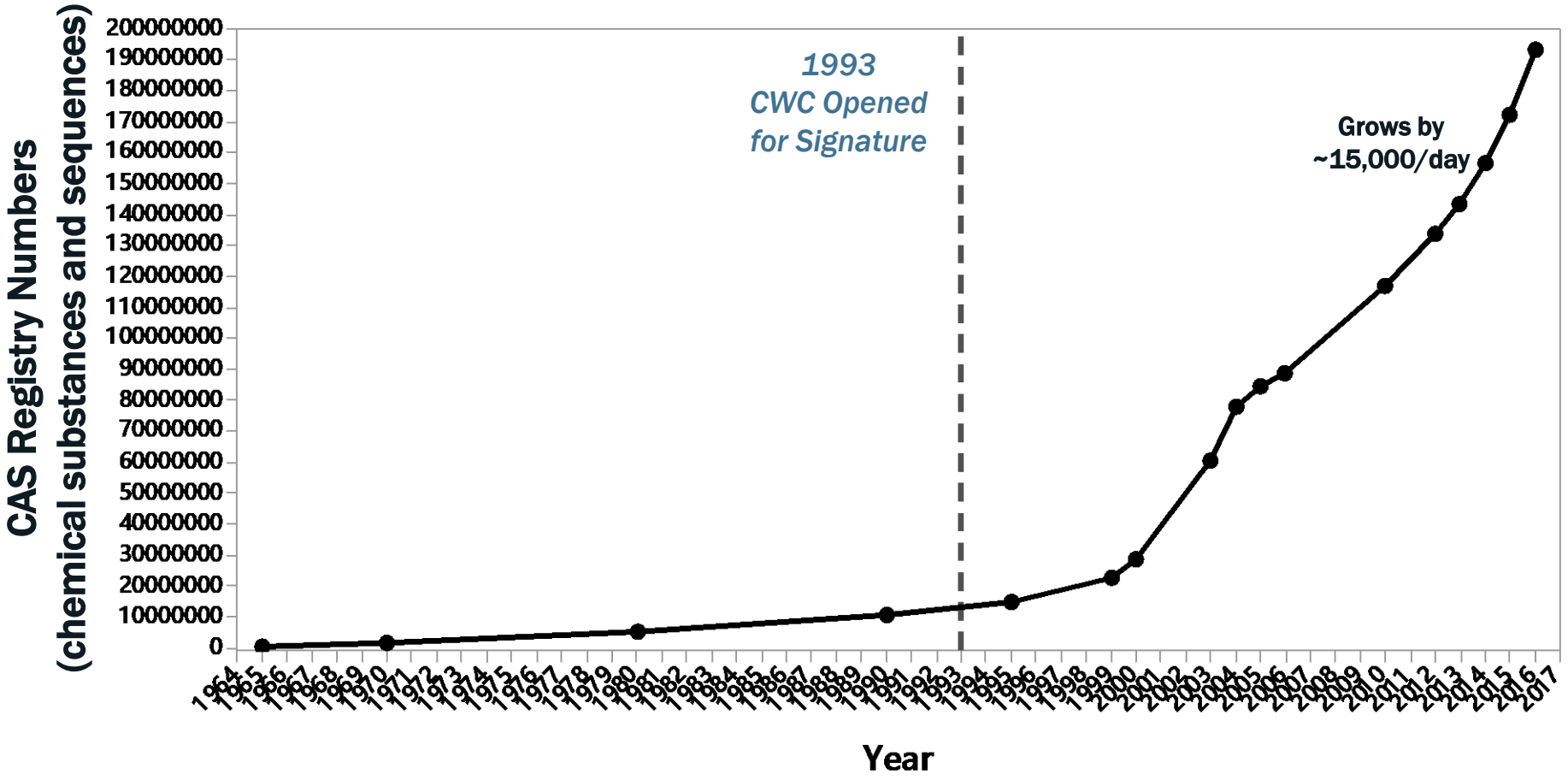
Article VIII

Articles IX and X

Article XI

Implementation Is Not Possible Without Science and Technology

“Rapid Advances in Science and Technology”



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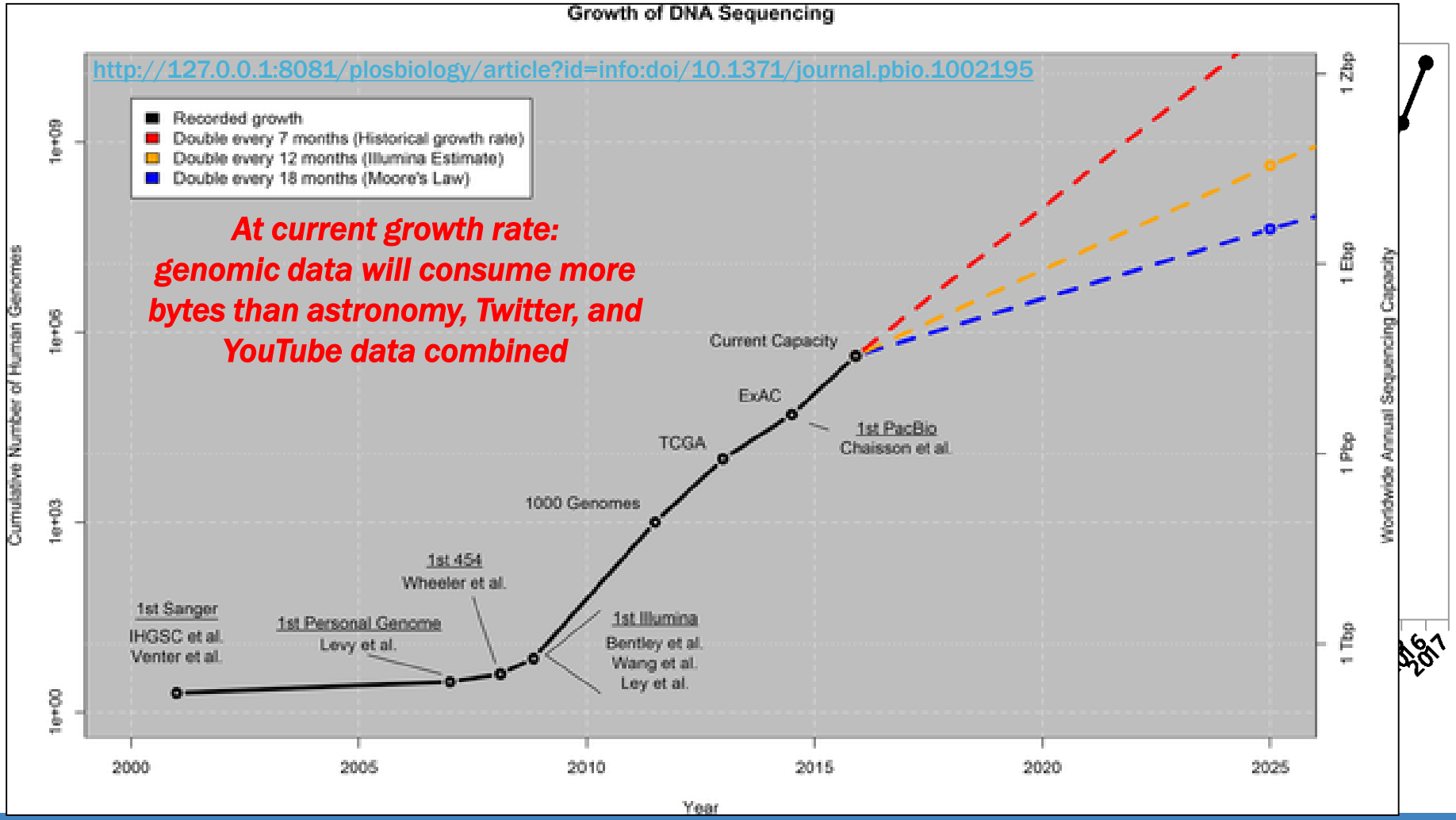

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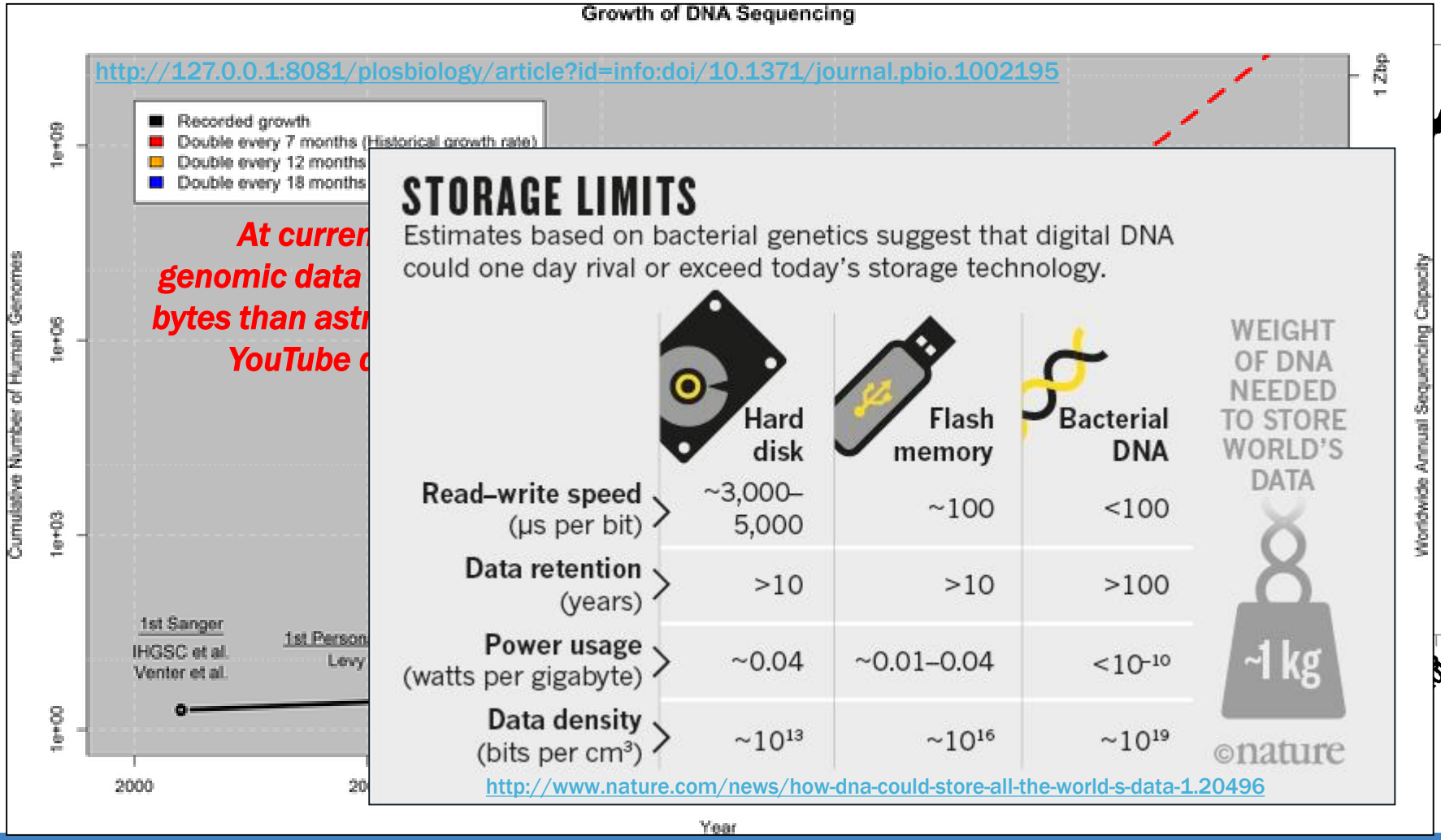


STORAGE LIMITS

Estimates based on bacterial genetics suggest that digital DNA could one day rival or exceed today's storage technology.

	Hard disk	Flash memory	Bacterial DNA
Read–write speed (μs per bit)	~3,000–5,000	~100	<100
Data retention (years)	>10	>10	>100
Power usage (watts per gigabyte)	~0.04	~0.01–0.04	$<10^{-10}$
Data density (bits per cm^3)	$\sim10^{13}$	$\sim10^{16}$	$\sim10^{19}$

WEIGHT OF DNA NEEDED TO STORE WORLD'S DATA

~1 kg

©nature

http://www.nature.com/news/how-dna-could-store-all-the-world-s-data-1.20496

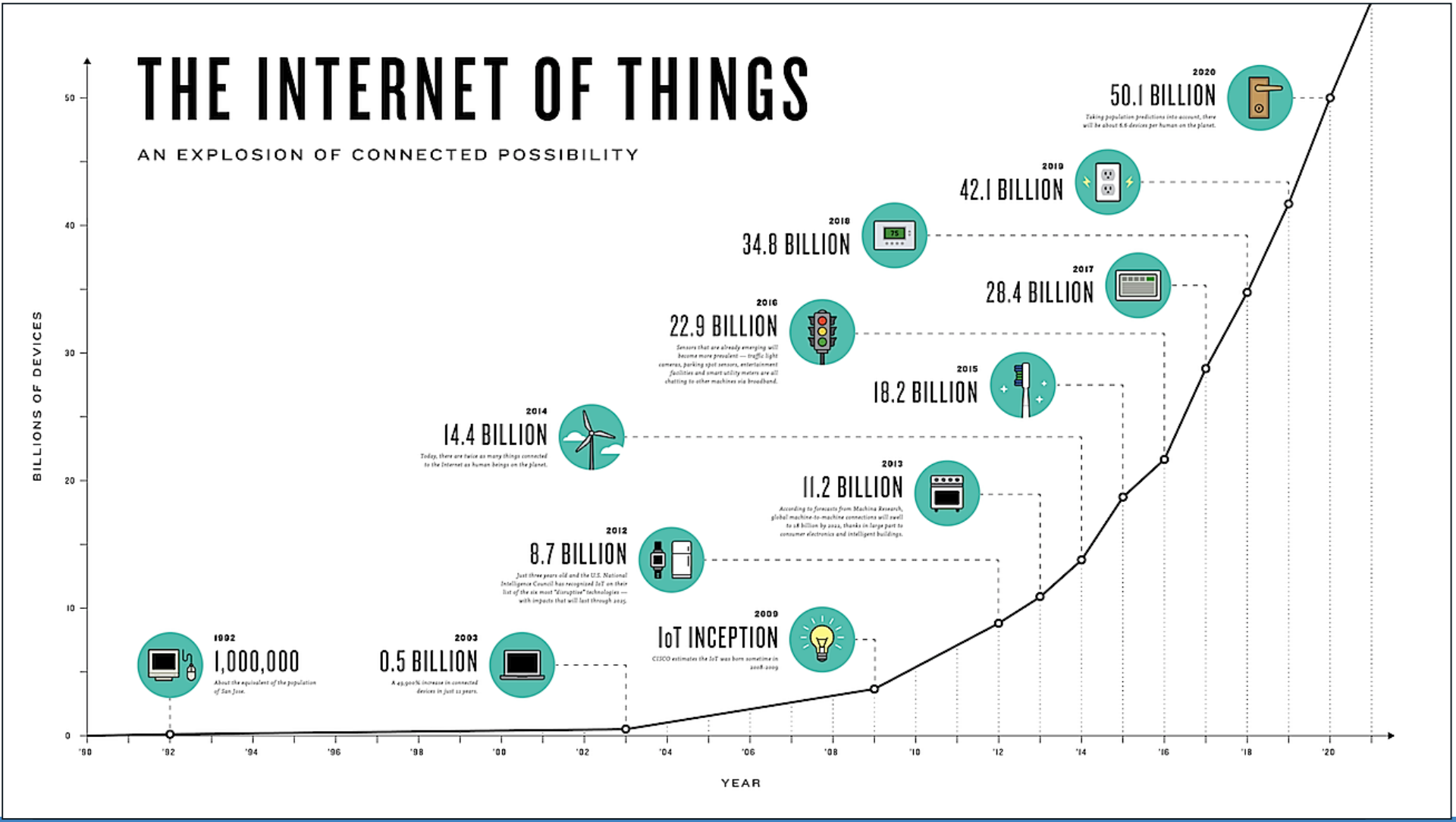
“Rapid Advances in Science and Technology”

International cooperation: This is good right?

http://olihb.com/2014/08/11/map-of-scientific-collaboration-redux/

http://www.nature.com/news/how-dna-could-store-all-the-world-s-data-1.20496

“Rapid Advances in Science and Technology”



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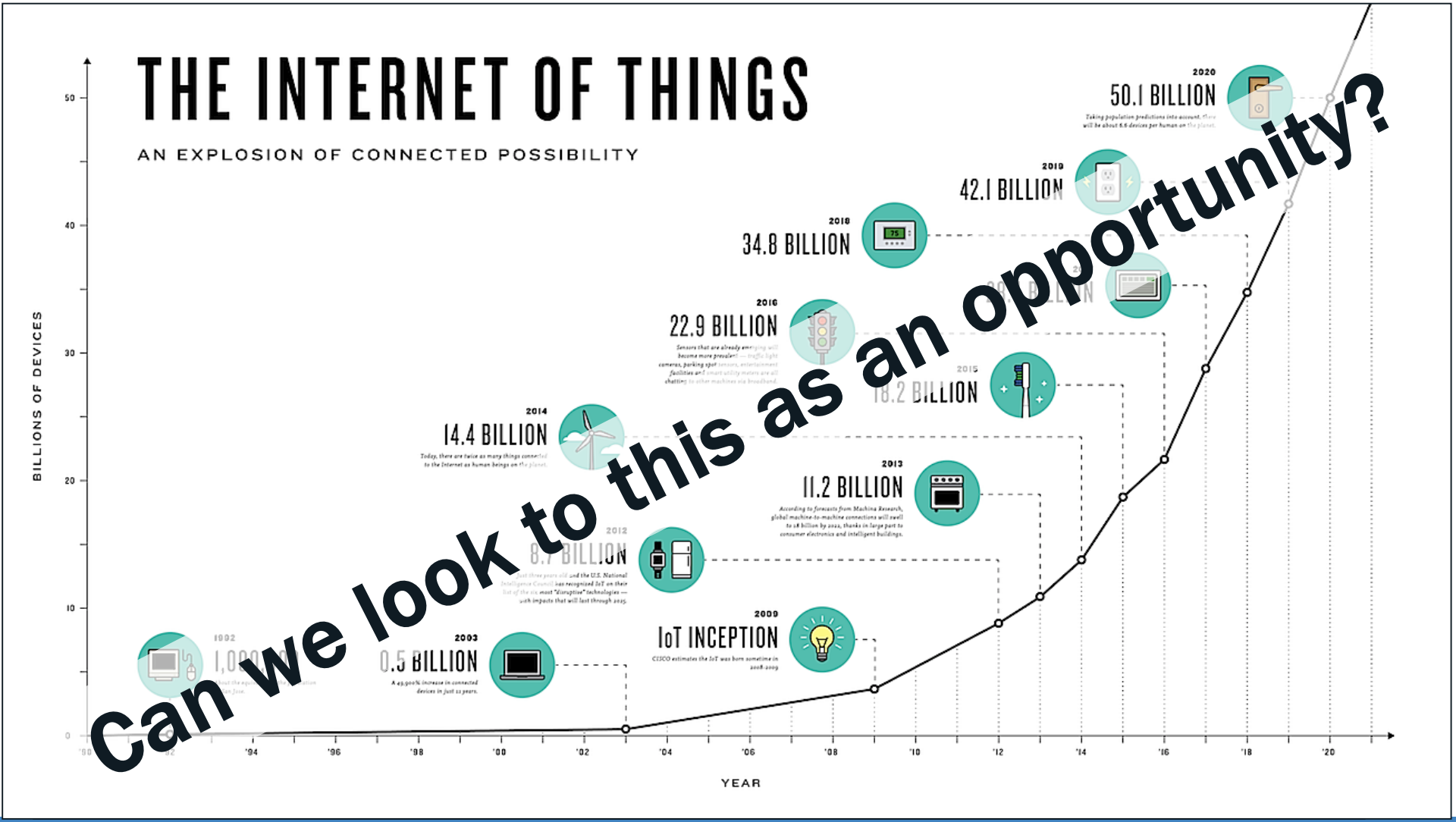
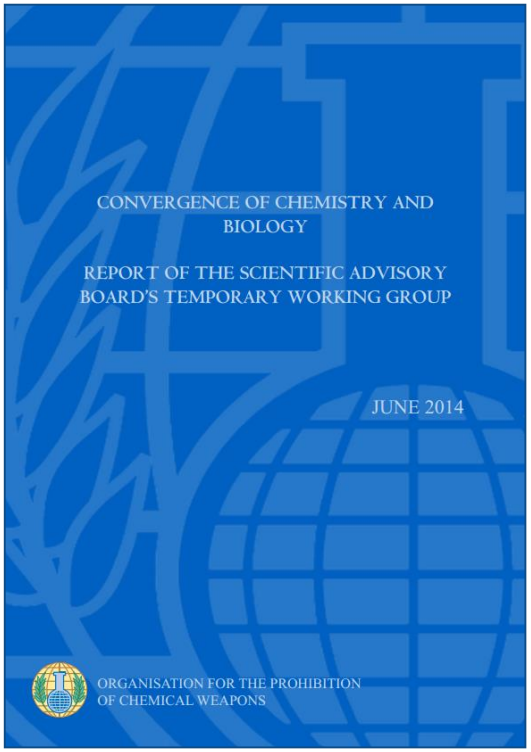
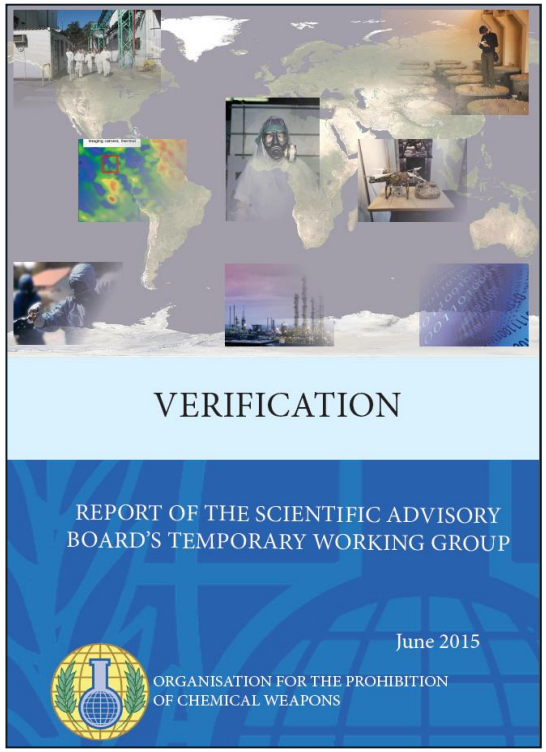
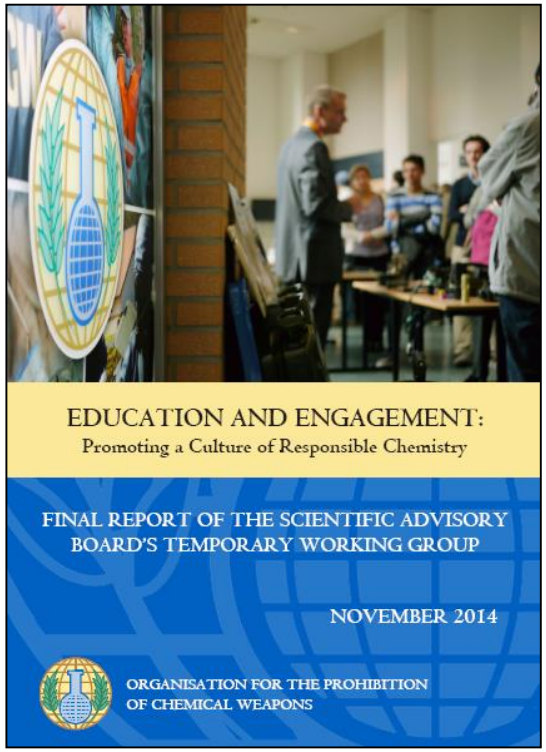


The Scientific Review

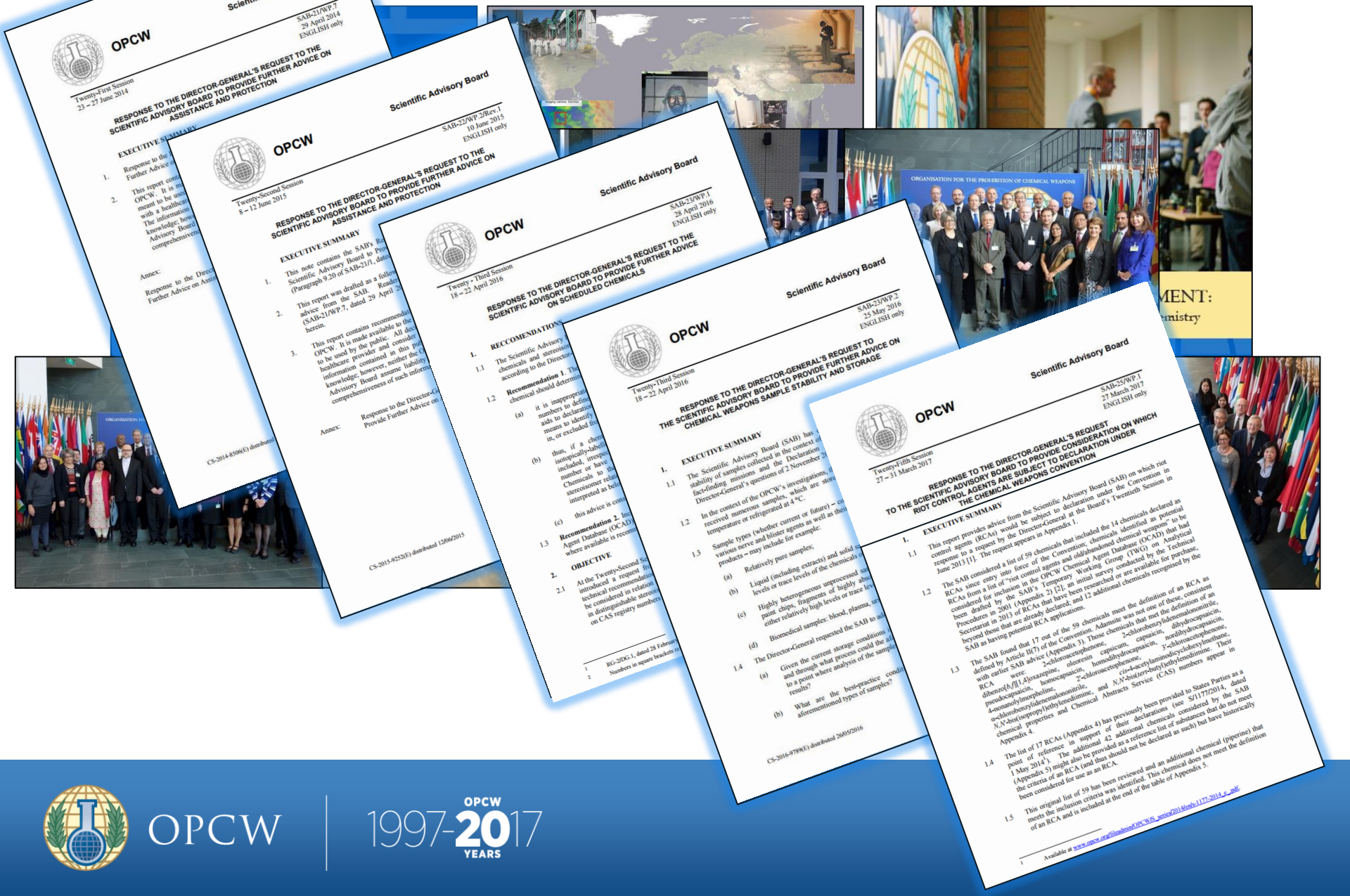






The Scientific Review

The Scientific Review



The Scientific Review

The Scientific Review

25 Events

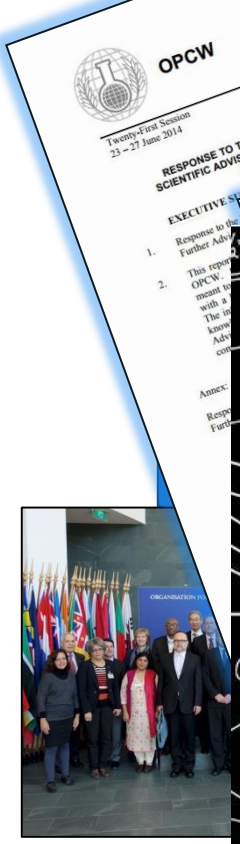
676 Attendees

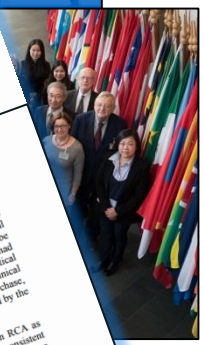
- 256 individuals
- 56 Nationalities

405 Speakers

- 191 individuals
- 56 Nationalities

30 Reports





Chemical Forensics: Capabilities across the Field and the Potential Applications in Chemical Weapons Convention Implementation

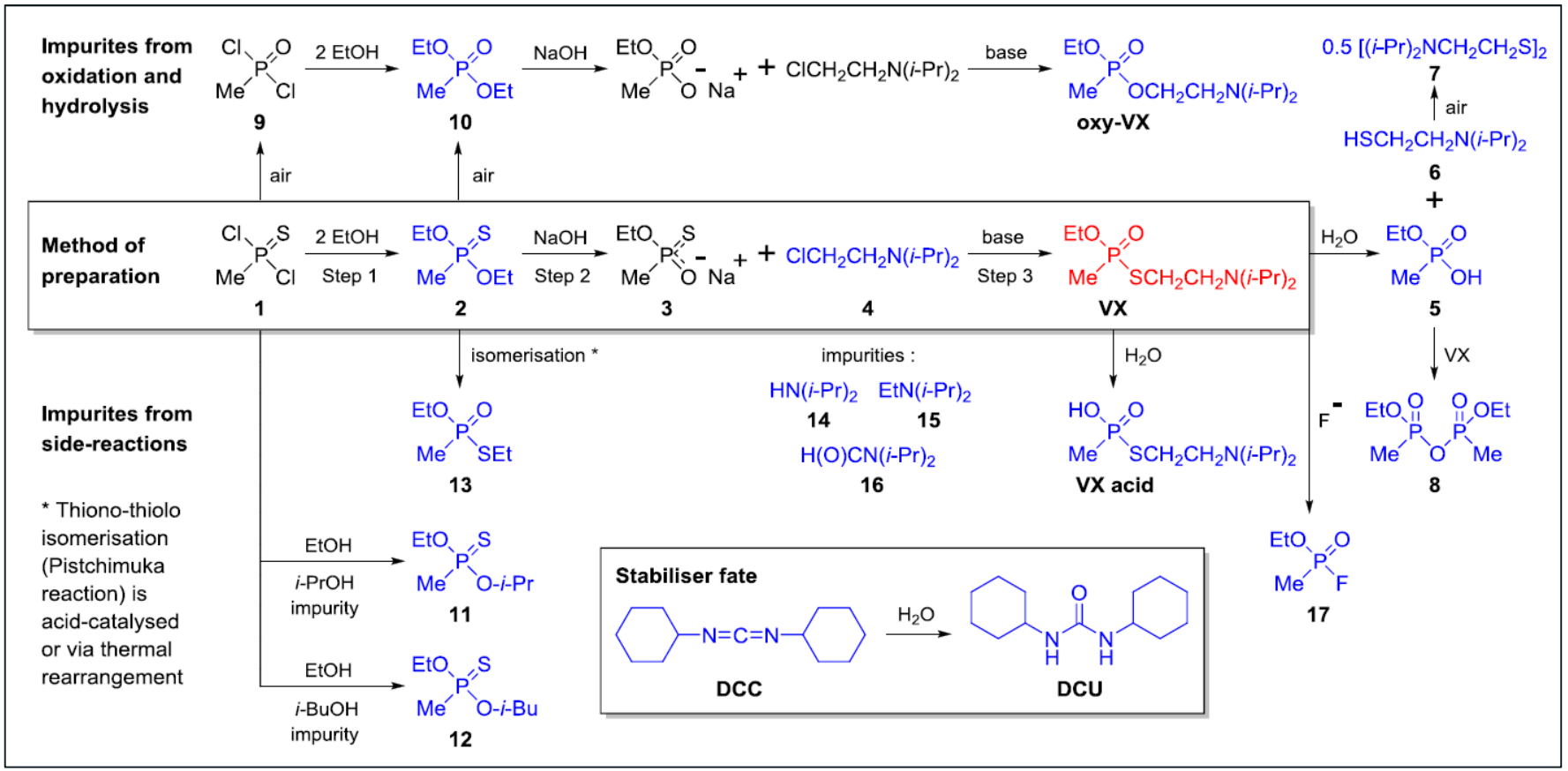
Helsinki, Finland. 20 to 22 June 2016

SAB-24/WP.1, dated 14 July 2016, URL: http://q-r.to/bap1gy

Coorganizer: VERIFIN

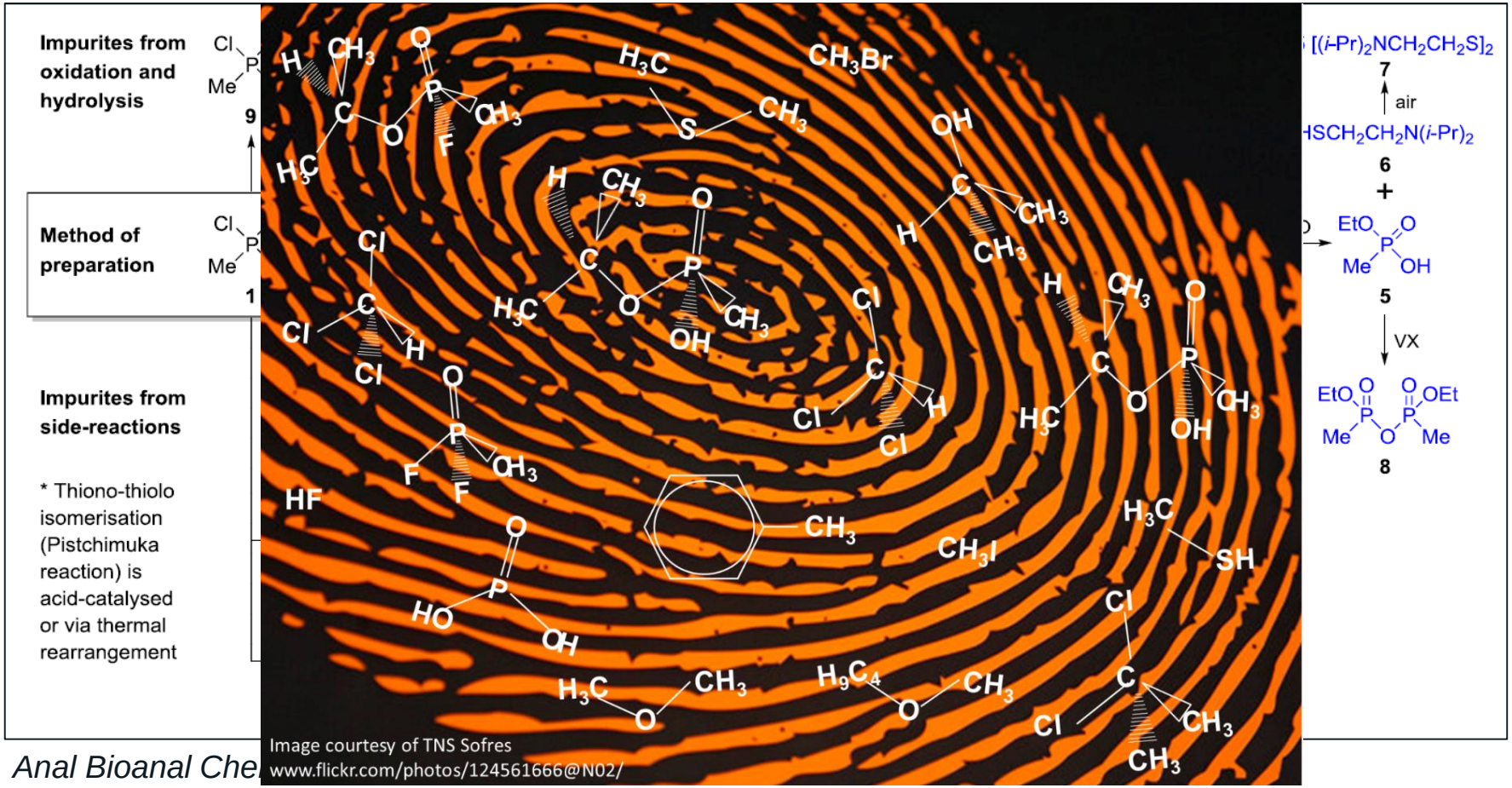
SCAN ME

Chemical Forensics and Sampling



Anal Bioanal Chem, 2014, *406*, 5121–5135
DOI 10.1007/s00216-014-7963-9

Chemical Forensics and Sampling



Anal Bioanal Che
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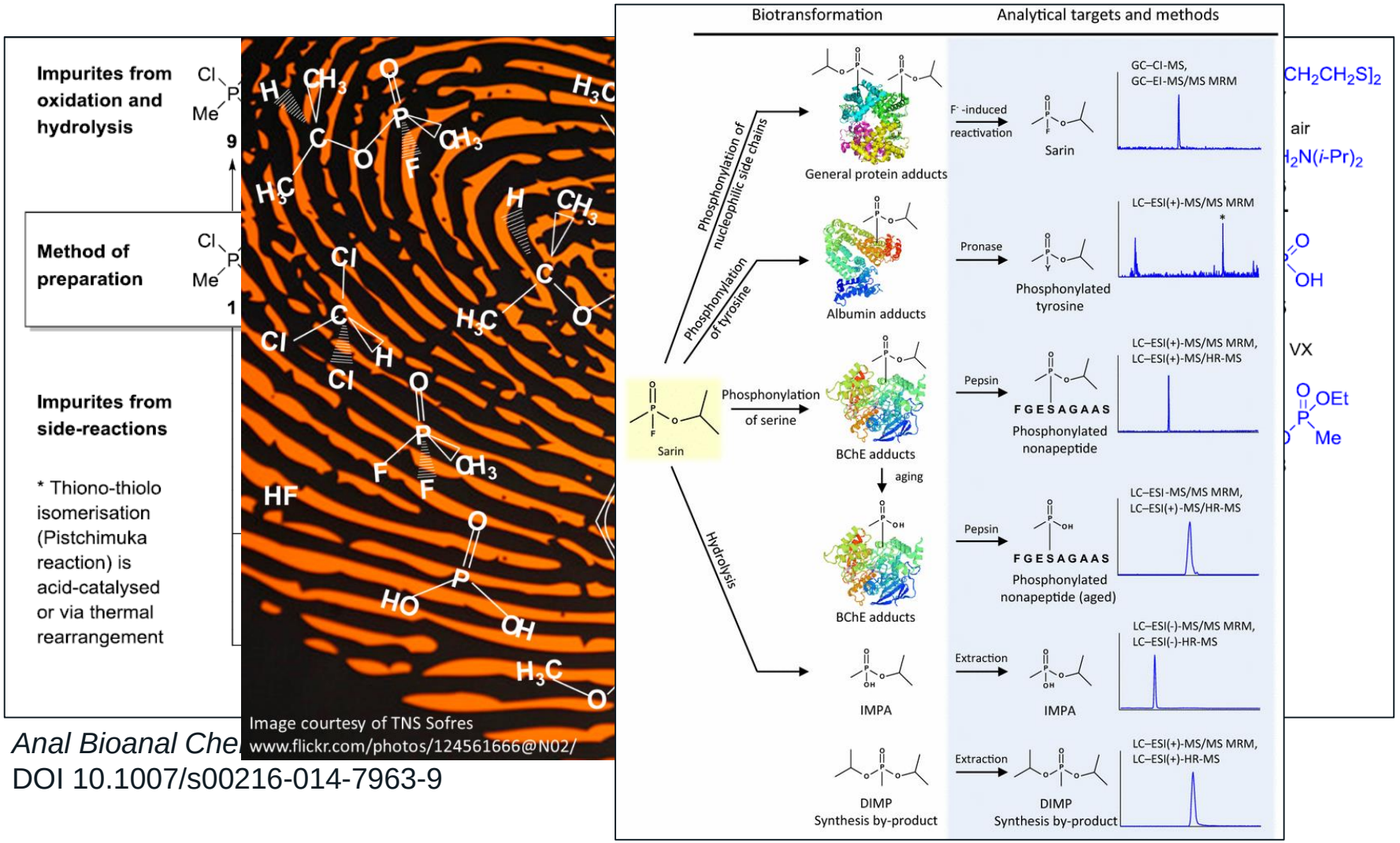
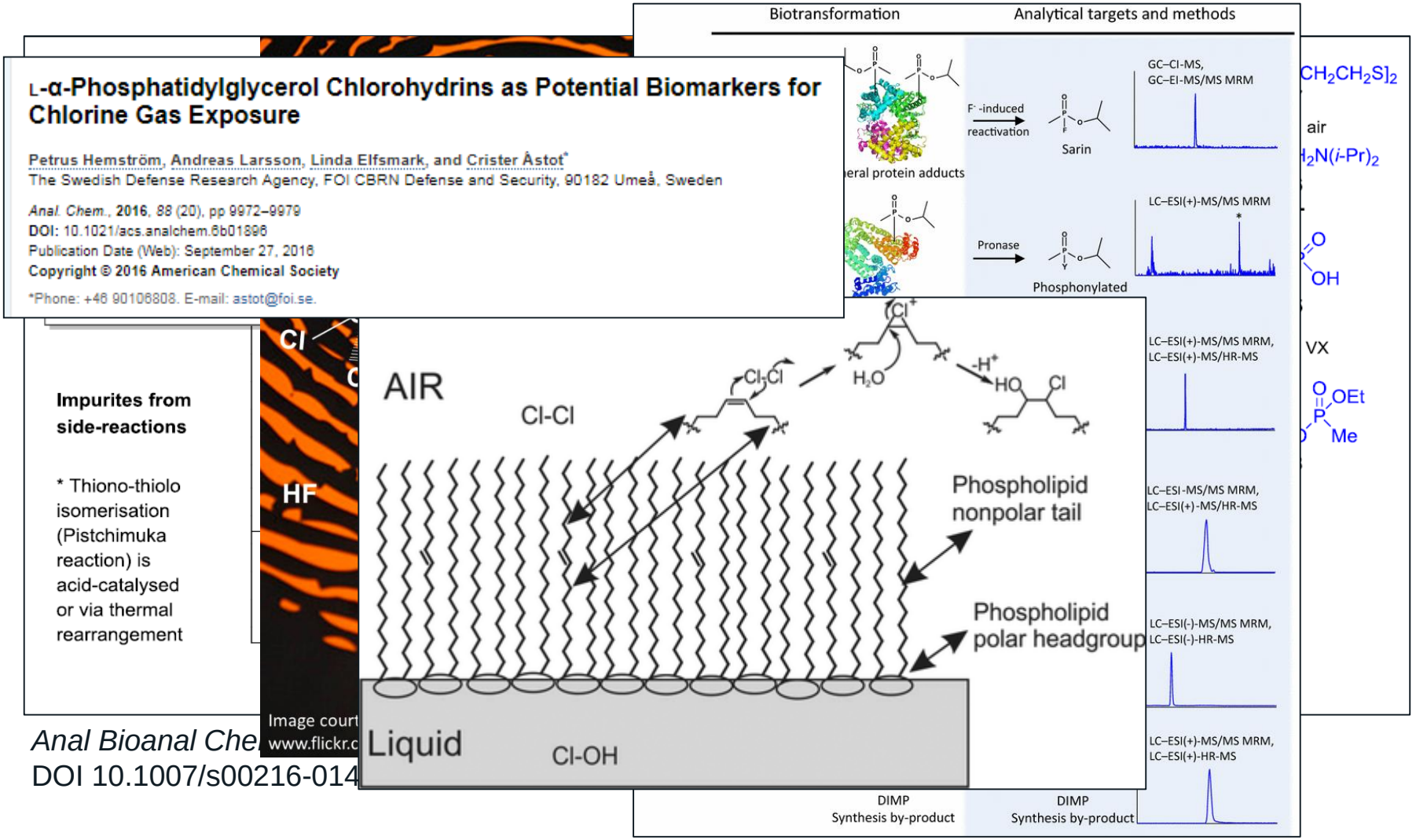


Anal Bioanal Che
DOI 10.1007/s00216-014-7963-9

Biomedical Samples
DOI 10.1007/s11419-017-0376-7

Chemical Forensics and Sampling



Anal Bioanal Che
DOI 10.1007/s00216-014

OPCW | 1997-2017 OPCW 20 YEARS

Biomedical Samples

DOI 10.1007/s11419-017-0376-7

Learning from the Experiences of Others

Learning from the Experiences of Others

2- Monitoring and reporting systems

Establisment (school, nursery, jail…) | Laboratory | Health services | Consumer

MANDATORY notification

DGS / Health ministry ↔ Health regional agency ↔ Local veterinay service ↔ Health Emergency Mission / Ministry of Food, Agriculture and Fishery

Epidemiological enquiry | Sampling organization | Food enquiry

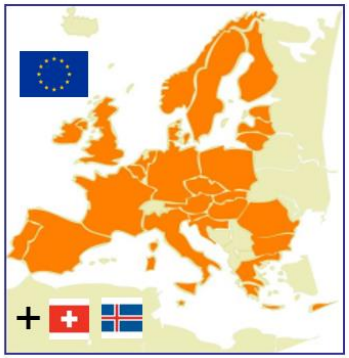
InVS | Health regional agency | Health regional agency | Local veterinary service | Local veterinary service

Clinical samples → Human health Laboratory

Food samples → Food laboratory

STAPHYLOCOQUES | NRC ↔ NRL | anses

RASFF



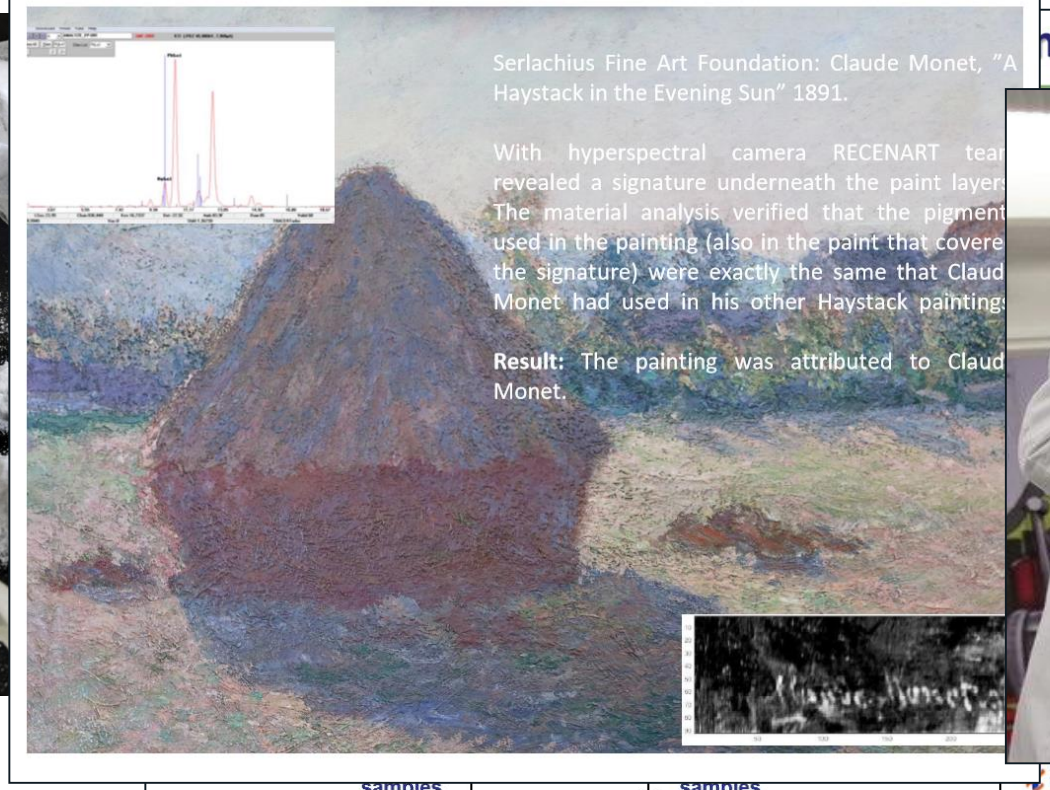
Animal, food and feed monitoring | FPO | Communicable human disease

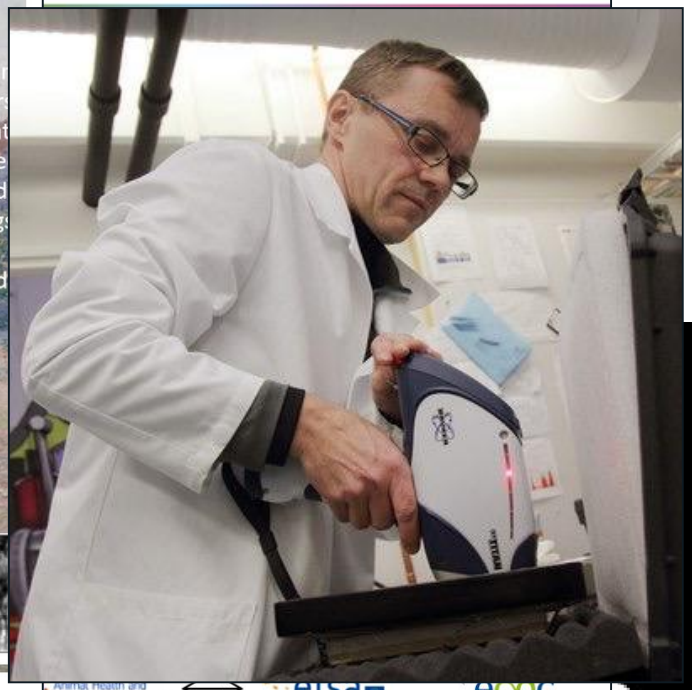
SANTÉ ET CONSOMMATEURS

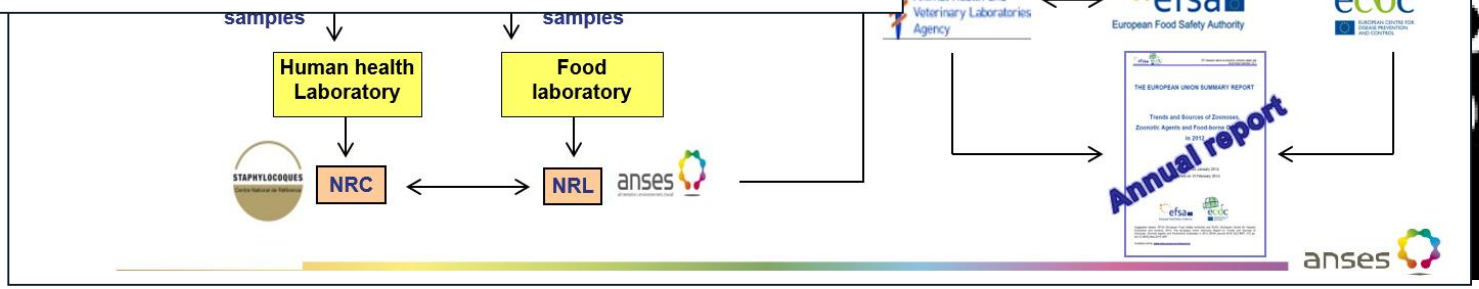
AHVLA Animal Health and Veterinary Laboratories Agency ↔ efsa European Food Safety Authority | ecdc

anses

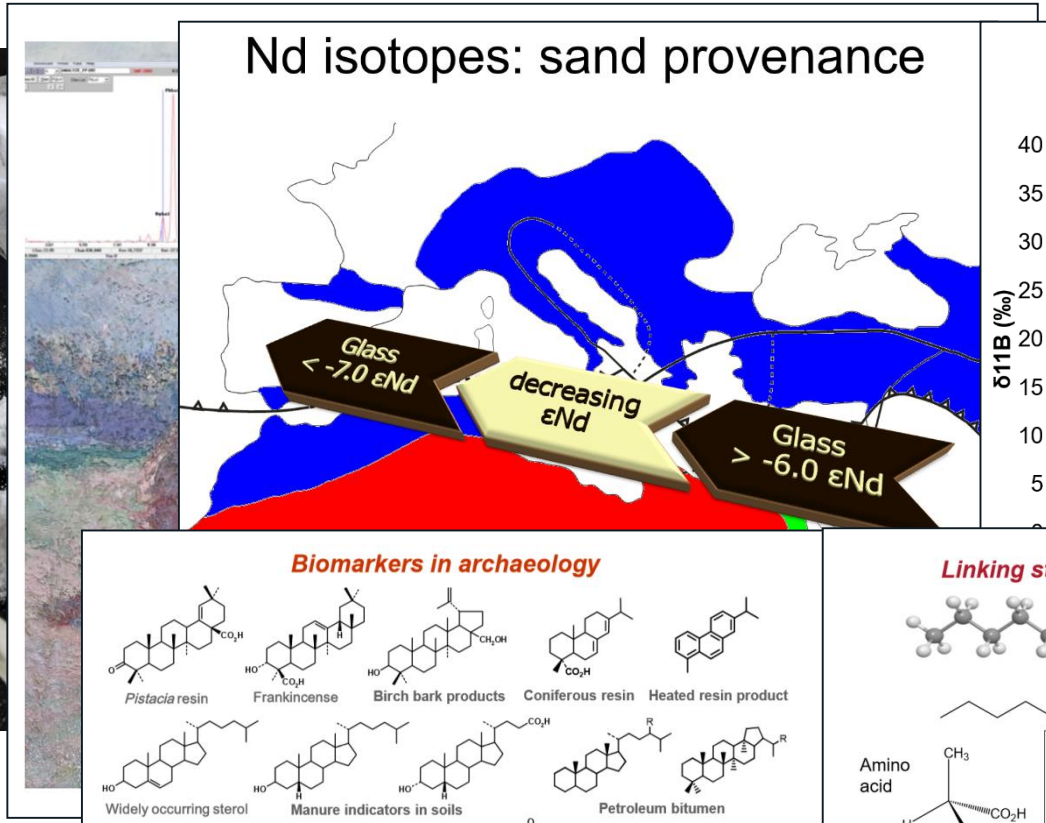
Learning from the Experiences of Others

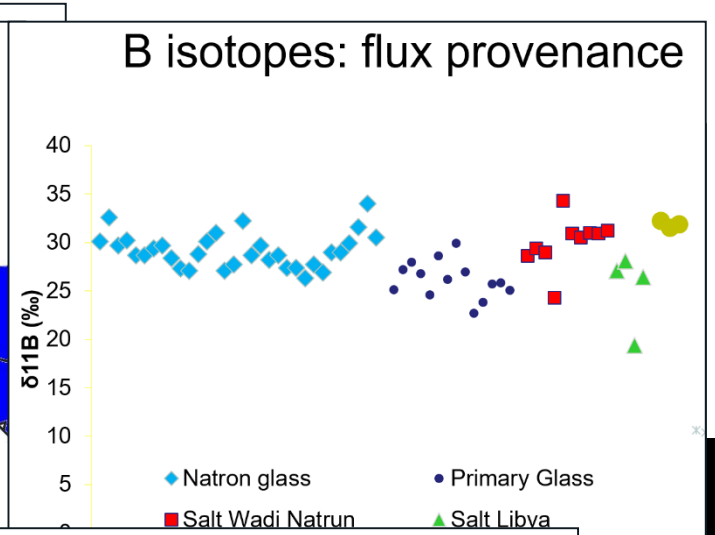


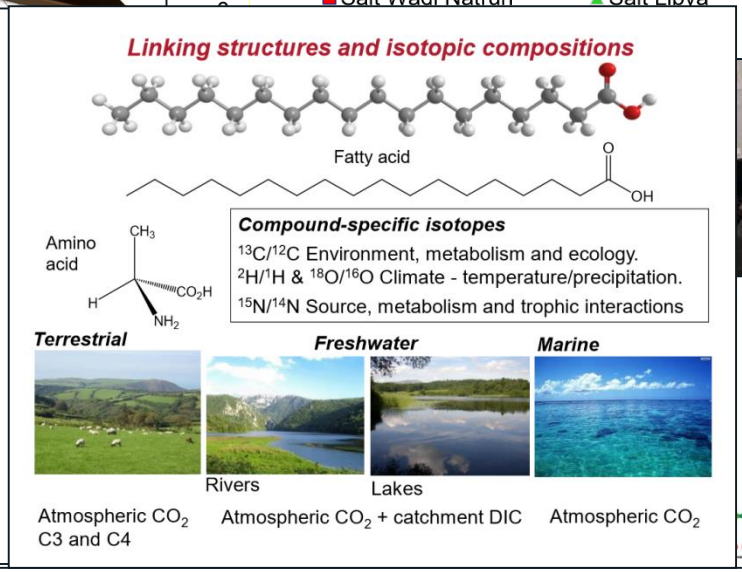




Learning from the Experiences of Others







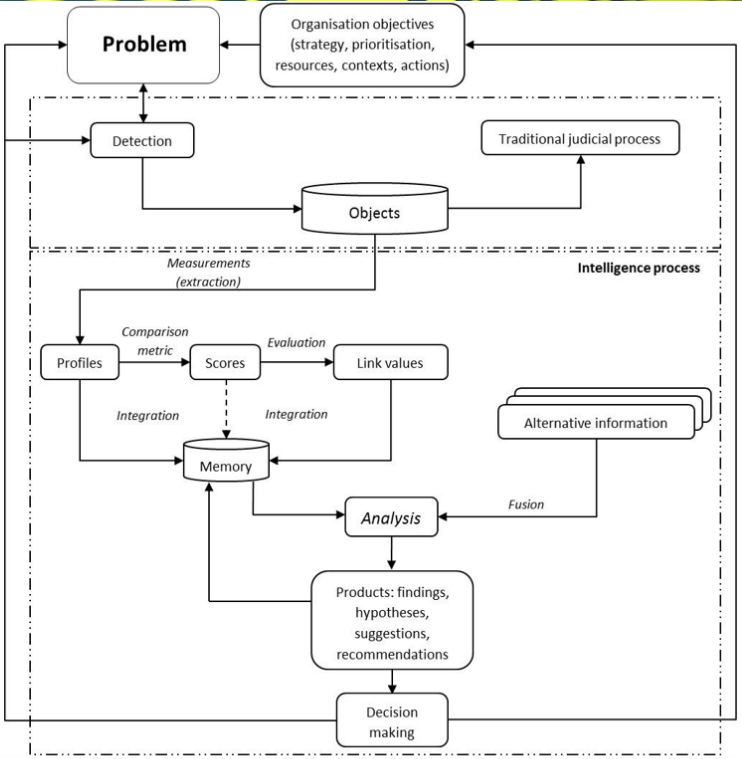
Learning from the Experiences of Others

AFP AUSTRALIAN FEDERAL POLICE

UNIL | Université de Lausanne

UNIVERSITY OF TECHNOLOGY SYDNEY

Induction of a forensic intelligence framework [24]



[24] Morelato M. & Baechler S. et al, 2014. *Forensic Sci. Int.,* vol.236, 181-190.

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.


SGDSN
SECRÉTARIAT GÉNÉRAL
DE LA DÉFENSE ET DE
LA SÉCURITÉ NATIONALE

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

SCAN ME

Chemical Warfare Agents: Toxicity, Emergency Response and Medical Countermeasures

Paris, France. 26 to 27 September 2016

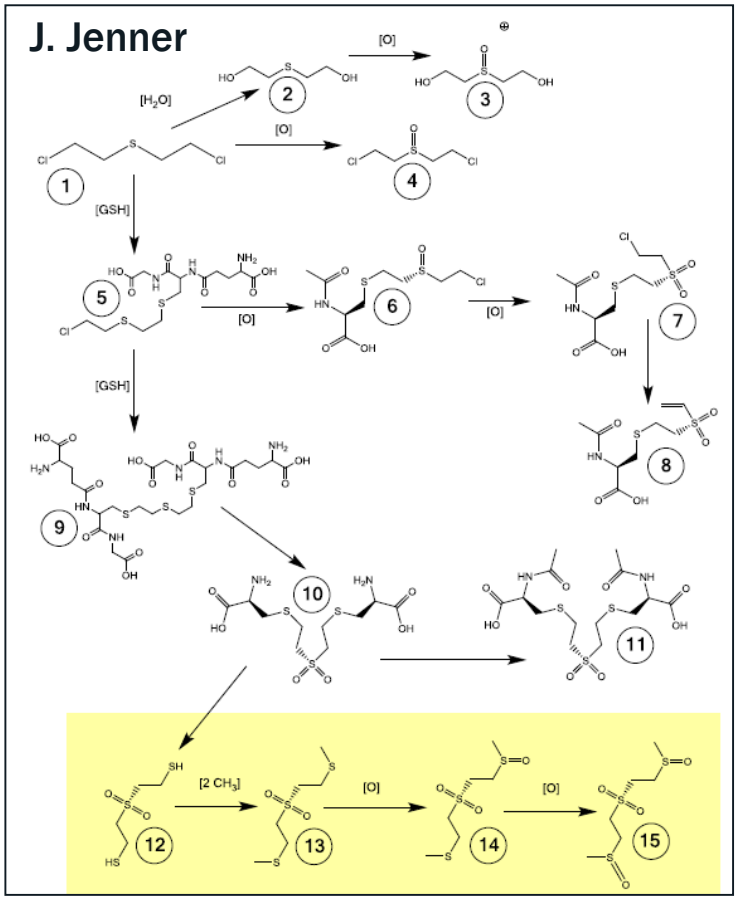
SAB-24/WP.2, dated 14 October 2016, URL: http://q-r.to/bap1h4

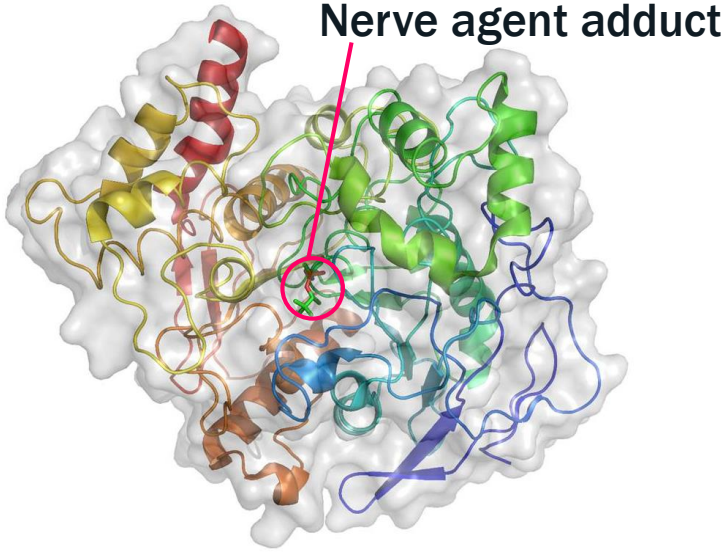
Coorganizer:

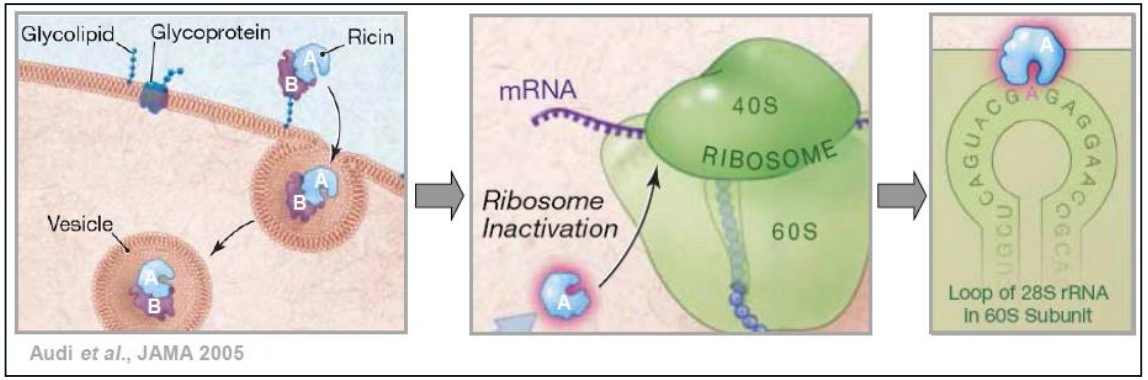
SGDSN

SCAN ME

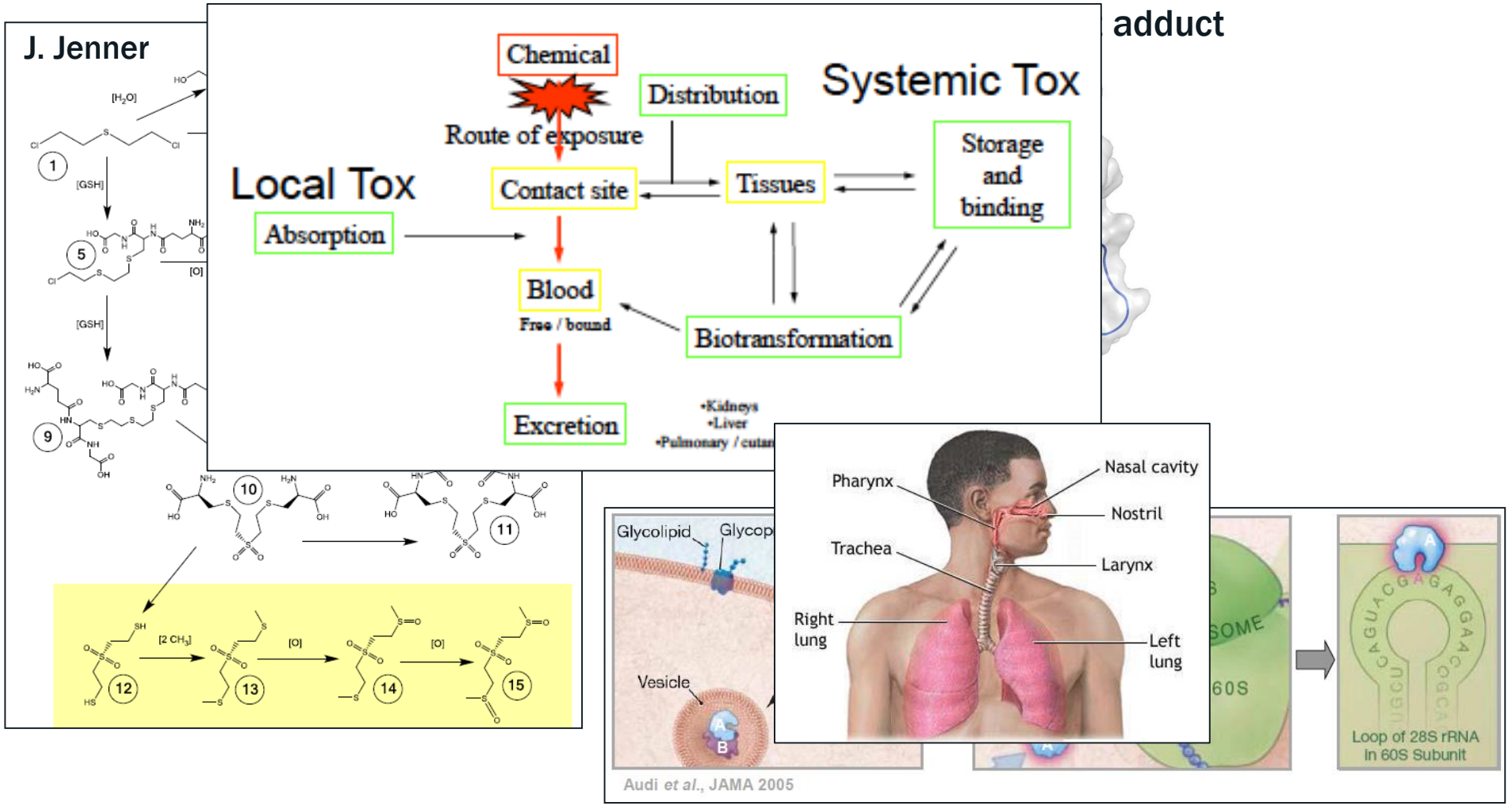
Mechanisms of Toxicity







Mechanisms of Toxicity



Mechanisms of Toxicity

Pre-treatment | Exposure | Signs of poisoning | First Aid Treatment | Emergency Medical Treatment | Advanced Medical Care | Palliative Care/ Rehabilitation

Scenario driven → Minutes to hours → ~ 10 min → ~ 1 h → ~ 2 h → + 24 h

Decontamination

Medical training, breadth of skills and staff numbers

Treatments, dosing routes and supportive care options

Physiological and biochemical casualty monitoring

Airway protection and ventilation (LIMITED)







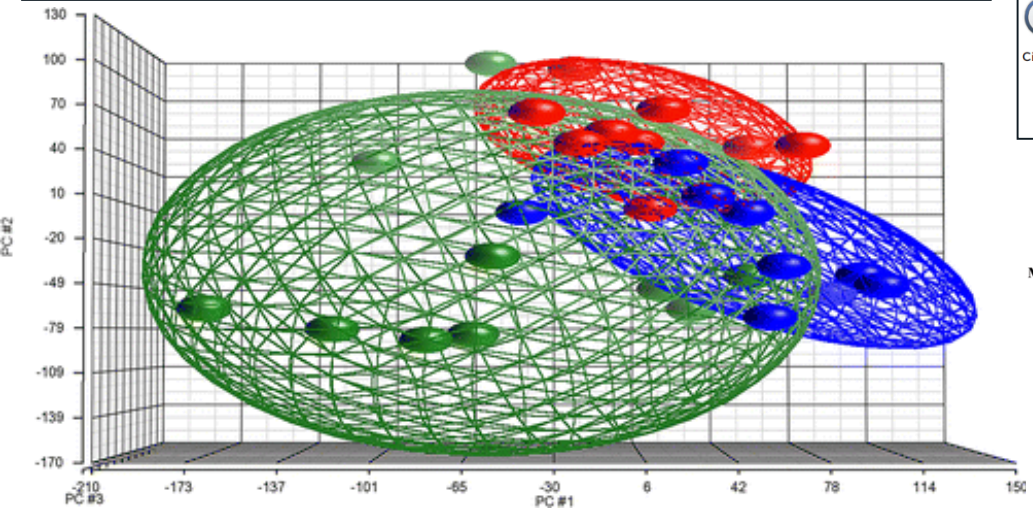
There is Still Much to Learn...

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

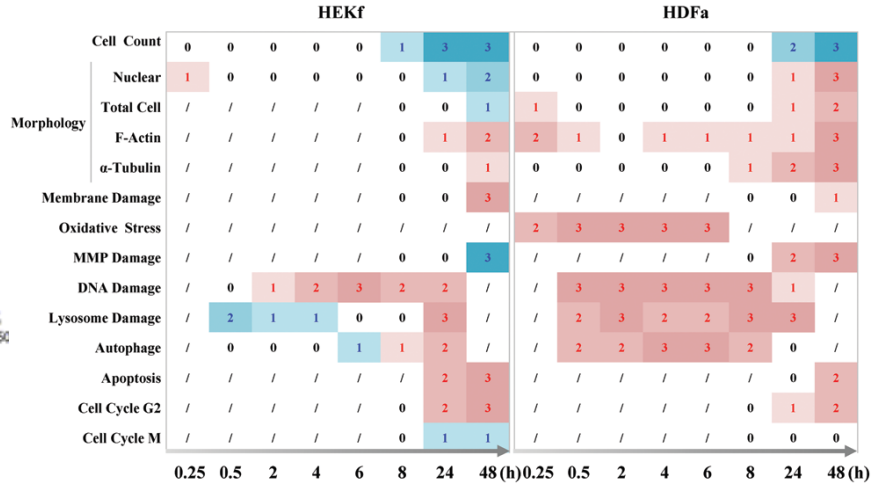
*E-mail: heidi.m.hoard-fruchey.civ@mail.mil.



Toxicology Research
ROYAL SOCIETY OF CHEMISTRY
PAPER
View Article Online
View Journal
CrossMark click for updates
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]



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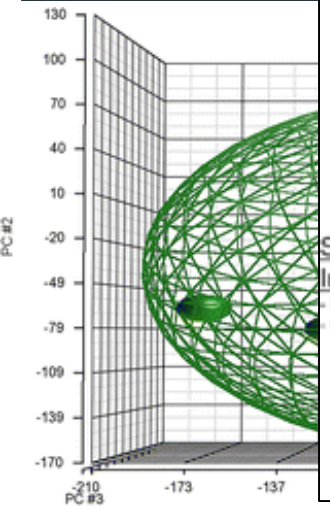

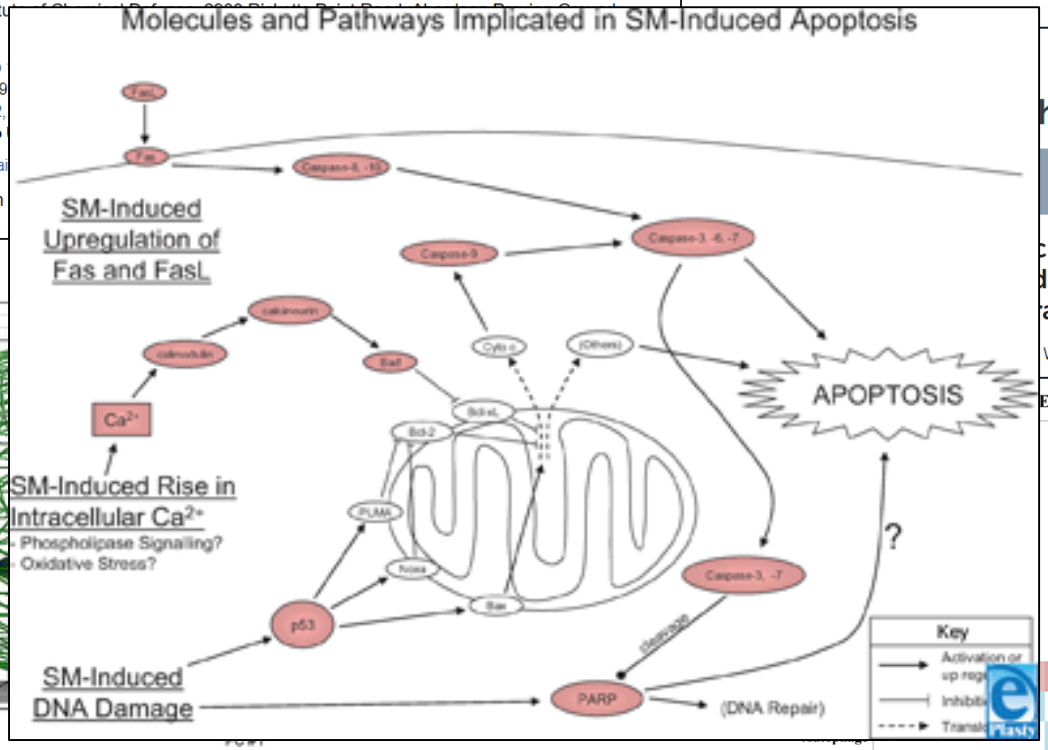

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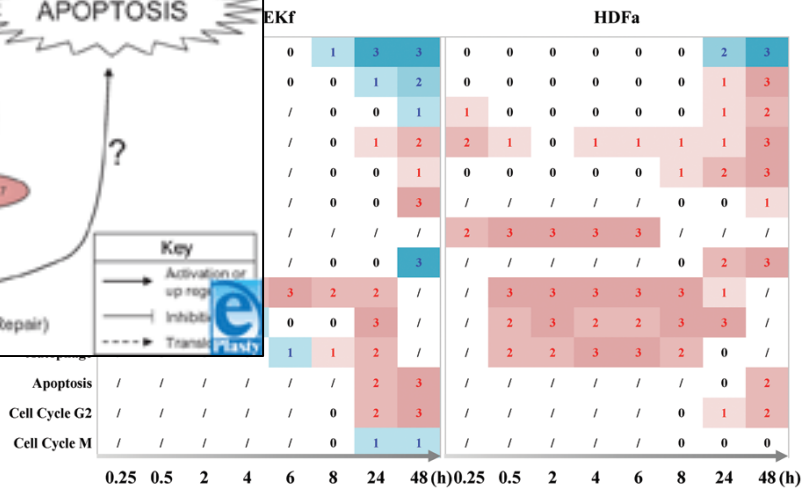


There is Still Much to Learn...

Toxicology Letters 244 (2016) 44–48

Contents lists available at ScienceDirect

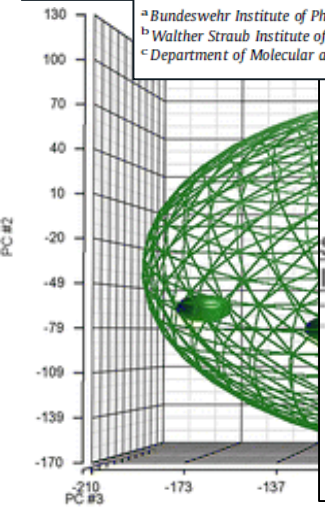
Toxicology Letters

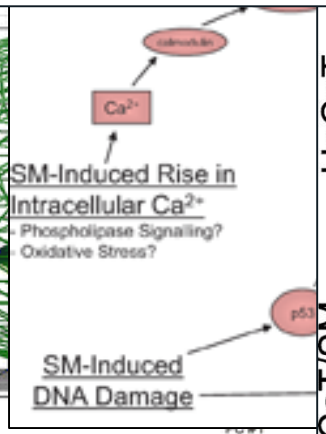
journal homepage: www.elsevier.com/locate/toxlet

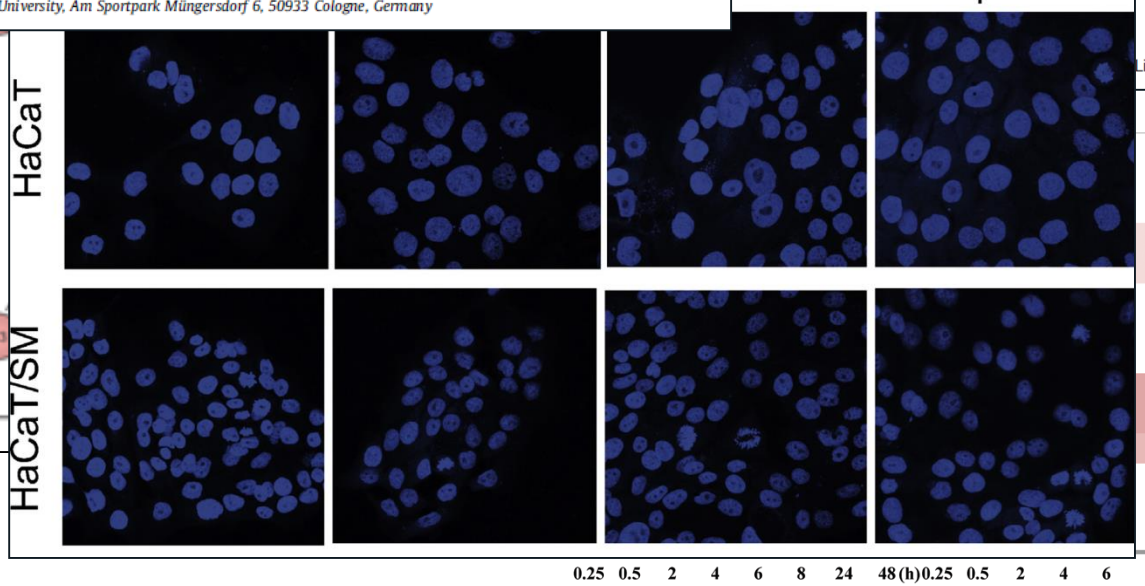
Development of the sulfur mustard resistant keratinocyte cell line HaCaT/SM

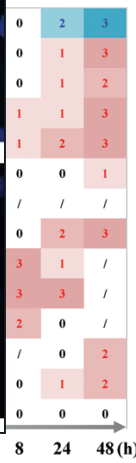
Annette Schmidt[a,c,*], Dirk Steinritz[a,b], Horst Thiermann[a]

[a] Bundeswehr Institute of Pharmacology and Toxicology, Neuherbergstraße 11, 80937 Munich, Germany
[b] Walther Straub Institute of Pharmacology and Toxicology, University of Munich, Goethestr. 33, 80336 Munich, Germany
[c] Department of Molecular and Cellular Sports Medicine, German Sports University, Am Sportpark Müngersdorf 6, 50933 Cologne, Germany









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[c] Department of Molecular and Cellular Sports Medicine, German Sports University, Am Sportpark Müngersdorf 6, 509 Germany

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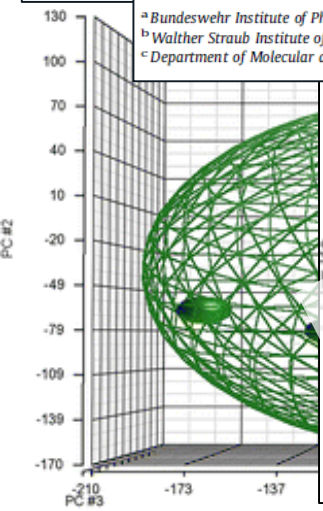
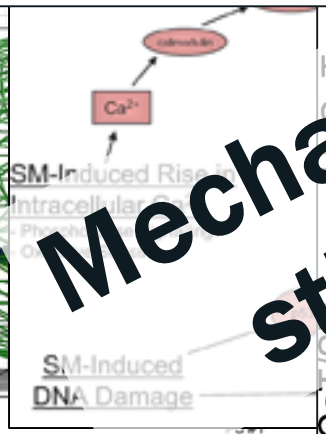
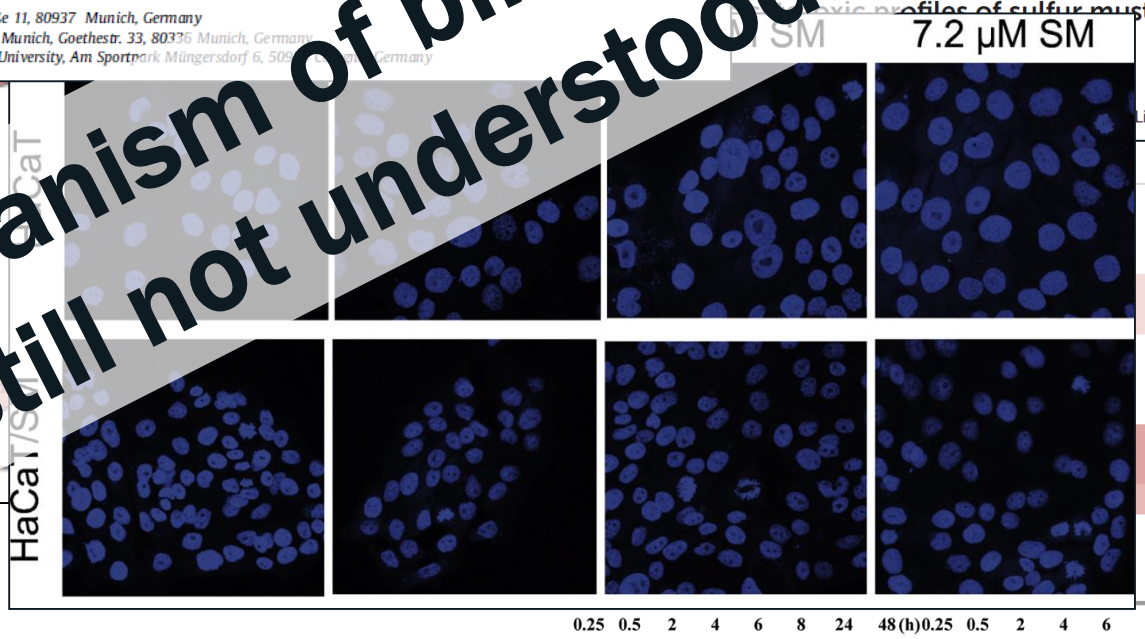
Li Wang*[a,b]

Mechanism of blistering is still not understood!








IUPAC
The National Academies of
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ENGINEERING
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ACADEMIA BRASILEIRA DE CIÊNCIAS
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Coorganizers: IUPAC, The National Academies of Sciences Engineering Medicine, Academia Brasileira de Ciências

Recognizing Unusual (Bio)Chemical Change:
If Plants Could Talk

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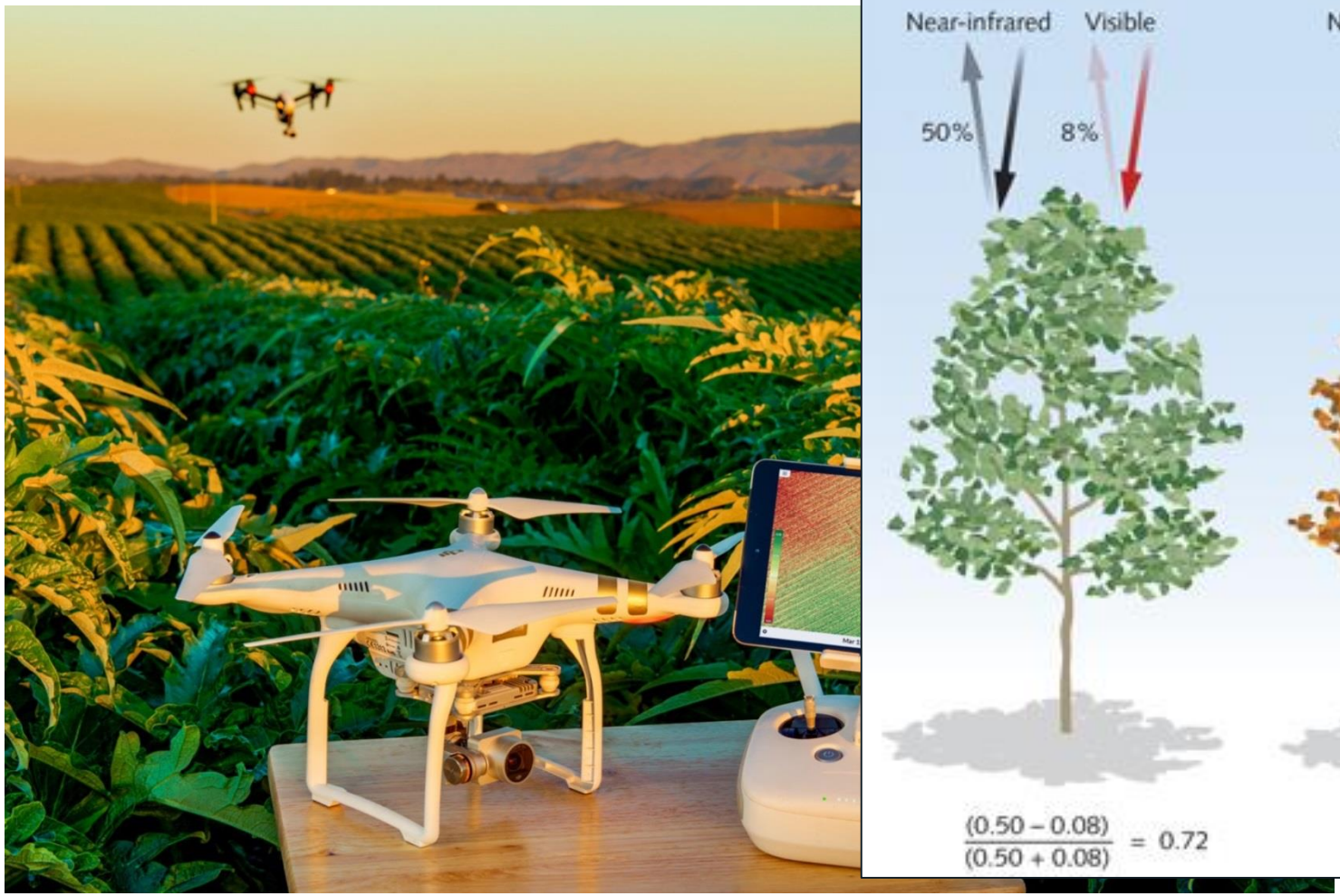
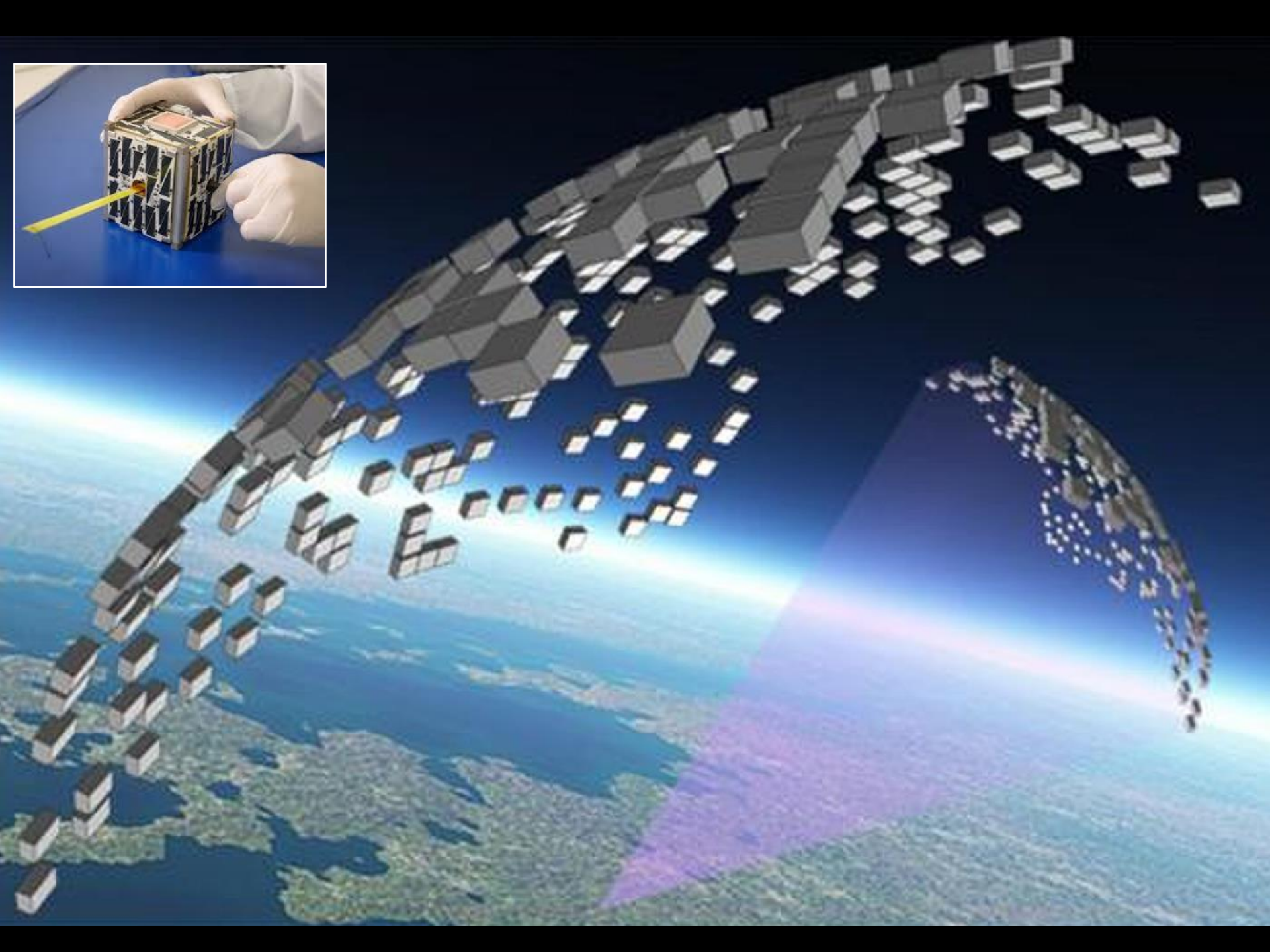
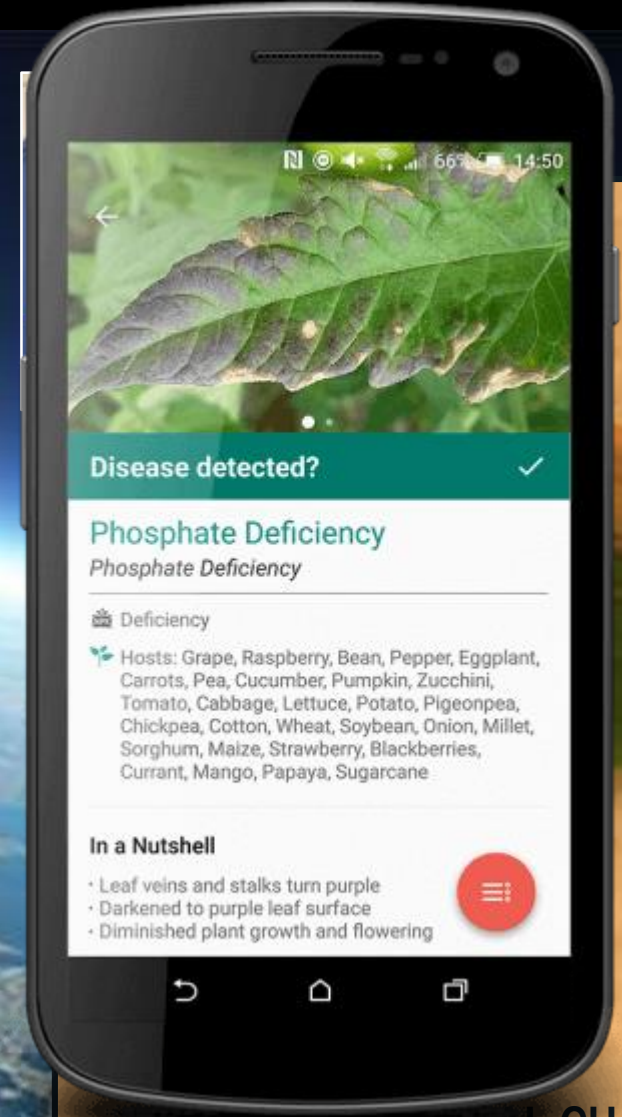




VISUAL CHARACTERIZATION OF VX DROPLETS ON PLANT FOLIAGE

http://www.dtic.mil/docs/citations/AD1012054

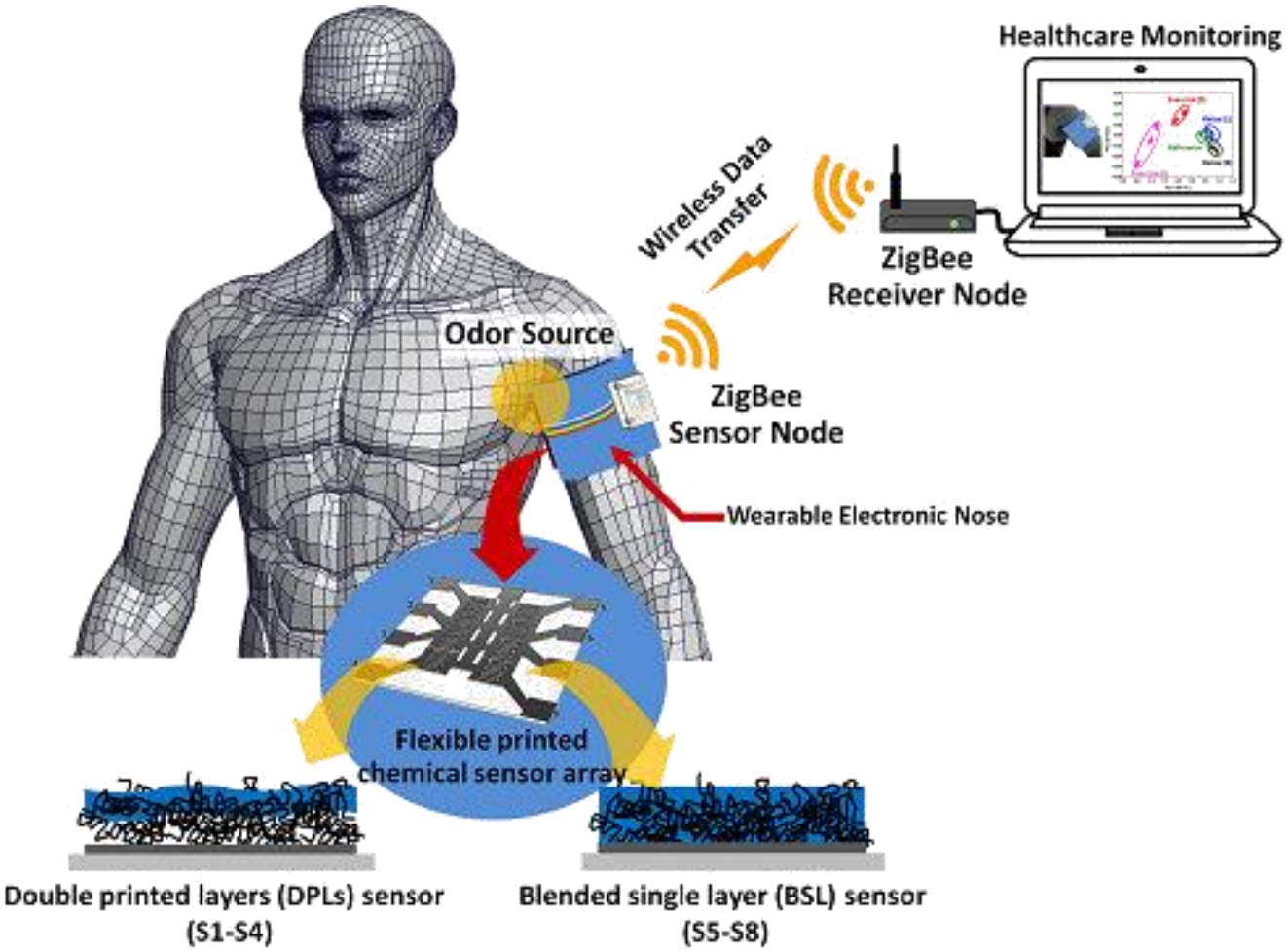


VISUAL CH

https://extension.umd.edu/hgic/chlorine-toxicity-trees-and-shrubs

http://www.dtic.mil/docs/citations/AD1012054

Humans as Sensors



Sensors 2014, *14*(10), 19700-19712; doi:10.3390/s141019700

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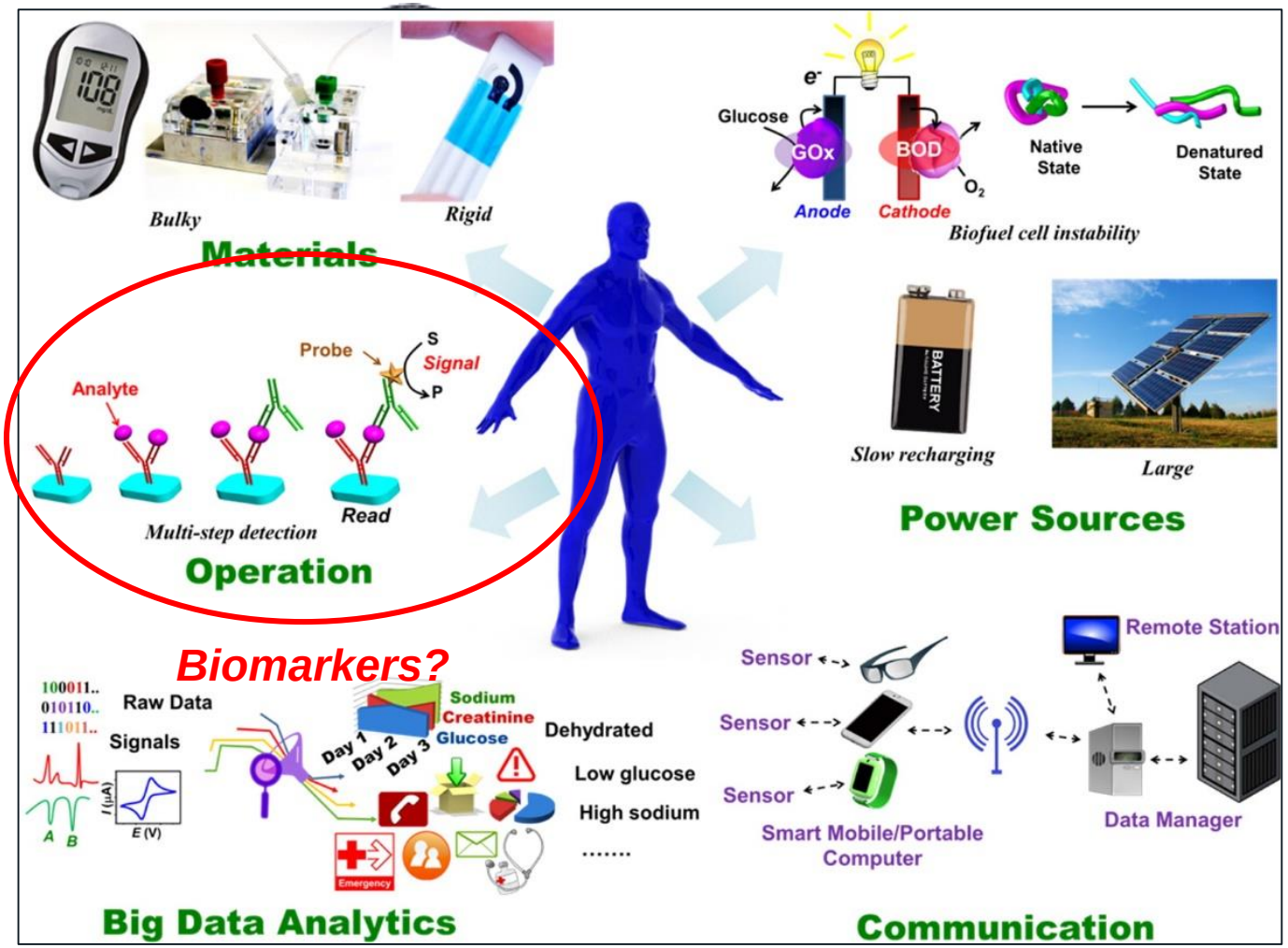

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Monitoring Health Indicators

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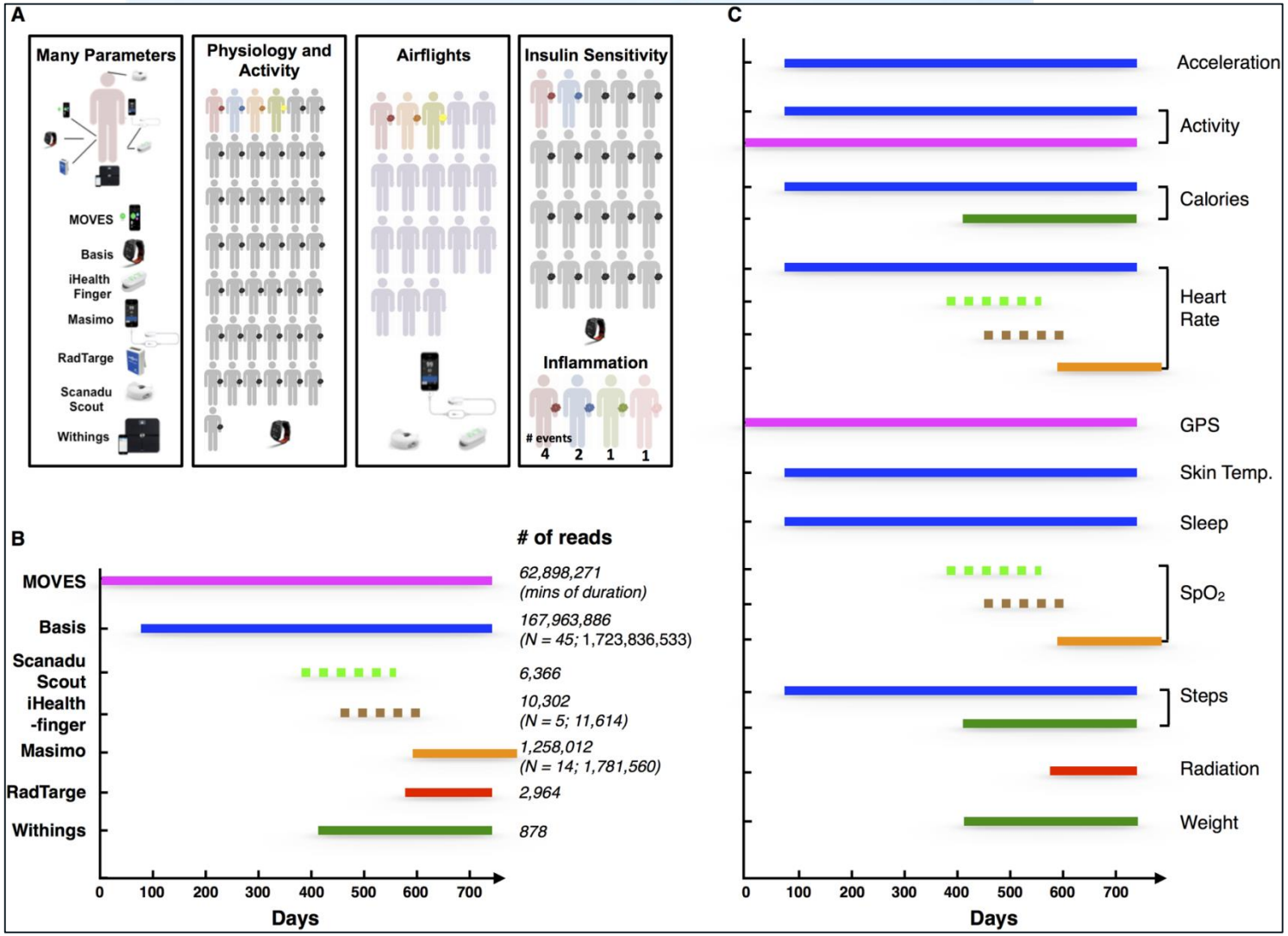

Dr X. Li, et al Digital Health: Tracking Physiomes and Activity Using Wearable Biosensors Reveals Useful Health-Related Information *PLoS Biol* 15(1): e2001402. doi:10.1371/journal.pbio.2001402

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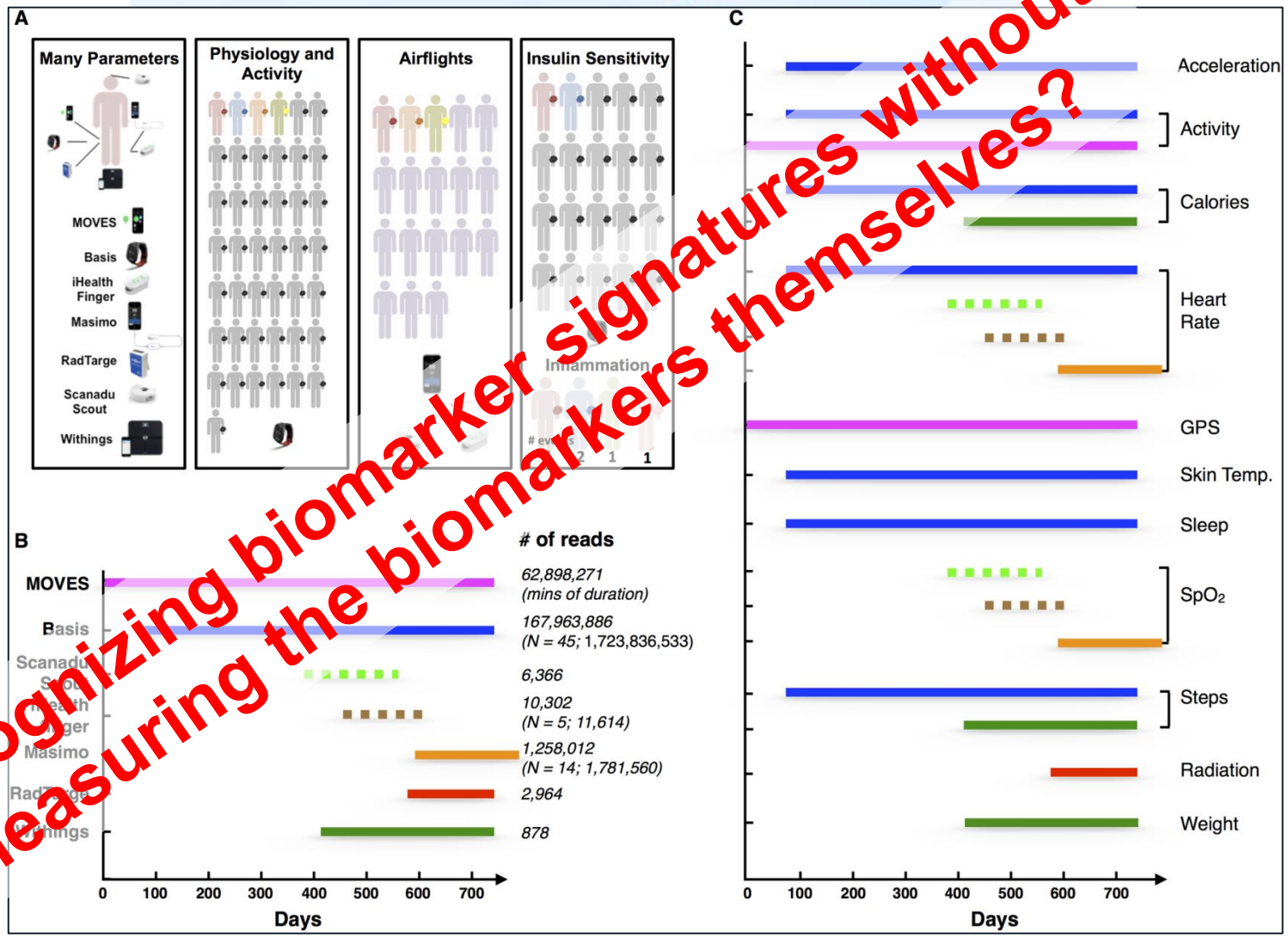
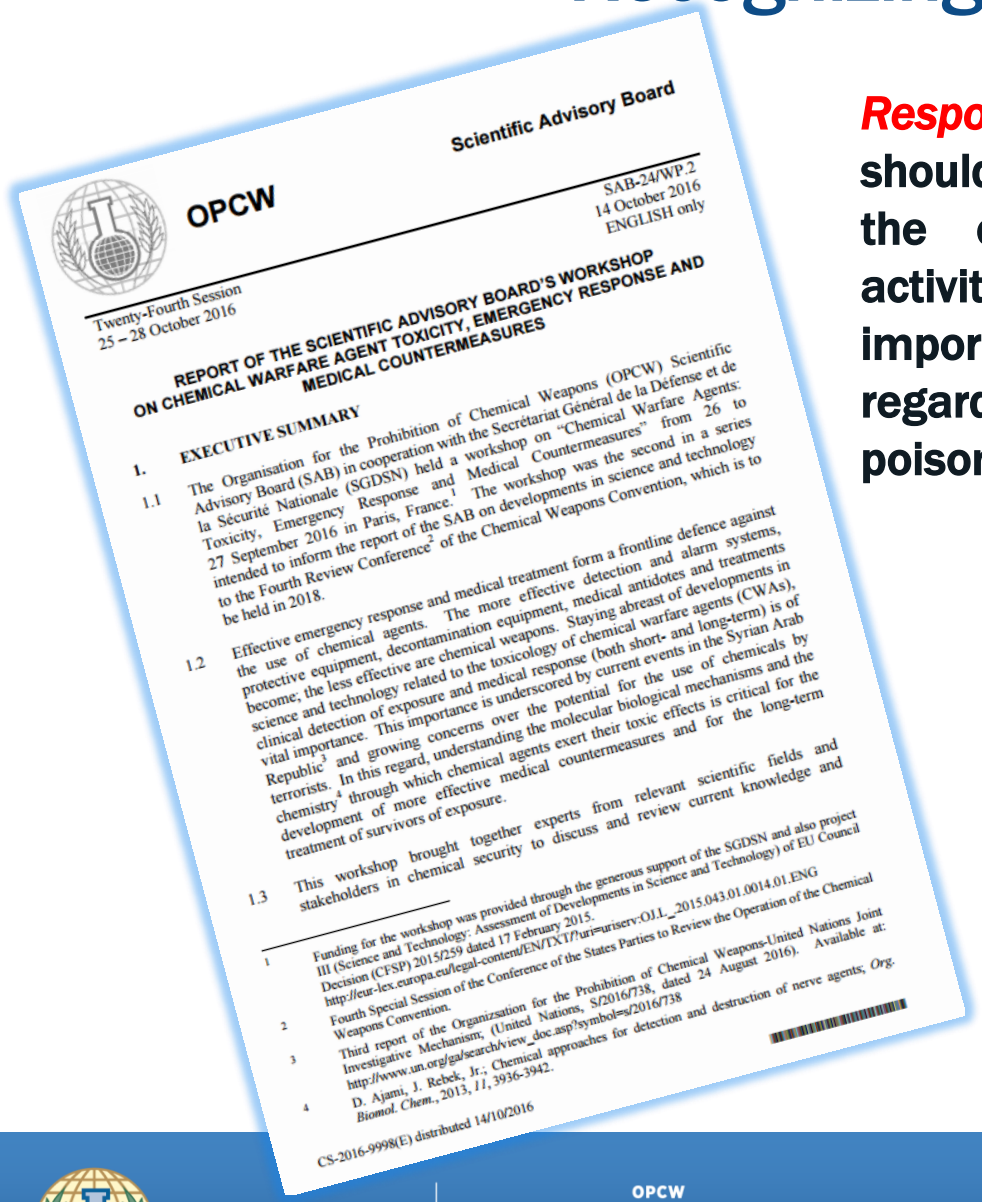


Recognizing biomarker signatures without measuring the biomarkers themselves?

Dr X. Li, et al Digital Health: Tracking Physiomes and Activity Using Wearable Biosensors Reveals Useful Health-Related Information *PLoS Biol* 15(1): e2001402. doi:10.1371/journal.pbio.2001402

Recognizing Exposure



OPCW

Scientific Advisory Board

SAB-24/WP.2
14 October 2016
ENGLISH only

Twenty-Fourth Session
25 – 28 October 2016

REPORT OF THE SCIENTIFIC ADVISORY BOARD'S WORKSHOP ON CHEMICAL WARFARE AGENT TOXICITY, EMERGENCY RESPONSE AND MEDICAL COUNTERMEASURES

1. EXECUTIVE SUMMARY

1.1 The Organisation for the Prohibition of Chemical Weapons (OPCW) Scientific Advisory Board (SAB) in cooperation with the Secrétariat Général de la Défense et de la Sécurité Nationale (SGDSN) held a workshop on "Chemical Warfare Agents: Toxicity, Emergency Response and Medical Countermeasures" from 26 to 27 September 2016 in Paris, France.[1] The workshop was the second in a series intended to inform the report of the SAB on developments in science and technology to the Fourth Review Conference[2] of the Chemical Weapons Convention, which is to be held in 2018.

1.2 Effective emergency response and medical treatment form a frontline defence against the use of chemical agents. The more effective detection and alarm systems, protective equipment, decontamination equipment, medical antidotes and treatments become; the less effective are chemical weapons. Staying abreast of developments in science and technology related to the toxicology of chemical warfare agents (CWAs), clinical detection of exposure and medical response (both short- and long-term) is of vital importance. This importance is underscored by current events in the Syrian Arab Republic[3] and growing concerns over the potential for the use of chemicals by terrorists. In this regard, understanding the molecular biological mechanisms and the chemistry[4] through which chemical agents exert their toxic effects is critical for the development of more effective medical countermeasures and for the long-term treatment of survivors of exposure.

1.3 This workshop brought together experts from relevant scientific fields and stakeholders in chemical security to discuss and review current knowledge and

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

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

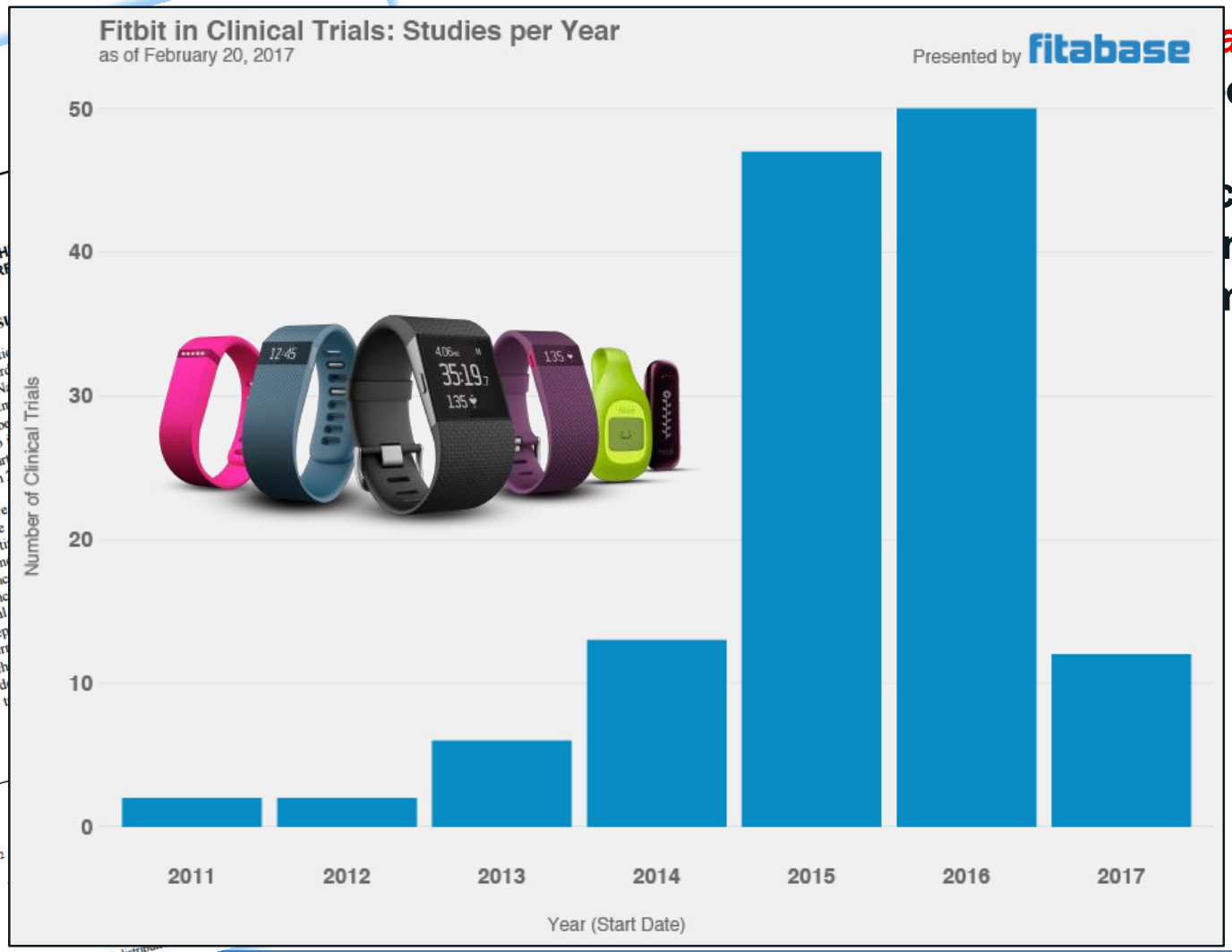
3 Third report of the Organization for the Prohibition of Chemical Weapons-United Nations Joint Investigative Mechanism, (United Nations, S/2016/738, dated 24 August 2016). Available at: http://www.un.org/ga/search/view_doc.asp?symbol=s/2016/738

4 D. Ajami, J. Rebek, Jr.; Chemical approaches for detection and destruction of nerve agents; *Org. Biomol. Chem.*, 2013, *11*, 3936-3942.

CS-2016-9998(E) distributed 14/10/2016

Response time for treatment is critical **and should be characterised and understood for the choice of countermeasures. AChE activity monitoring can be of critical importance to recognise exposure in this regard, before signs and symptoms of poisoning intensify.**

Recognizing Exposure



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A Role for Innovation in Disarmament and Security?


Institute
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Research and
Occupational
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Coorganizers: IUPAC, The National Academies of Sciences Engineering Medicine, Academia Brasileira de Ciências

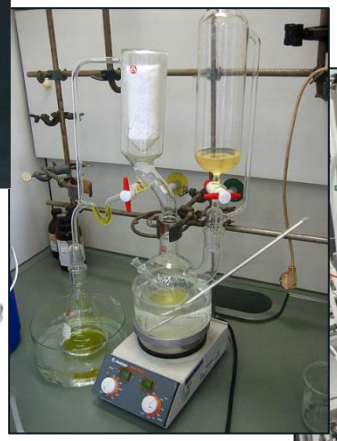
International Workshop on Trends in Chemical Production

Zagreb, the Republic of Croatia. 3 to 5 October 2017

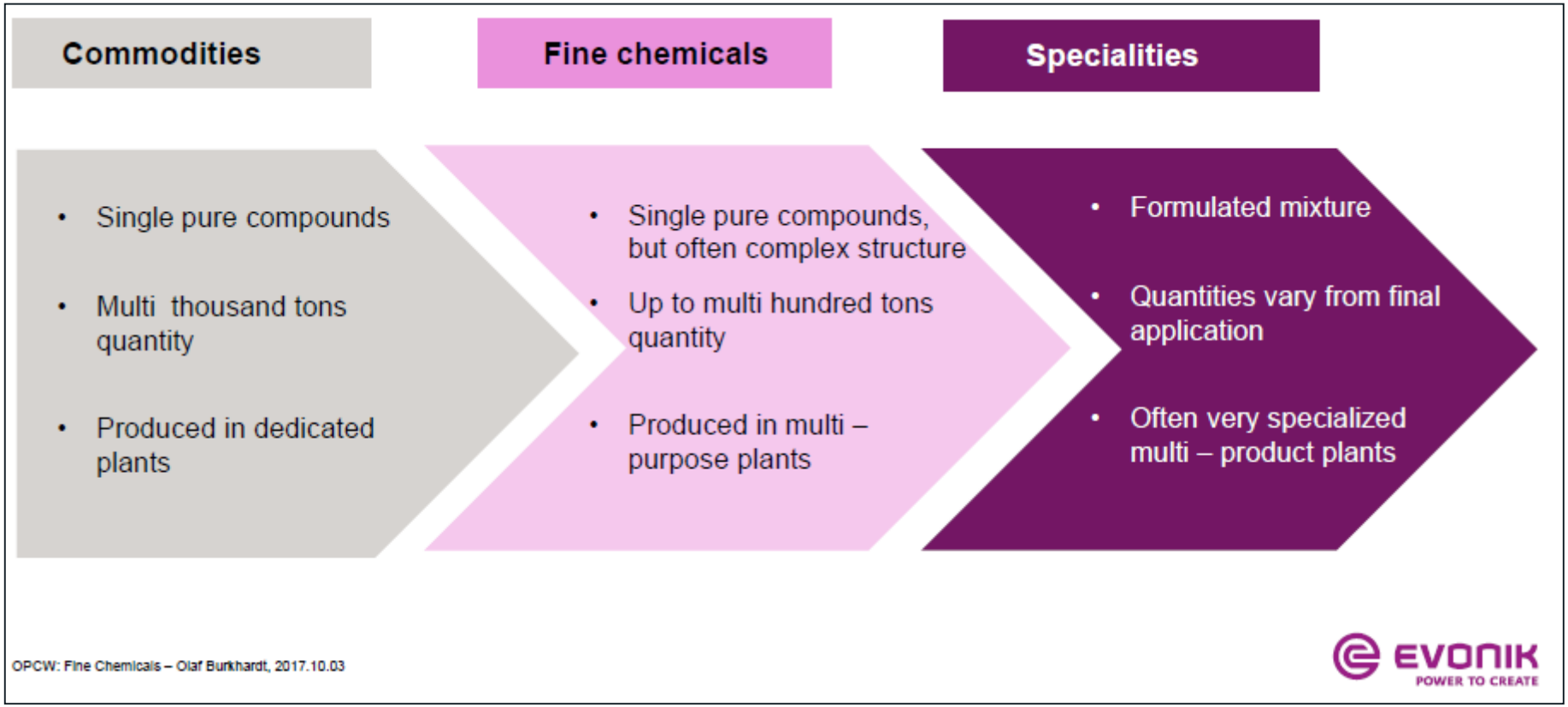
SAB-26/WP.2, dated 19 October 2017, URL: http://q-r.to/bap1hD

Coorganizers: Zagreb, Ministry of Economy, imi

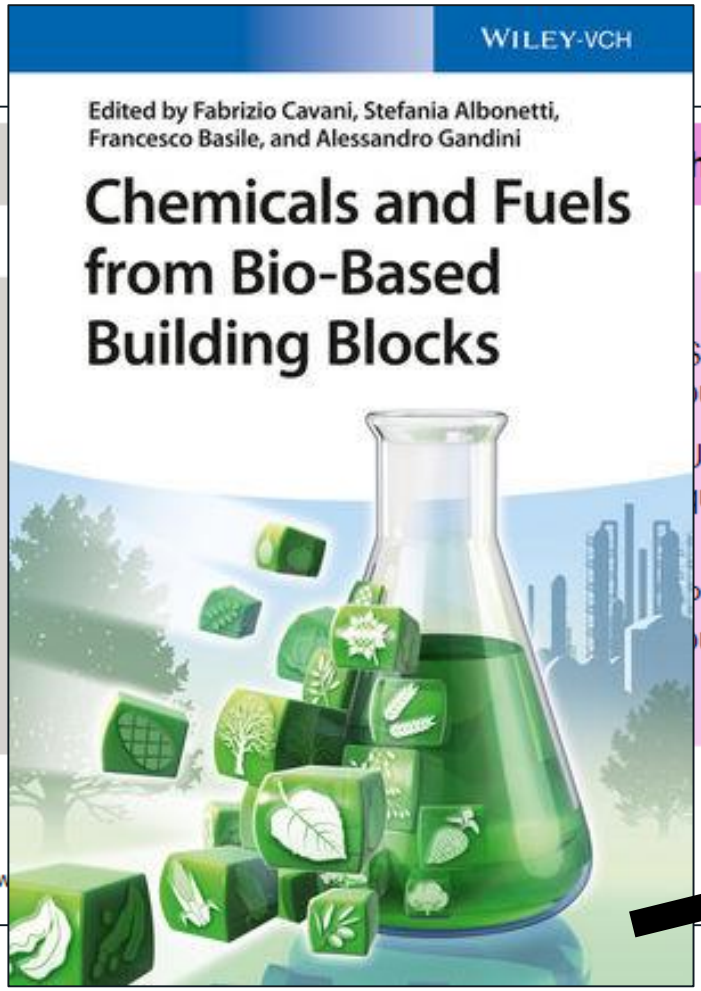
Chemical Synthesis From Small to Large



Chemical Sectors

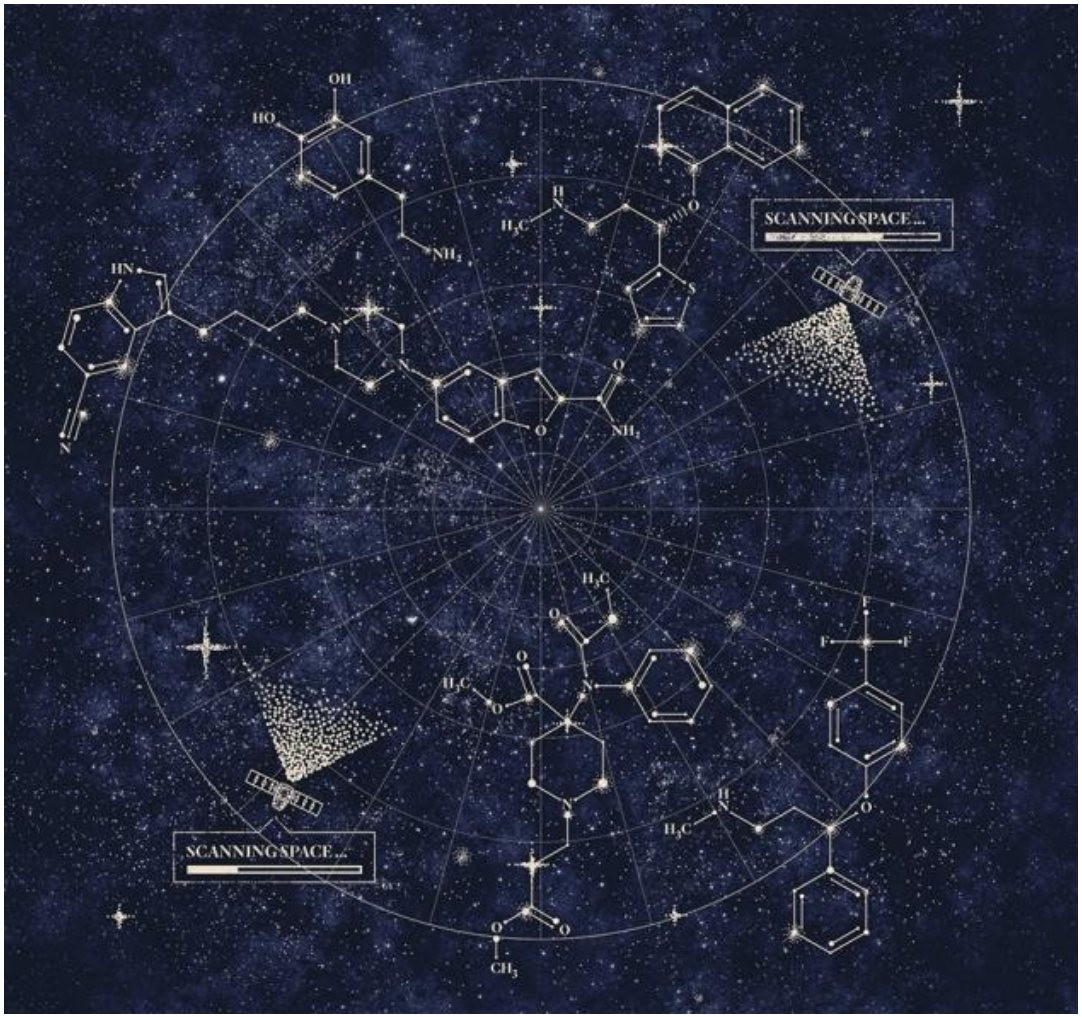


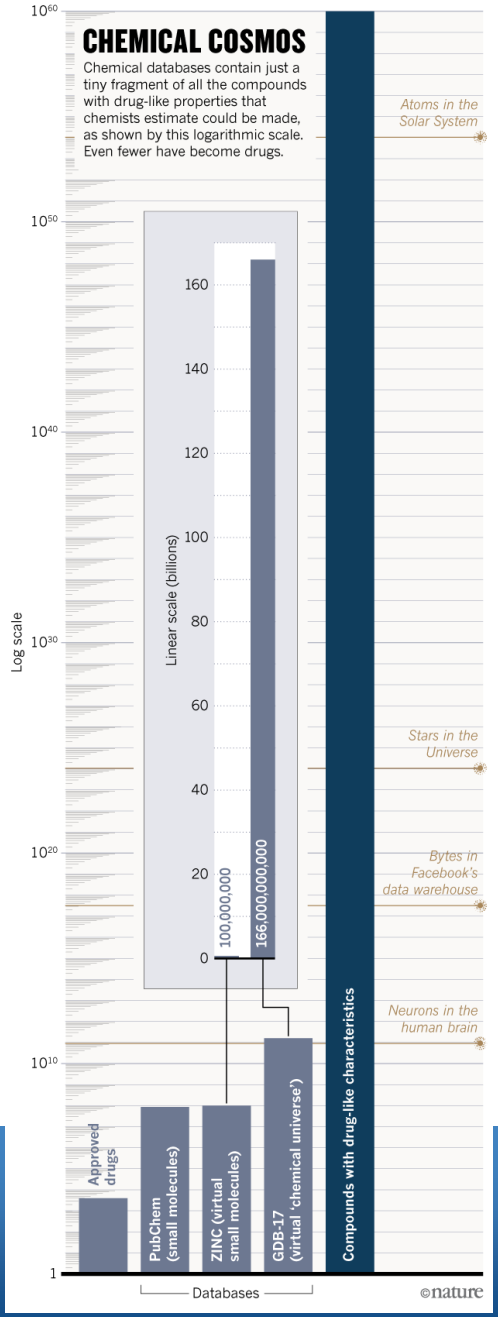
Chemical Sectors



Greater adoption of biobased methods seen here

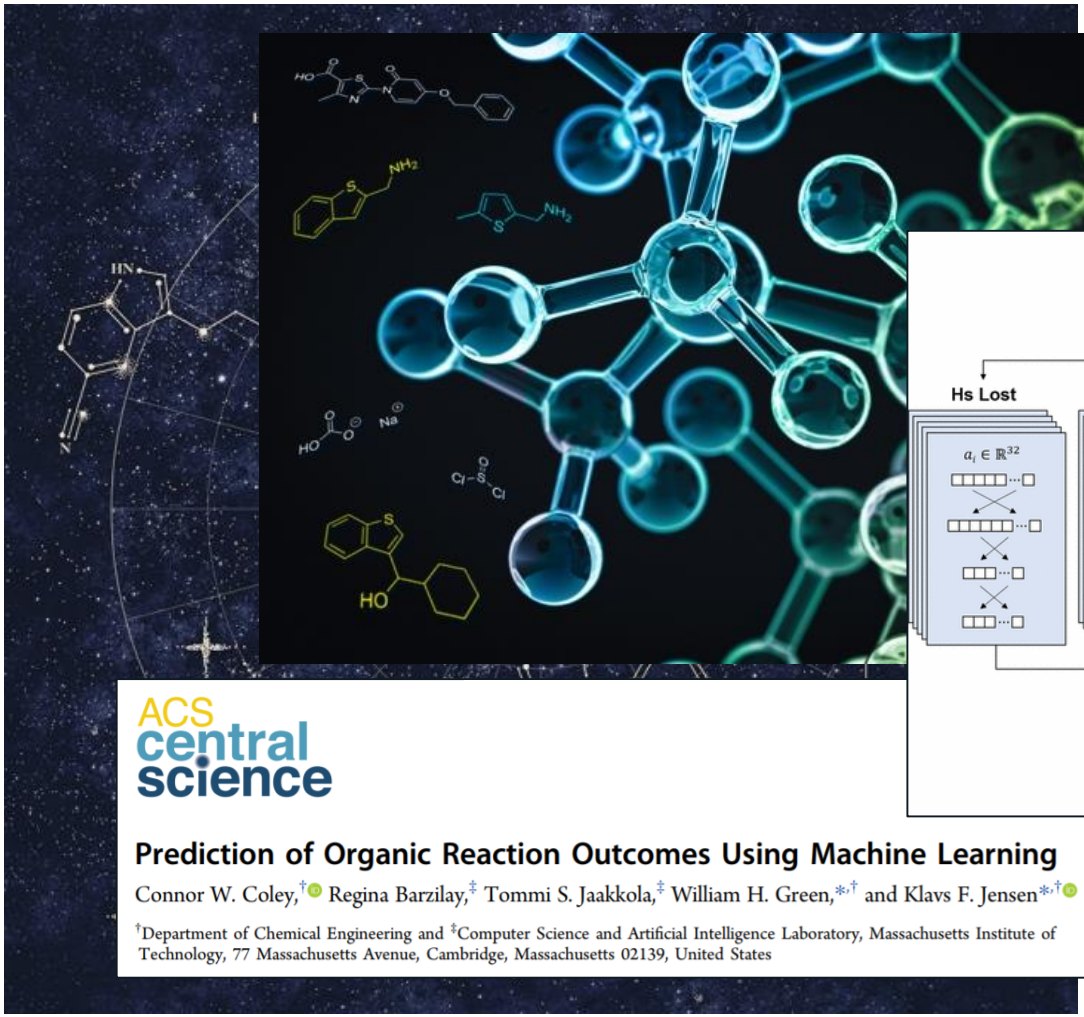
Chemical Discovery





https://www.nature.com/news/the-drug-maker-s-guide-to-the-galaxy-1.22683

Chemical Discovery

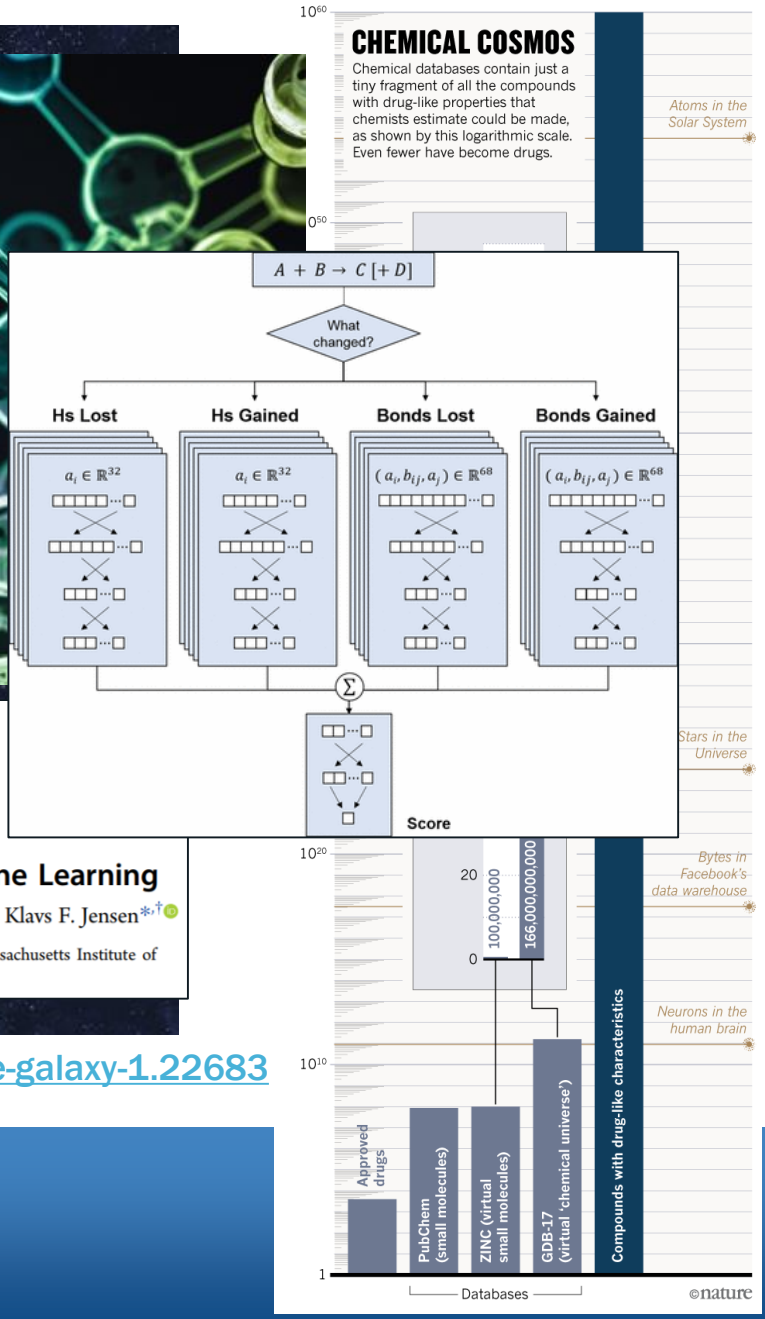


ACS central science

Prediction of Organic Reaction Outcomes Using Machine Learning

Connor W. Coley,[†] Regina Barzilay,[‡] Tommi S. Jaakkola,[‡] William H. Green,[*,†] and Klavs F. Jensen[*,†]

[†]Department of Chemical Engineering and [‡]Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Massachusetts 02139, United States



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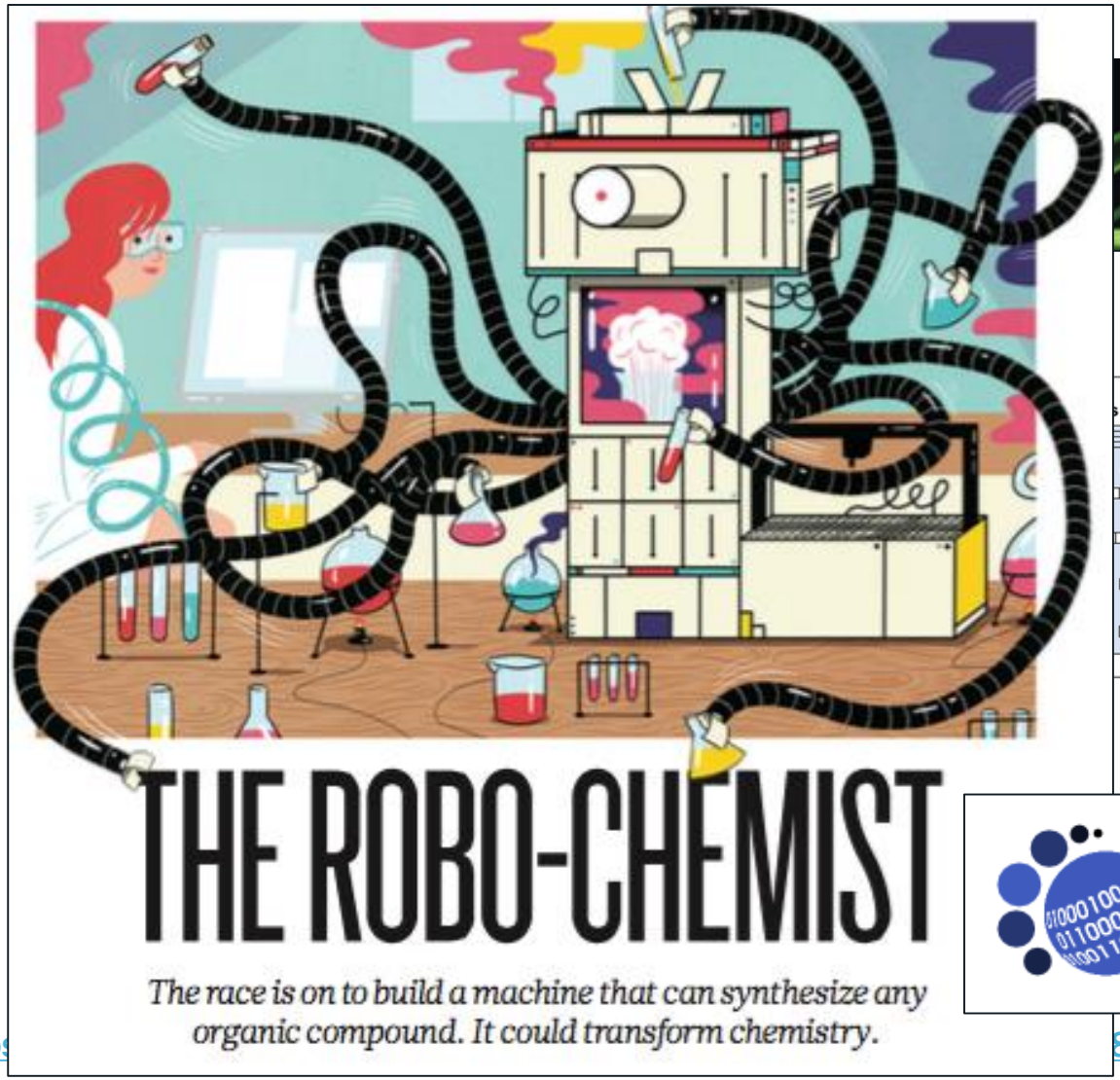
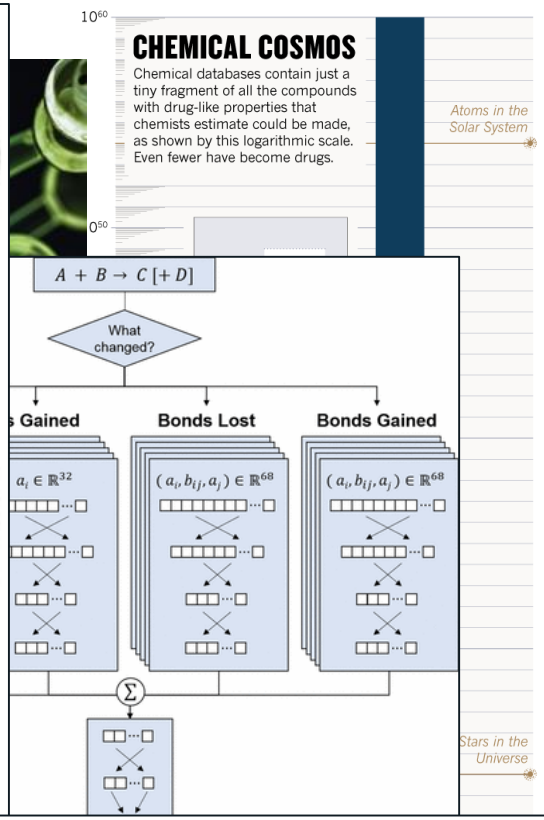
Chemical Discovery



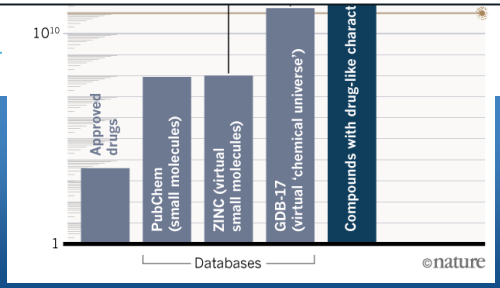
THE ROBO-CHEMIST

The race is on to build a machine that can synthesize any organic compound. It could transform chemistry.



DIAL-A-MOLECULE

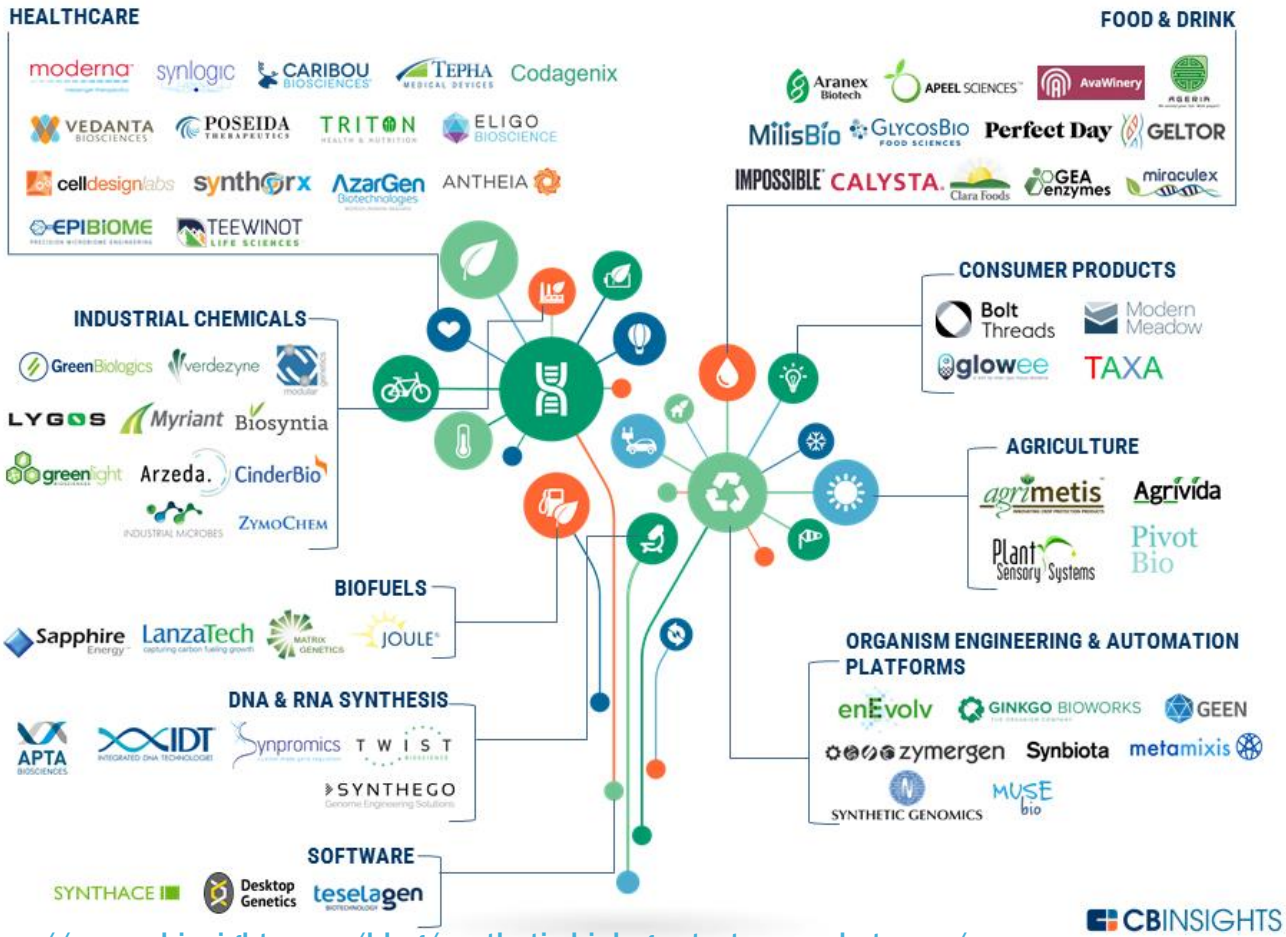
An EPSRC Grand Challenge Network



https 83


WORK ON ...
REPRESENTATIVE ASPECT OF THE COMMUNITY
ONLINE & SHARED LIBRARY ??
WIKIPEDIA
SPECIAL BLOG FOR PUBLISHING ??
SYSTEM
WAYS & MEANS OF PUBLICATION
• ACCESSIBLE
• DECENTRALIZED
DO IT YOURSELF BIOLOGY
BUYING SOME DNA...
ETHICAL
LEGAL ASPECT
HIGH COST FOR PUBLISHING
ISSUES

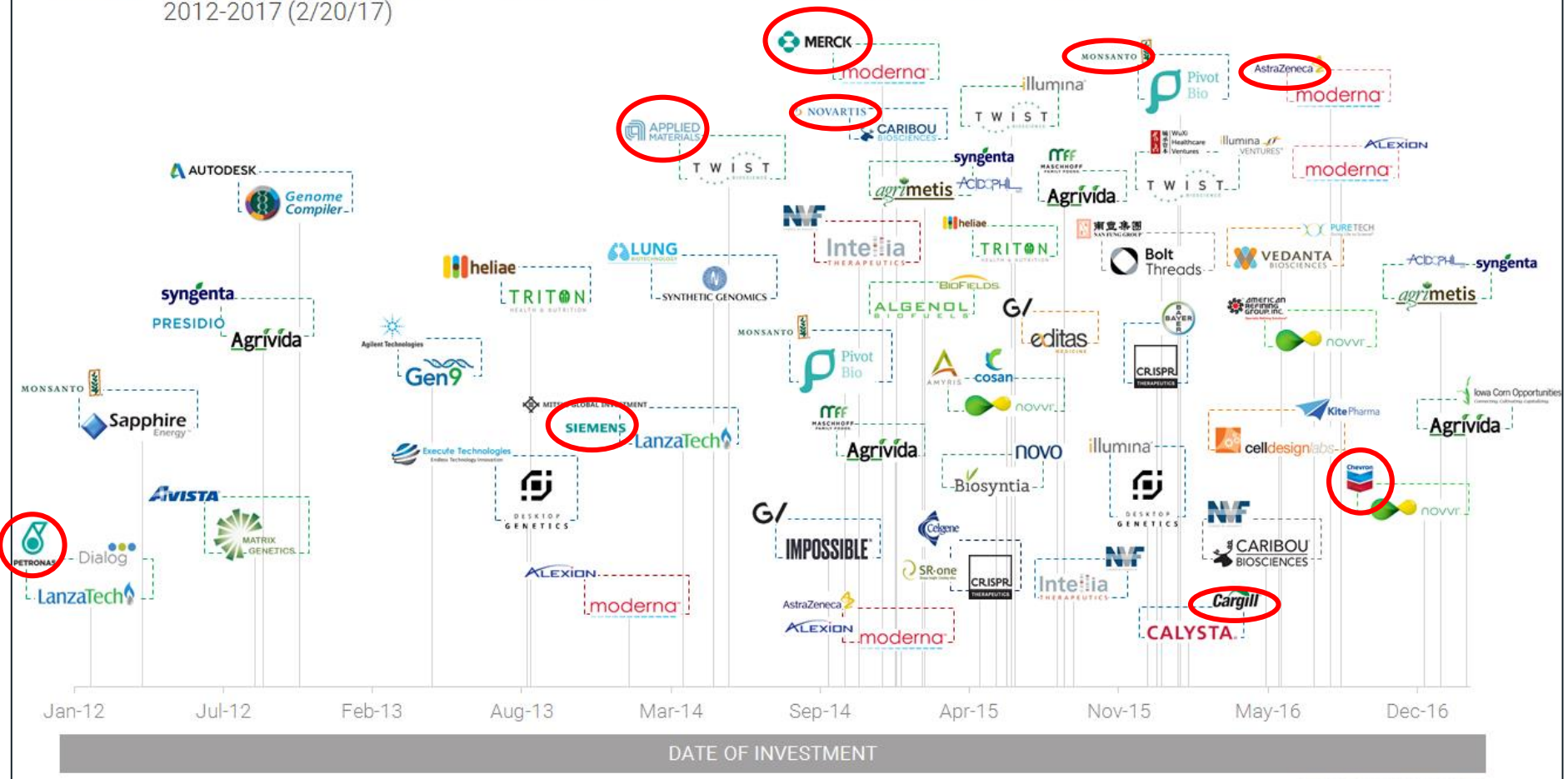
60+ SYNTHETIC BIOLOGY STARTUPS REIMAGINING FOOD, FUEL, HEALTHCARE, AND MORE



https://www.cbinsights.com/blog/synthetic-biology-startup-market-map/

SYNTHETIC BIOLOGY STARTUPS

A TIMELINE OF CORPORATE EQUITY INVESTMENT IN SYNTHETIC BIOLOGY COMPANIES
2012-2017 (2/20/17)



www.cbinsights.com

https://www.cbinsights.com/blog/synthetic-biology-corporate-investments /

CBINSIGHTS

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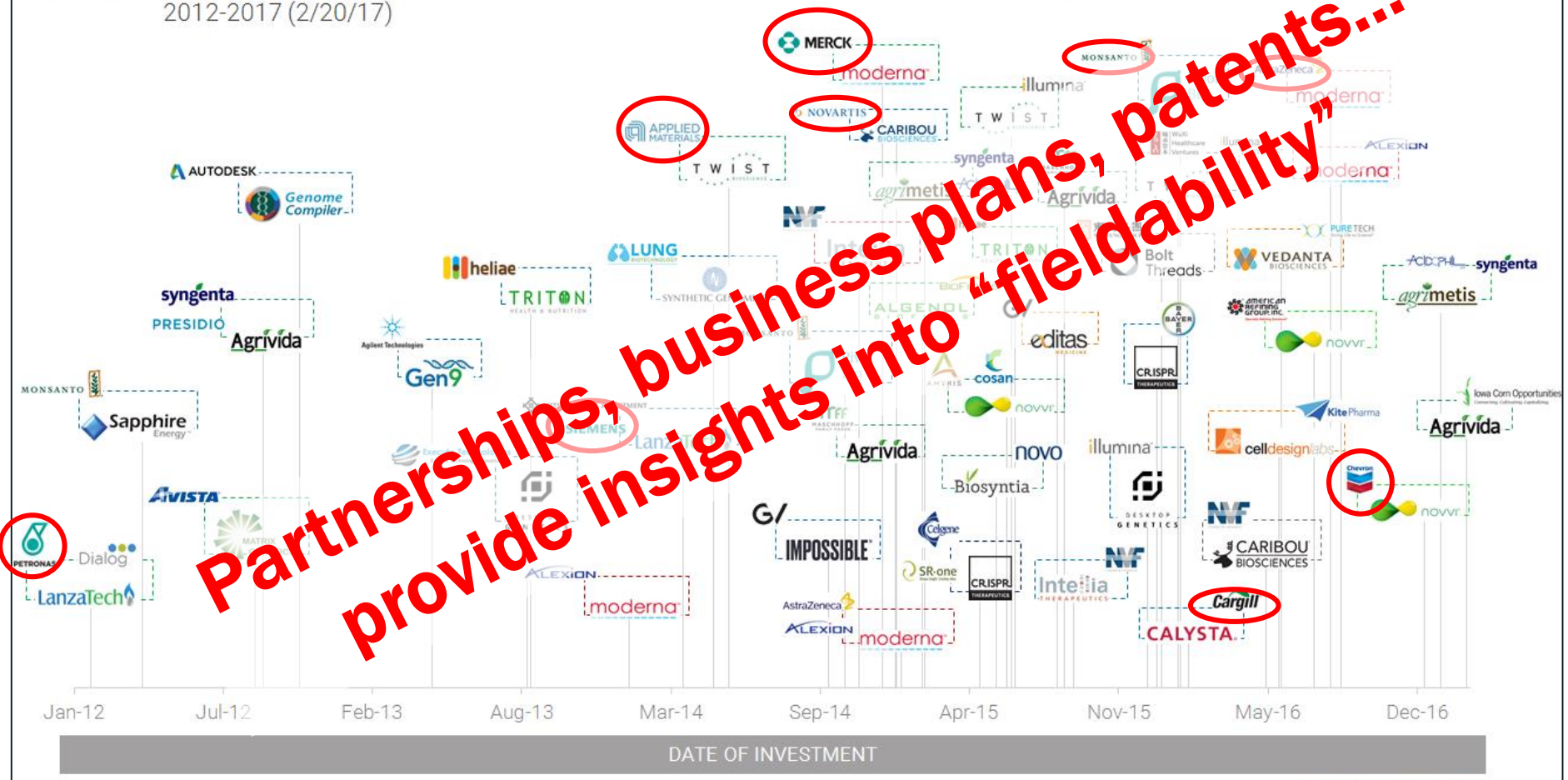


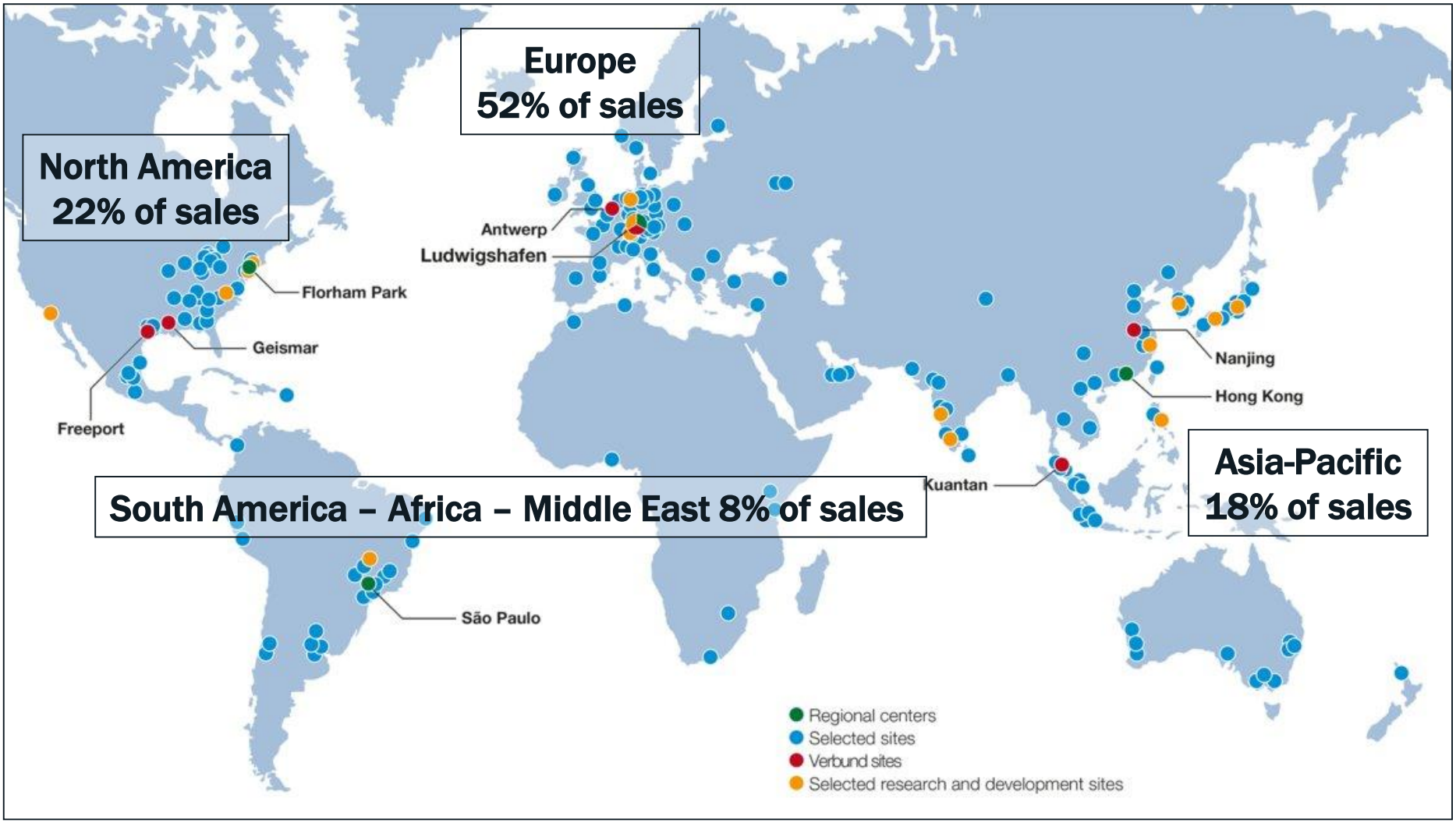
Partnerships, business plans, patents... provide insights into "fieldability"

www.cbinsights.com

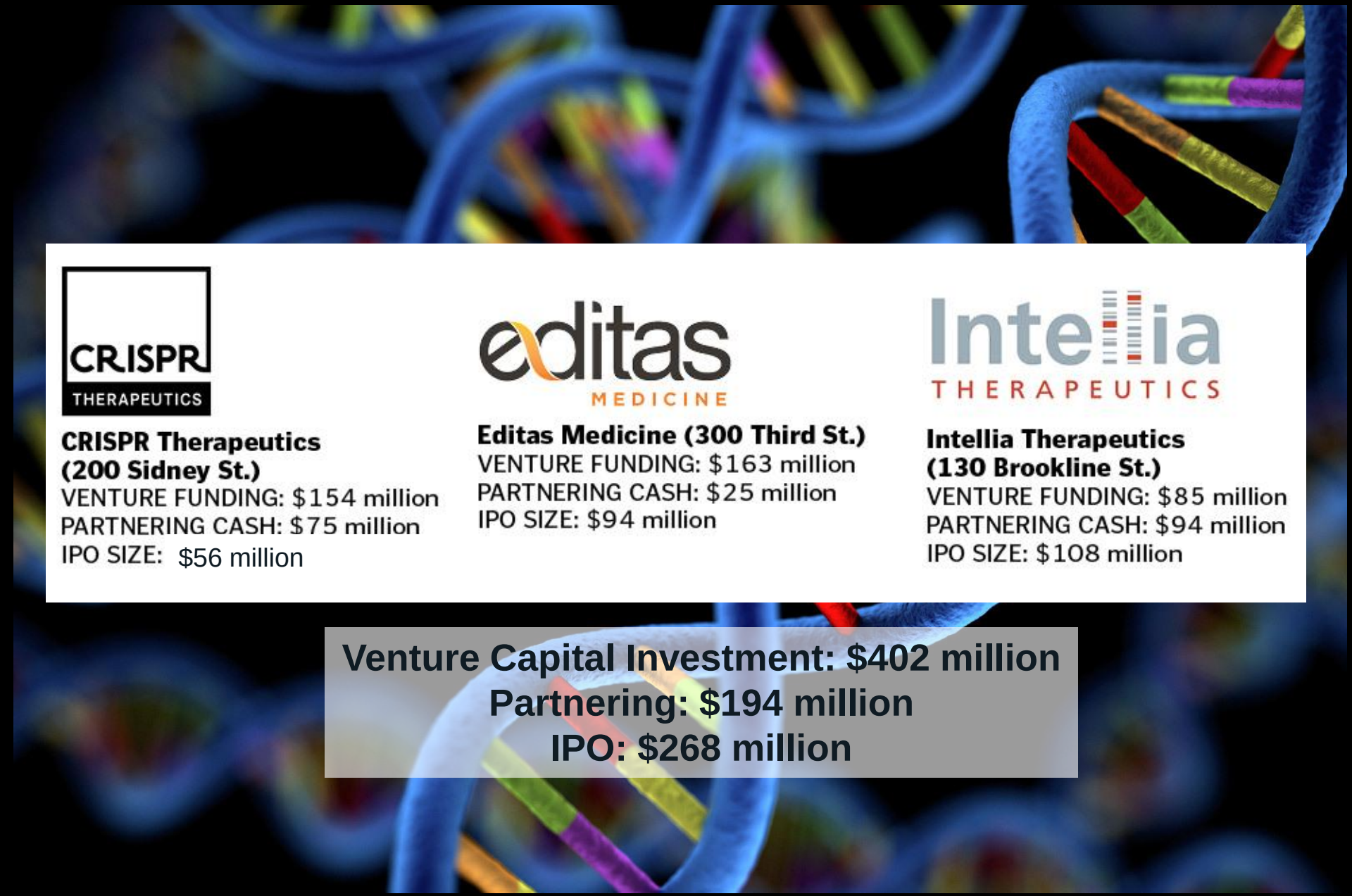
https://www.cbinsights.com/blog/synthetic-biology-corporate-investments /

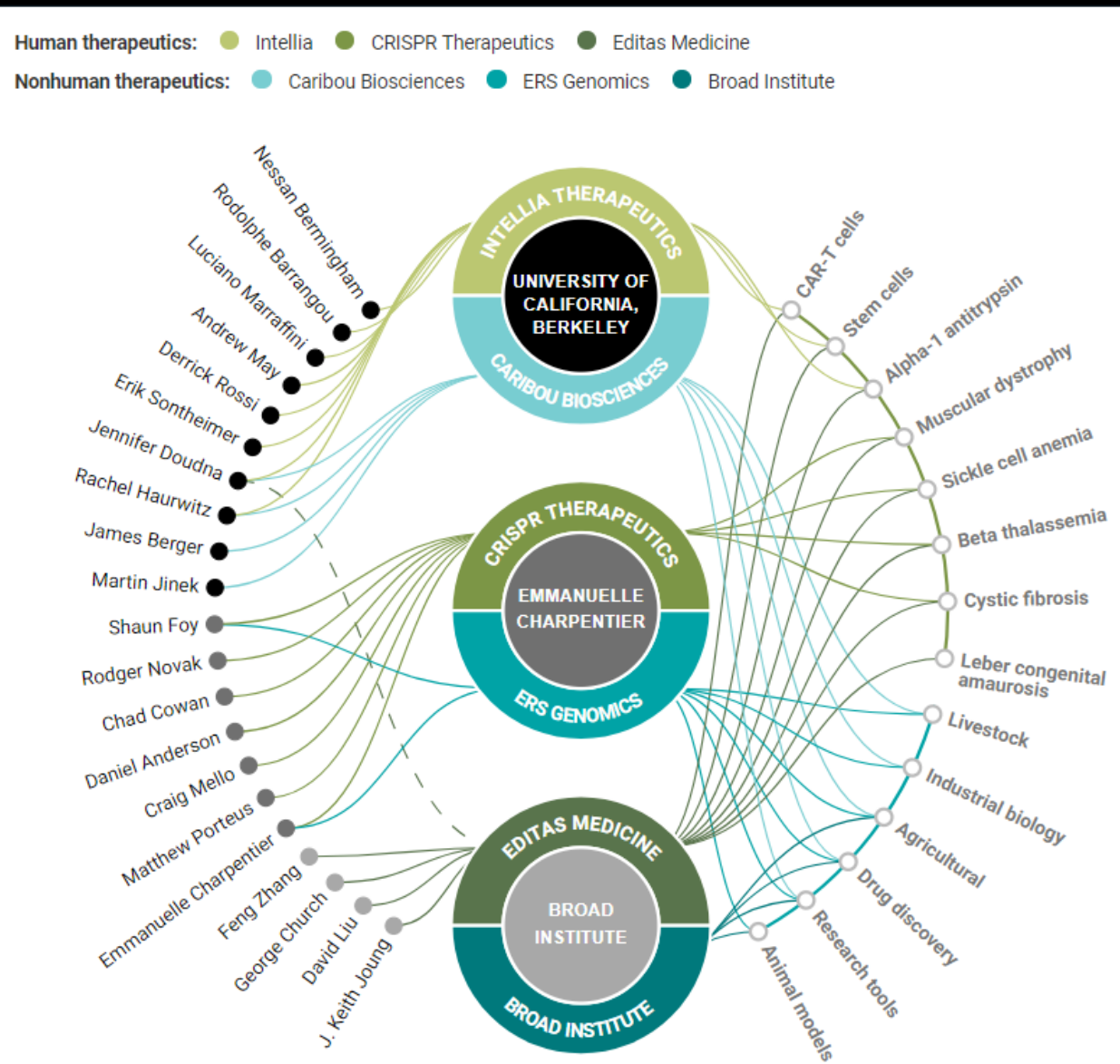
CBINSIGHTS

Economic Growth and the Diffusion of Technology



One Chemical Company with facilities across > 80 States Parties!

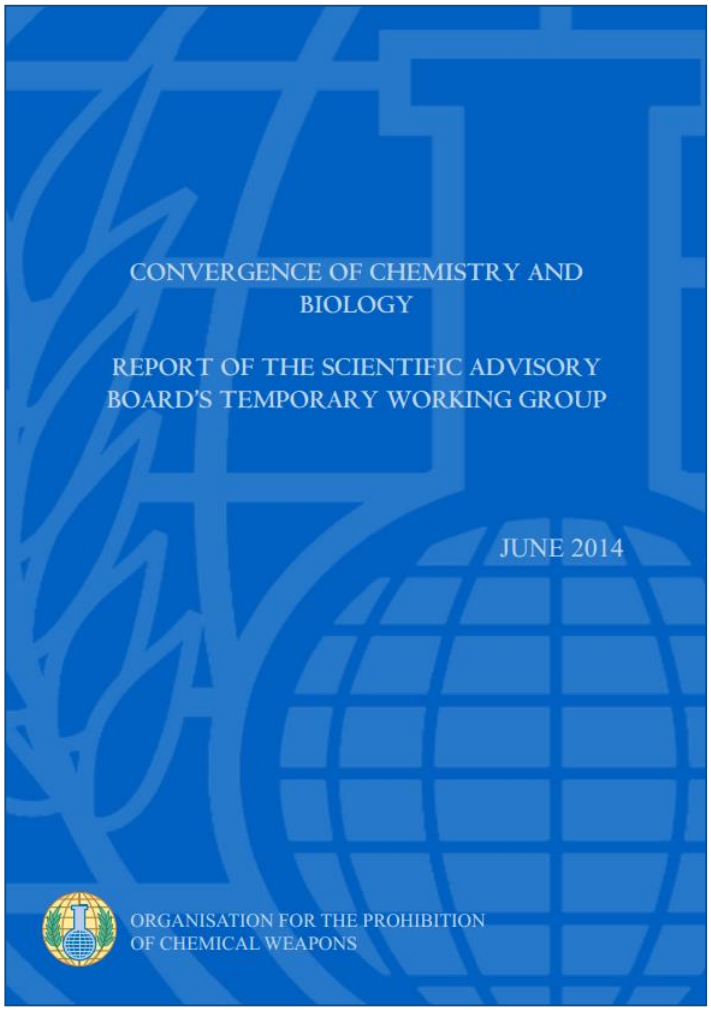

CRISPR
THERAPEUTICS
CRISPR Therapeutics
(200 Sidney St.)
VENTURE FUNDING: $154 million
PARTNERING CASH: $75 million
IPO SIZE: $56 million
editas
MEDICINE
Editas Medicine (300 Third St.)
VENTURE FUNDING: $163 million
PARTNERING CASH: $25 million
IPO SIZE: $94 million
Intellia
THERAPEUTICS
Intellia Therapeutics
(130 Brookline St.)
VENTURE FUNDING: $85 million
PARTNERING CASH: $94 million
IPO SIZE: $108 million
Venture Capital Investment: $402 million
Partnering: $194 million
IPO: $268 million



www.sciencemag.org/news/2017/02/how-battle-lines-over-crispr-were-drawn

(Interactive)J. You/Science; (Graphic)G. Grullón/Science

Turning Findings into Recommendations and Advice



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

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons

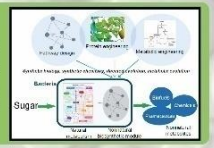
Recommendations From The OPCW Scientific Advisory Board's Report on Convergence of Chemistry & Biology

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.



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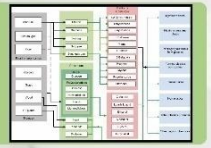
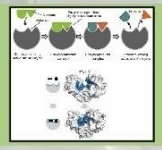
The SAB should continue to monitor the range of chemicals being studied and produced using biological or biologically-mediated processes.



Recommendation 4

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

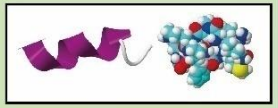


Recommendation 5

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.



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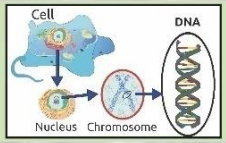


Recommendation 8

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

Recommendation 9

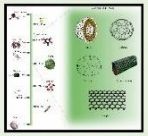
The OPCW should monitor advances in protective equipment and possible applications for OPCW personnel as they become commercially available

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-sections/science-technology/science-technology-monitor/

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.

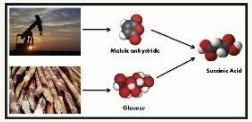
The TS, supported by the SAB, should continue to participate in such meetings and continue to address convergence.

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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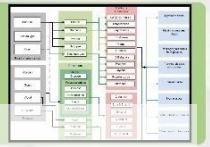

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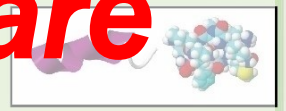

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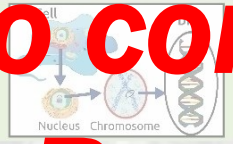

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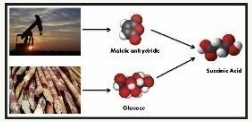

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13/19 Recommendations are "to continue monitoring"

4/19 Recommendations are to "engage" with stakeholders

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/opcwonline

/company/opcw

/opcw

Report available at: https://www.opcw.org/fileadmin/OPCW/SAB/en/TWG_Scientific_Advsiory_Group_Final_Report.pdf

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

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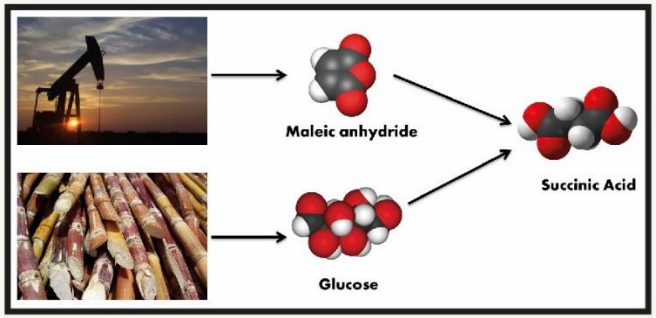

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ORGANISATION … L WEAPONS

Rec … iology

Recommendation 1

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Recommendation …

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OPCW Technical Secretariat

S/1534/2017
14 September 2017
Original: ENGLISH

NOTE BY THE TECHNICAL SECRETARIAT

RESULTS OF THE SURVEY ON BIOMEDIATED PROCESSES

1. Paragraph 1 of Part IX of the Verification Annex to the Chemical Weapons Convention (hereinafter "the Verification Annex") requires declarations of other chemical production facilities (OCPFs) that produce by synthesis unscheduled discrete organic chemicals (DOCs)[1] over specified thresholds. The outstanding issue on the scope of the definition of "production by synthesis" under paragraph 1 of Part IX of the Verification Annex is whether the term includes biologically mediated processes (hereinafter "biomediated processes") for unscheduled chemicals, the Conference of the States Parties (hereinafter "the Conference") decided at its Second Session to include these processes in the definition of "production" (C-II/DEC.6, dated 5 December 199…). For unscheduled DOCs, the Conference at its Third Session referred the issue to the Scientific Advisory Board (SAB), in accordance with decision C-III/…, dated 19 November 1998.

2. As discussed during …, on chemical industry and Article VI issues, to assess the … SAB's view that "… designed for the formation of a chemical substance should be covered by the term "produced by synthesis" (SAB-9/…, dated 12 September …/DG.1, dated 29 …, the Technical Secretariat … a survey (…/2016, dated … November 2016). … objective of the survey were to … the number and the relevance to the … Weapons Convention … that would become declarable if the … mendation was brought into …

Results

3. A total of 32 States Parties[2] from … all regional groups (Figure 1), responded to the survey, the extended … for which was 15 August 2017. Not all responses contained … of additional plant sites that could become declarable.

[1] … accordance with paragraph 4 of Part I of the Verification Annex, "'Discrete Organic Chemical' means any chemical belonging to the class of chemical compounds consisting of all compounds of … except for its oxides, sulfides and metal carbonates, identifiable by chemical name, by structural formula, if known, and by Chemical Abstracts Service registry number, if assigned".

[2] Andorra, Argentina, Australia, Austria, Bangladesh, Belarus, Brazil, Burkina Faso, Canada, Chile, Costa Rica, Croatia, Cuba, the Czech Republic, France, Greece, Iran (Islamic Republic of), Ireland, Italy, Japan, the Netherlands, New Zealand, Portugal, the Russian Federation, Slovakia, Slovenia, Switzerland, Thailand, Turkey, the United Kingdom of Great Britain and Northern Ireland, the United States of America, and Uzbekistan.

CS-2017-0541(E) distributed 15/09/2017

Has impact on declaration practices and there are divergent views across States Parties

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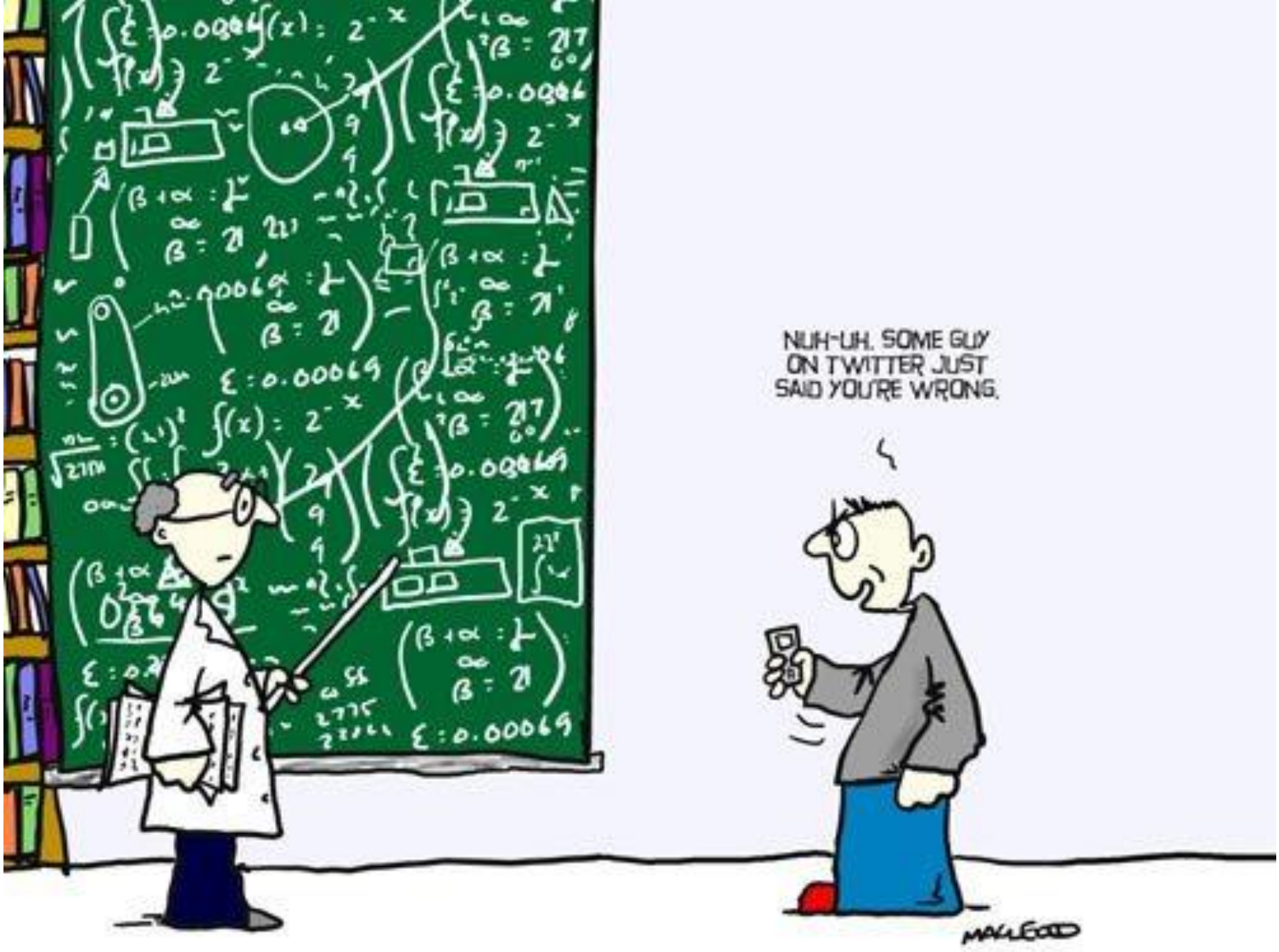
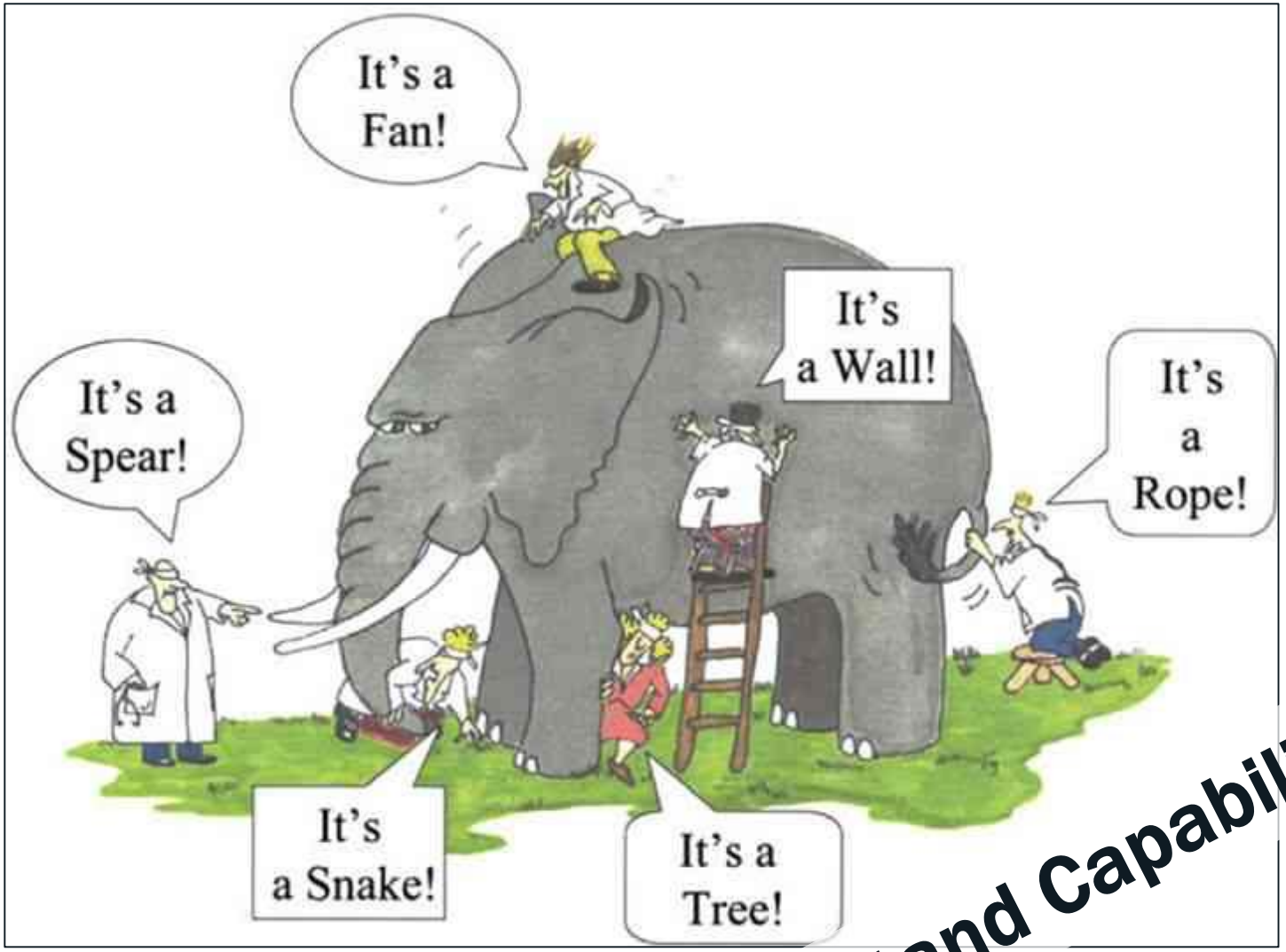
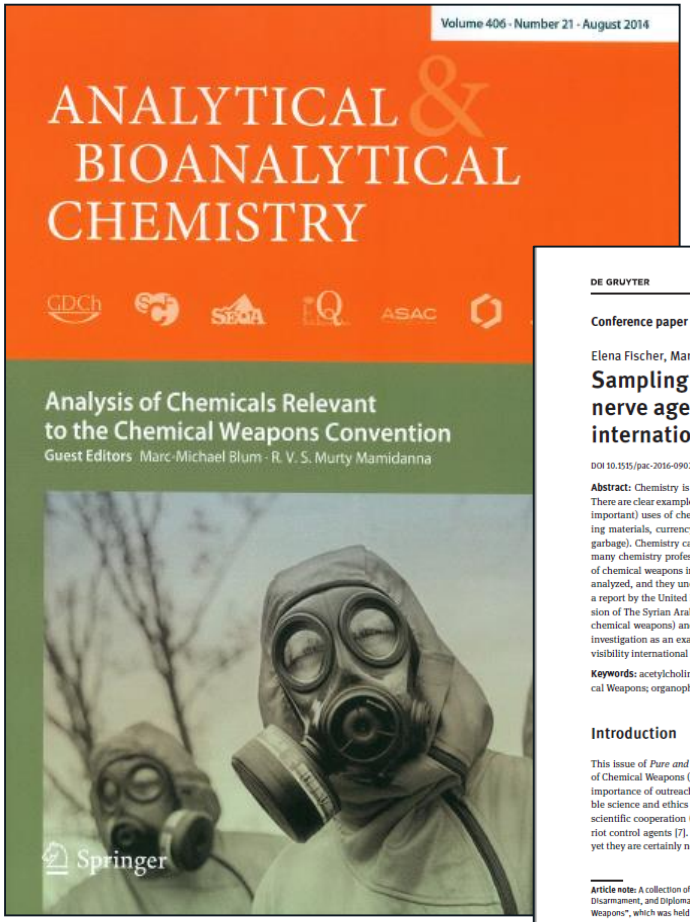

NUH-UH. SOME GUY ON TWITTER JUST SAID YOU'RE WRONG.
MACLEOD

A Need to Look Beyond "Scientific Labels"



Understand Capabilities

A Need to Take Part in the Conversation!



The Intersection of Science and Chemical Disarmament

By Beatrice Maneshi and Jonathan E. Forman - 09.21.2015

SCIENCE HAS ALWAYS PLAYED AN IMPORTANT ROLE in international diplomacy, particularly in regard to weapons of mass destruction disarmament treaties. Yet science and disarmament often appear at odds. From a security perspective, scientific discoveries and technological advances bring forth concerns about "dual-use"[1] potential that overshadow

Headquarters for the Organisation for the Prohibition of Chemical Weapons in The Hague, Netherlands. Credit: WikimediaCommons/Szilas

DE GRUYTER

Conference paper

Elena Fischer, Marc-Michael Blum, Wesam S. Alwan* and Jonathan E. Forman*

Sampling and analysis of organophosphorus nerve agents: analytical chemistry in international chemical disarmament

DOI 10.1515/pac-2016-0902

Abstract: Chemistry is a science that contributes to all aspects of our everyday lives and our professions. There are clear examples in law enforcement (forensics) and public health and perhaps less clear (but equally important) uses of chemicals in applications that include automobile manufacturing, electronics, packaging materials, currency printing, and even waste management (recycling and value-added products from garbage). Chemistry can also influence international diplomacy – an area that is likely to be unfamiliar to many chemistry professionals. Take for example the United Nations led investigation into the alleged use of chemical weapons in Syria in August of 2013. Environmental and biomedical samples were collected and analyzed, and they undisputedly confirmed the use of the nerve agent sarin. The results were published in a report by the United Nations Secretary-General and were one of the many influences leading to the accession of The Syrian Arab Republic to the Chemical Weapons Convention (an international treaty prohibiting chemical weapons) and the declaration and dismantlement of a chemical weapons programme. Using this investigation as an example, we highlight some of the chemistry that influenced decision making in a high visibility international event.

Keywords: acetylcholinesterase; chemical weapons; nerve agent; Organisation for the Prohibition of Chemical Weapons; organophosphorus; sarin; 2016 Spring ConfChem; Syria; United Nations.

Introduction

This issue of *Pure and Applied Chemistry* looks at the contributions of the Organisation for the Prohibition of Chemical Weapons (OPCW) that were presented in a recent ConfChem [1], including papers describing the importance of outreach in achieving the goals of universal chemical disarmament [2], the role of responsible science and ethics in chemistry education [3–5], the use of sensors as educational tools for supporting scientific cooperation (a norm of the Chemical Weapons Convention) [6], and the chemistry and history of riot control agents [7]. These topics touch upon many important dimensions of the OPCW and its mission, yet they are certainly not what immediately comes to mind when most people think about the OPCW. Rather,

Article note: A collection of invited papers based on presentations at the Open Access Online Conference "Science, Disarmament, and Diplomacy in Chemical Education: The Example of the Organisation for the Prohibition of Chemical Weapons", which was held from 2nd May till 20th June 2016.

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Identification of chemicals relevant to the Chemical Weapons Convention using the novel sample-preparation methods and strategies of the Mobile Laboratory of the Organization for the Prohibition of Chemical Weapons

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ARTICLE INFO

Keywords:
Analytical strategy
Chemical warfare agent
Chemical Weapons Convention
Gas chromatography
GC-MS
Mass spectrometry
On-site analysis
Organization for the Prohibition of Chemical Weapons
Sample preparation
Thermal desorption

ABSTRACT

The standard approach to on-site sample preparation for gas chromatography-mass spectrometry analysis of chemicals relevant to the Chemical Weapons Convention provides relatively good coverage of the target analytes, but it suffers from a number of drawbacks, such as low sample throughput, use of bulky equipment, extensive manual work, extensive use of organic solvents, problems in preparing multiphase-sample systems and relatively large amounts of hazardous waste generated. We present the analytical strategies and the novel sample-preparation methods developed for the Mobile Laboratory of the Organization for the Prohibition of Chemical Weapons (OPCW) that deal efficiently with these issues. We illustrate the effectiveness of the approach with several practical examples.

A Need to Take Part in the Conversation!

Volume 406 · Number 21 · August 2014
ANALYTICAL &

J. Am. Soc. Mass Spectrom. (2016)
DOI: 10.1007/s13361-016-1430-0

RESEARCH ARTICLE

GC-MS Study of Mono- and Bishaloethylphosphonates Related to Schedule 2.B.04 of the Chemical Weapons Convention: The Discovery of a New Intramolecular Halogen Transfer

Nerea Picazas-Márquez,[1] María Sierra,[1] Clara Nova,[1] Juan Manuel Moreno,[2] Nuria Aboitiz,[1] Gema de Rivas,[2] Miguel A. Sierra,[3] Roberto Martínez-Álvarez,[3] Esther Gómez-Caballero[2]

[1]Ingeniería de Sistemas para la Defensa de España (ISDEFE), Beatriz de Bobadilla 3, E-28040, Madrid, Spain
[2]Laboratorio de Verificación de Armas Químicas (LAVEMA), Área de Defensa Química, Subdirección General de Sistemas Terrestres, INTA, Campus La Marañosa, San Martín de la Vega, E-28330, Madrid, Spain
[3]Departamento de Química Orgánica, Facultad de Ciencias Químicas, Universidad Complutense, E-28040, Madrid, Spain

Abstract. A new class of compounds, mono- and bis-haloethylphosphonates (HAPs and bisHAPs, respectively), listed in Schedule 2.B.04 of the Chemical Weapons Convention (CWC), has been synthesized and studied by GC-MS with two aims. First, to improve the identification of this type of chemicals by the Organization for the Prohibition of Chemical Weapons, (OPCW). Second, to study the synergistic effect of halogen and silicon atoms in molecules undergoing mass spectrometry. Fragmentation patterns of trimethylsilyl derivatives of HAPs were found to depend on the nature of the halogen atom; this was in agreement with DFT-calculations. The data suggest that a novel intramolecular halogen transfer takes place during the fragmentation process.

Keywords: Iodine transfer, Haloethylphosphonates, Chemical weapons convention

Received: 10 February 2016/Revised: 19 May 2016/Accepted: 24 May 2016

The Intersection of Science and Chemical Disar

By Beatrice Maneshi and Jonathan E. Forman -

METAL-ORGANIC FRAMEWORKS

Breaking bad chemicals down

A metal–organic framework with large pores catalytically destroys chemical warfare agents.

Matthew J. Rosseinsky, Martin W. Smith and Christopher M. Timperley

This year marks the centennial of the first large-scale use of chemical weapons. The response then — during the First World War — was to equip personnel with mouth pads, and later with gas masks whose canisters contained activated carbon. Today, this carbon-based material takes the form of a highly porous granular solid with a typical surface area of 1,000 $m^2 g^{-1}$. For military use, the carbon is impregnated with metal salts, which improve protection against volatile toxic chemicals, such as hydrogen cyanide. Such canisters save lives (Fig. 1) and without them personnel can succumb quickly to chemical warfare, for example, in the Ghouta attack on 21 August 2013 where the organophosphorus nerve agent sarin[1] caused around 1,500 deaths. The Organisation for the Prohibition of Chemical Weapons (OPCW; www.opcw.org), winner of the 2013 Nobel Peace Prize for "its extensive efforts to eliminate chemical weapons"[2], is able to coordinate the destruction there with international partners, of the chemical stockpile of the Syrian Arab Republic. This episode emphasized the global need for efficient systems to neutralize and destroy chemical warfare agents, provide personal and collective protection, and eliminate chemical stockpiles.

the delivery of medically active species[8]. Because both the metal and molecular components can have catalytic activity, there is considerable interest in the application of MOFs in catalysis[9], as their pore dimensions may allow them to process larger molecules compared with currently available crystalline open frameworks. Stable framework-forming chemistries are available that can enable catalytic applications in demanding environments such as water[10]. One of the most promising MOF families is based on the oxygen-bridged Zr_6 cation clusters[11], where water-stable crystalline materials with surface areas of over 4,000 $m^2 g^{-1}$ are available[12]. The small, highly charged Zr^{4+} the negatively charged reg agent, in particular to the phosphonate group. This the nerve agents so that t more readily by water. By cluster chemistry through bridging species from hy oxo (O^{2-}), the authors red of oxide-based species bi centres (that is, their coor from 8 to 6 and thus enha acidity for binding and ac agents. The selection of a that both stably connects

Keywords:
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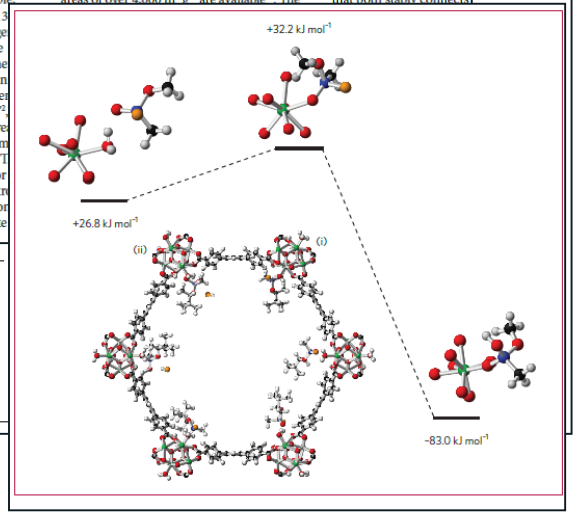
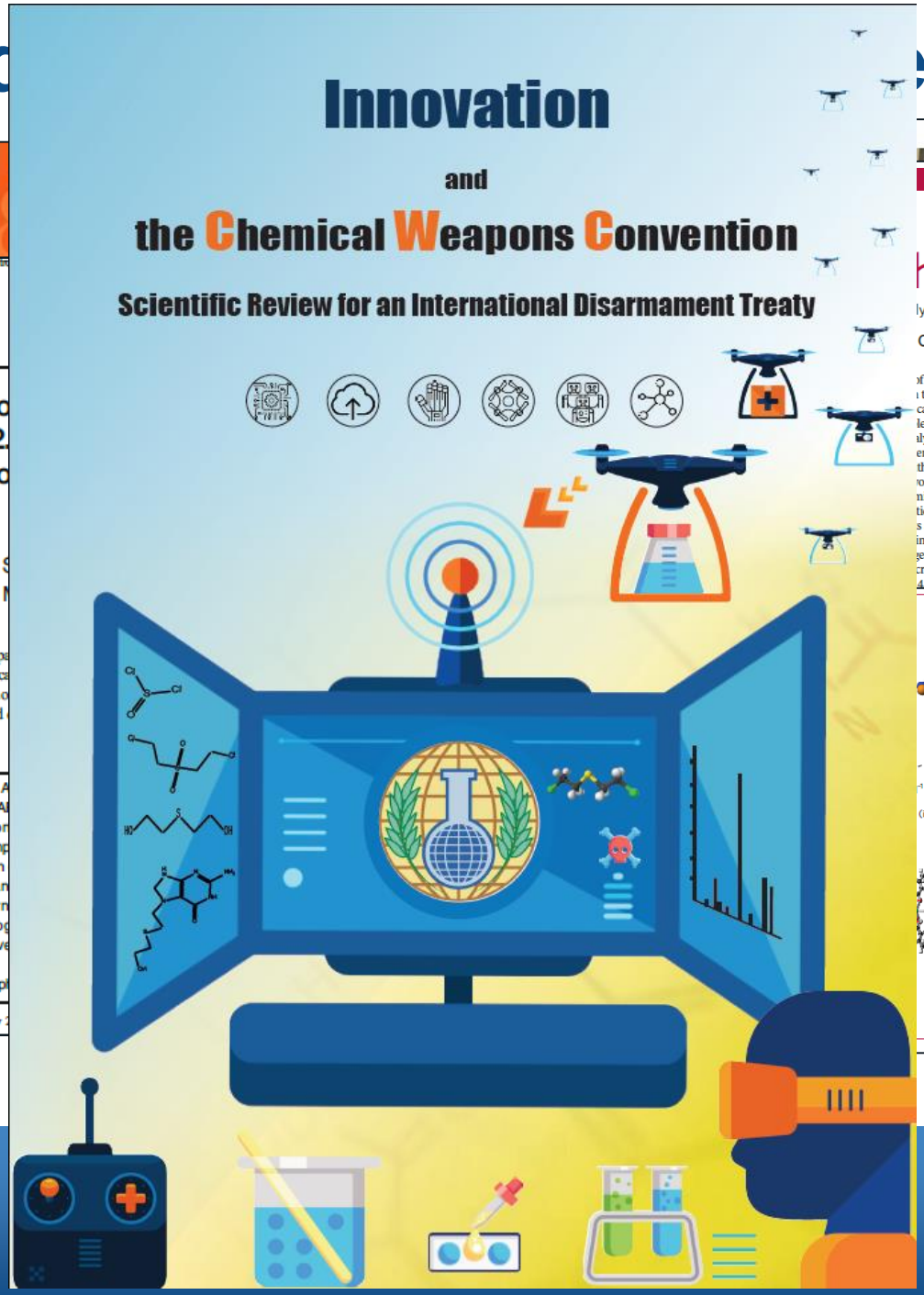
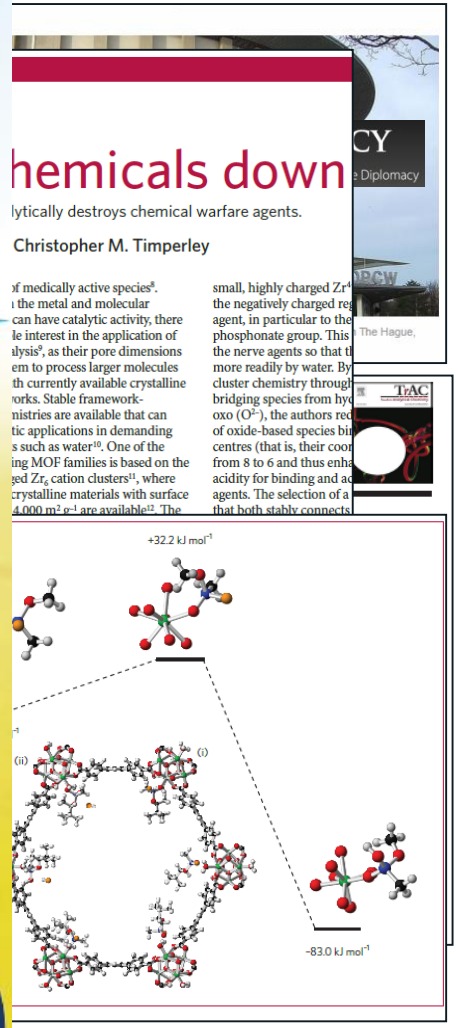


Elena Fischer and Wesam S. Alwan: Office of Strategy and Policy, Organisation for the Prohibition of Chemical Weapons, The Hague, The Netherlands
Marc-Michael Blum: OPCW Laboratory, Organisation for the Prohibition of Chemical Weapons, Rijswijk, The Netherlands

A Need ersation!





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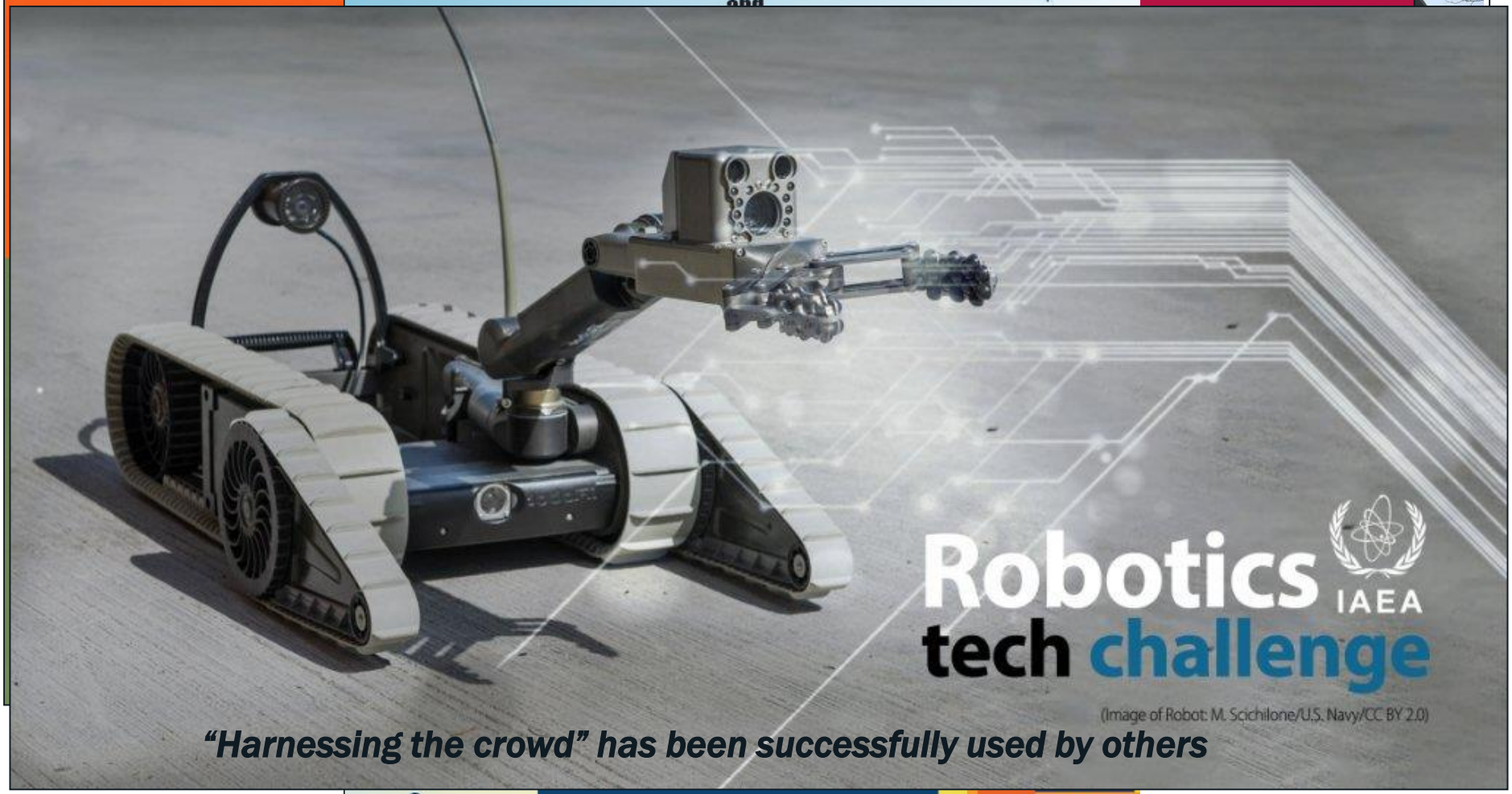
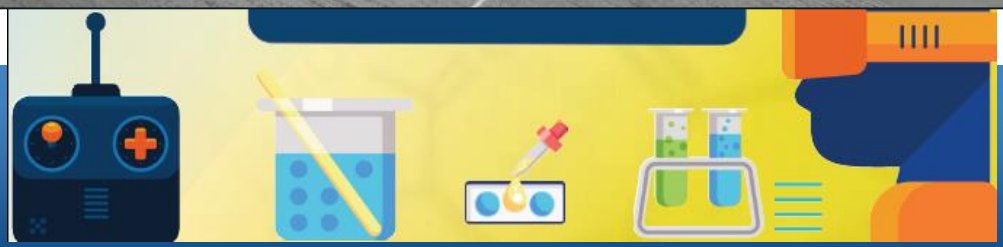
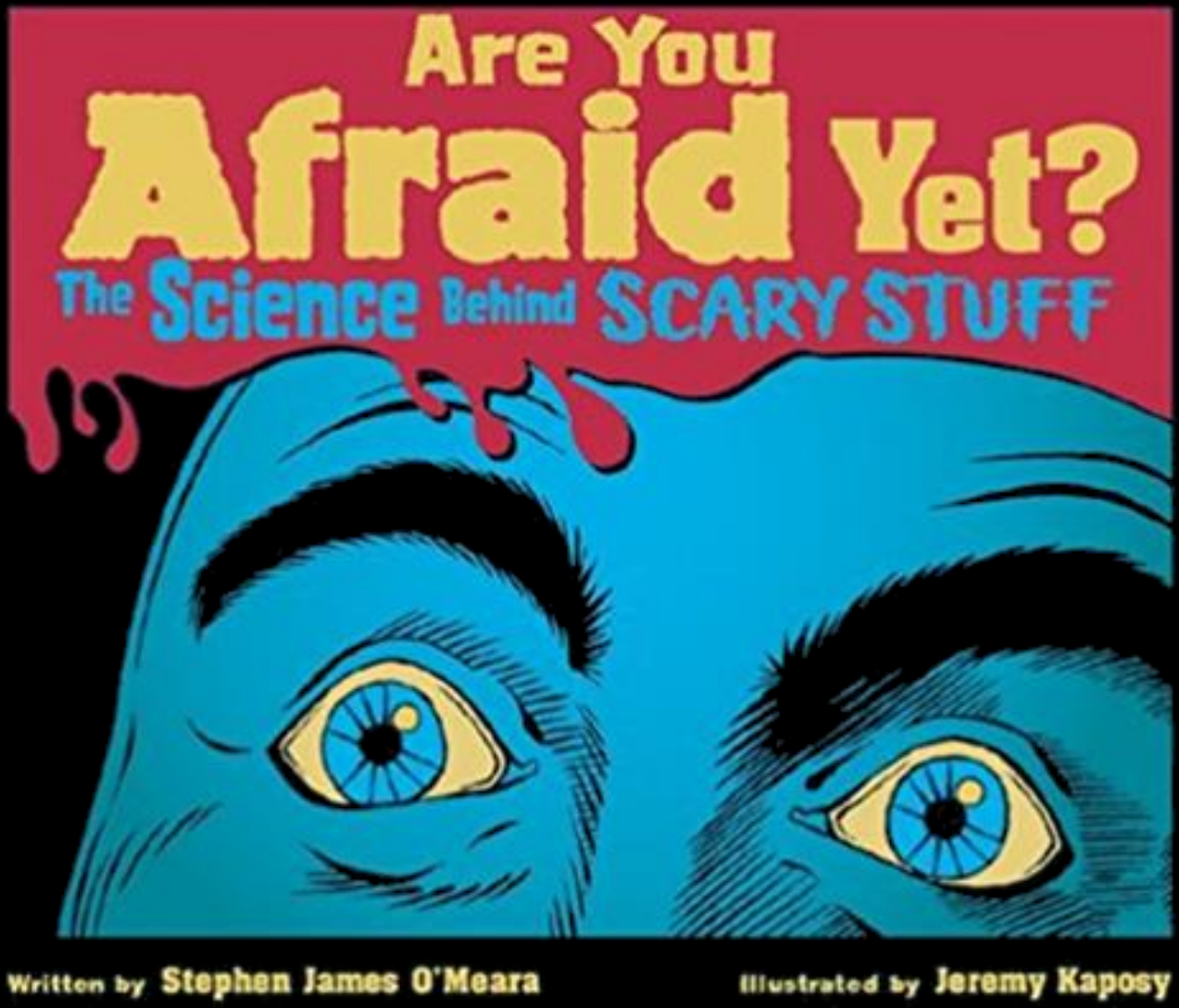


"Harnessing the crowd" has been successfully used by others

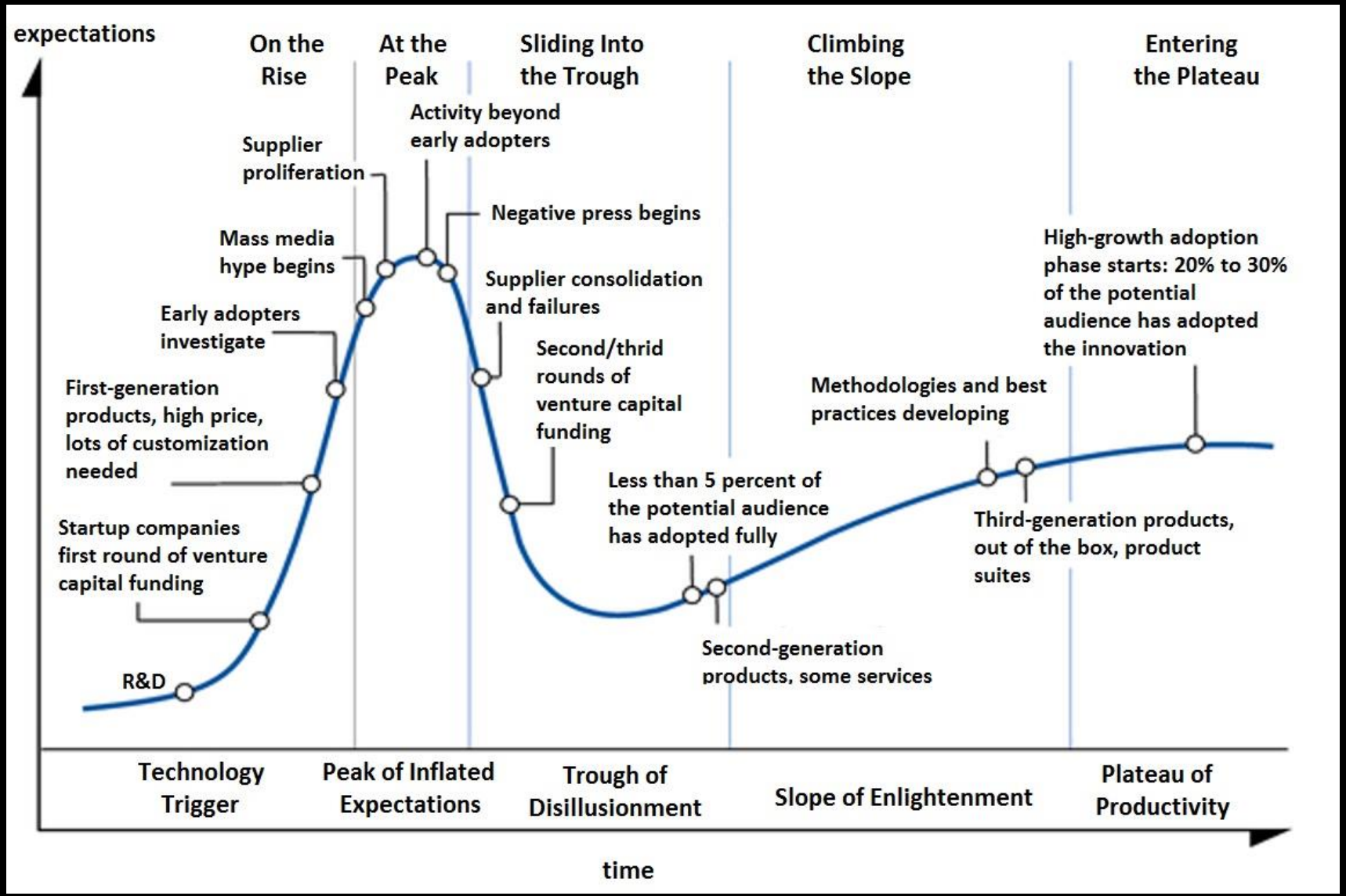


OPCW

Don’t Be Afraid: Disarmament Needs Scientific Literacy!



Don’t Be Afraid: Disarmament Needs Scientific Literacy!



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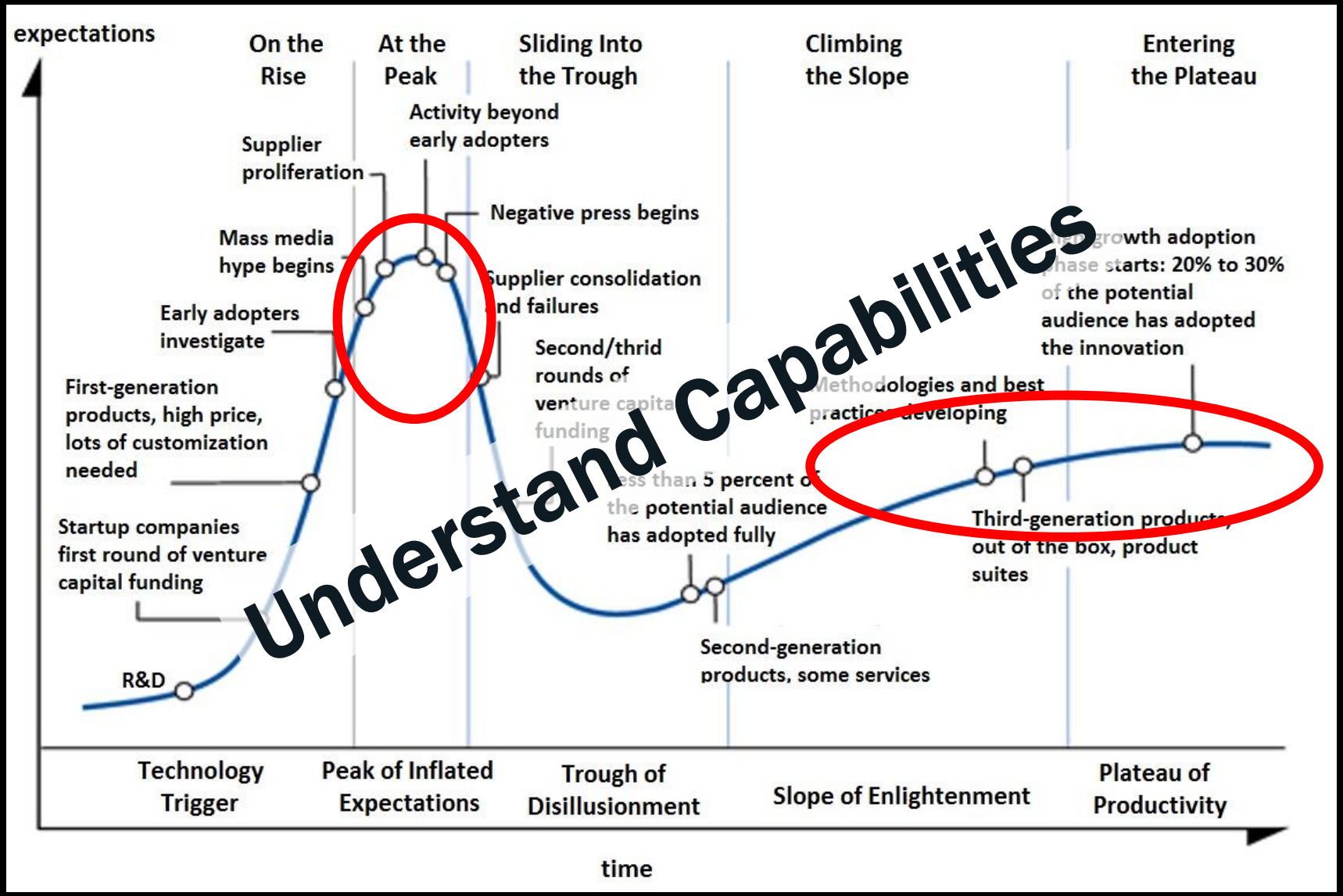
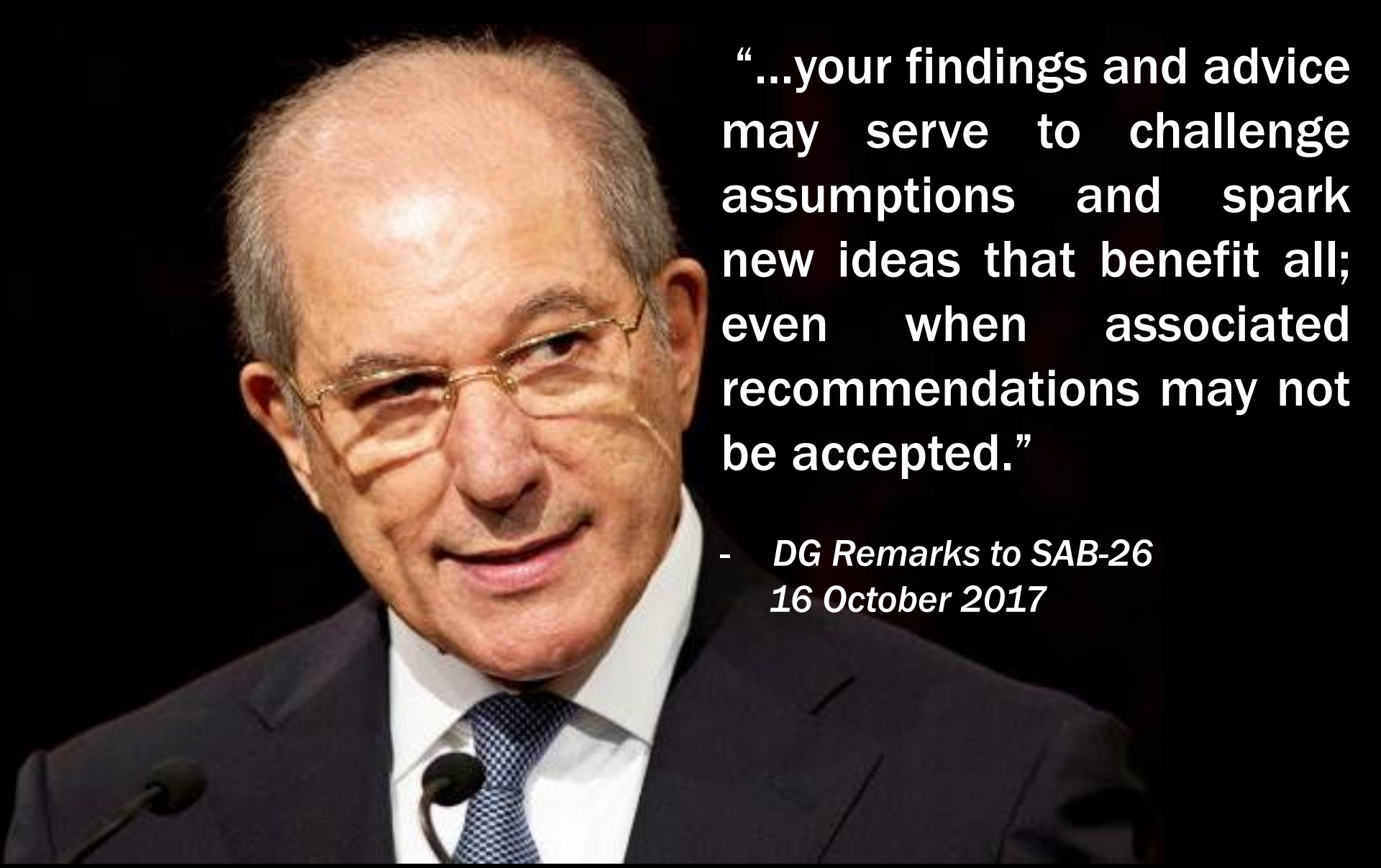
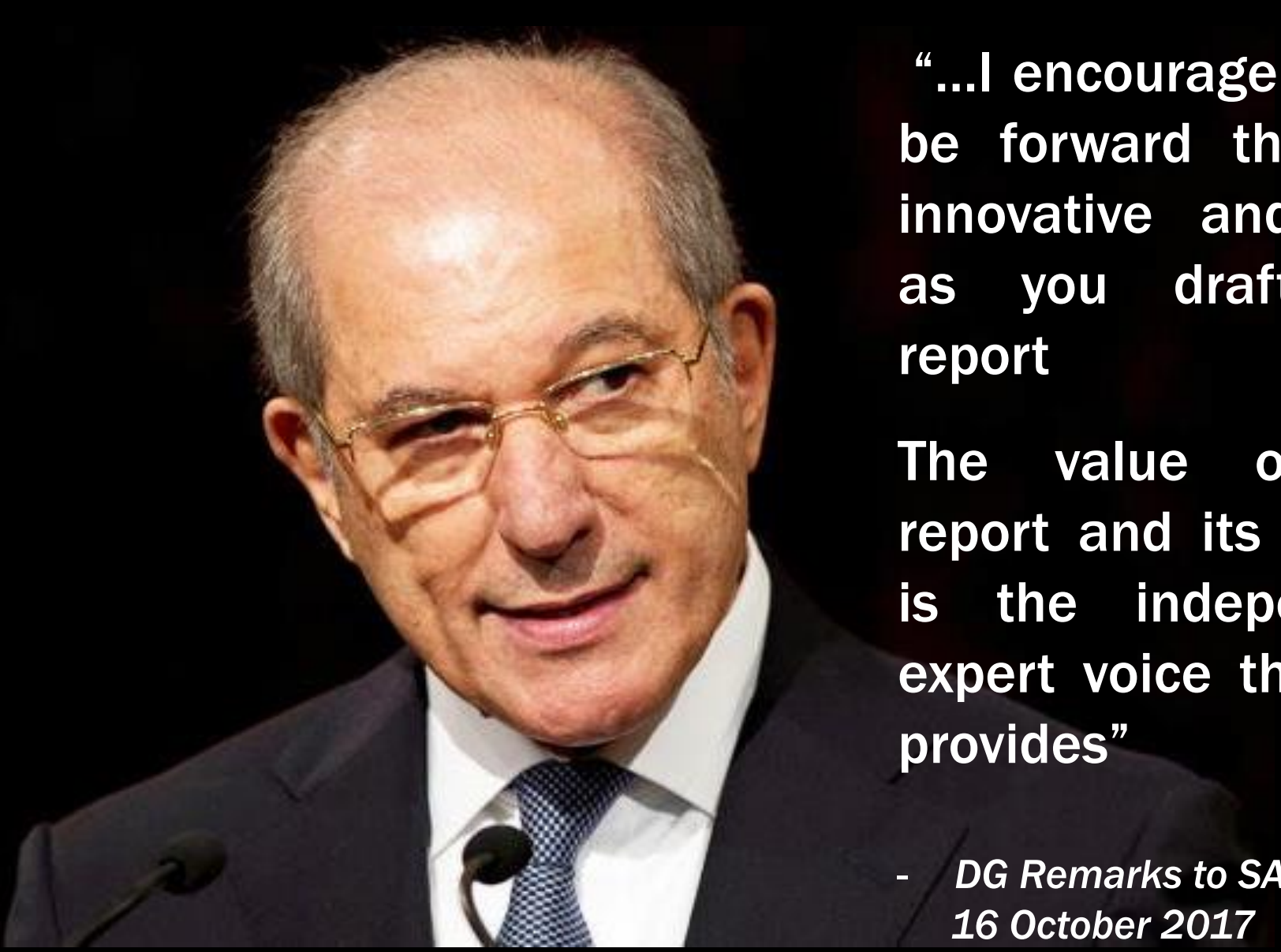




"...your findings and advice may serve to challenge assumptions and spark new ideas that benefit all; even when associated recommendations may not be accepted."

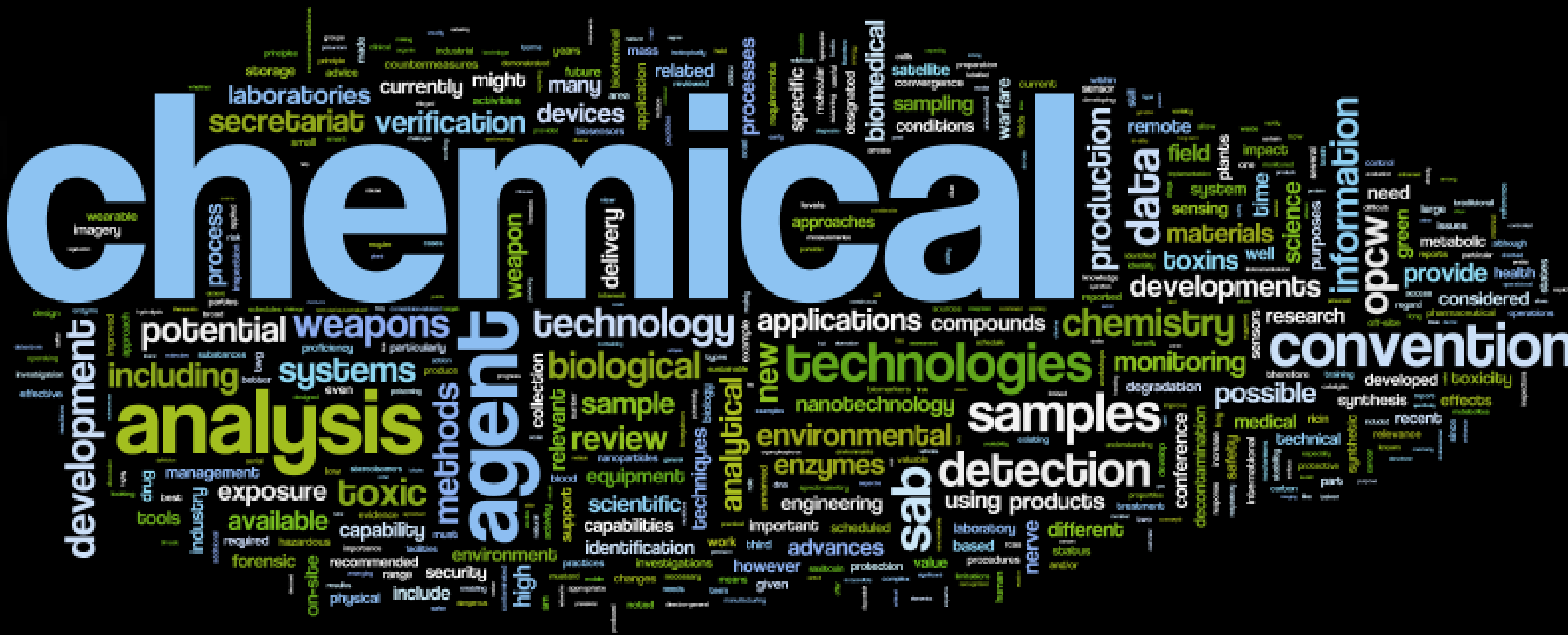
- *DG Remarks to SAB-26*
  16 October 2017



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

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

- *DG Remarks to SAB-26*
  16 October 2017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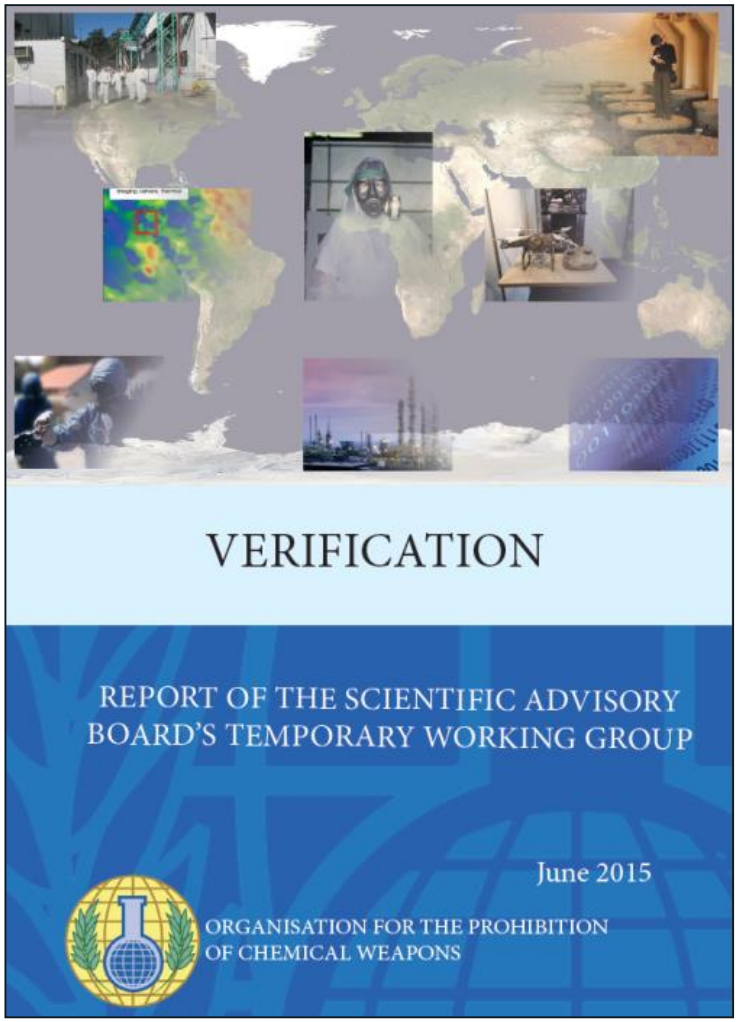
Stimulating Discussion with States Parties

OEWG-FP, January 2017



OPCW Scientific Advisory Board Briefing to States Parties

OPCW | 1997-2017 OPCW 20 YEARS

Thursday, 19 October 2017

Ieper Room | 13:30-15:00

Light lunch served at 13:00

Science for Diplomats at EC-86

Innovation

and

the Chemical Weapons Convention:

The Scientific Advisory Board's Report on Emerging Technologies

Tuesday, 10 October 2017

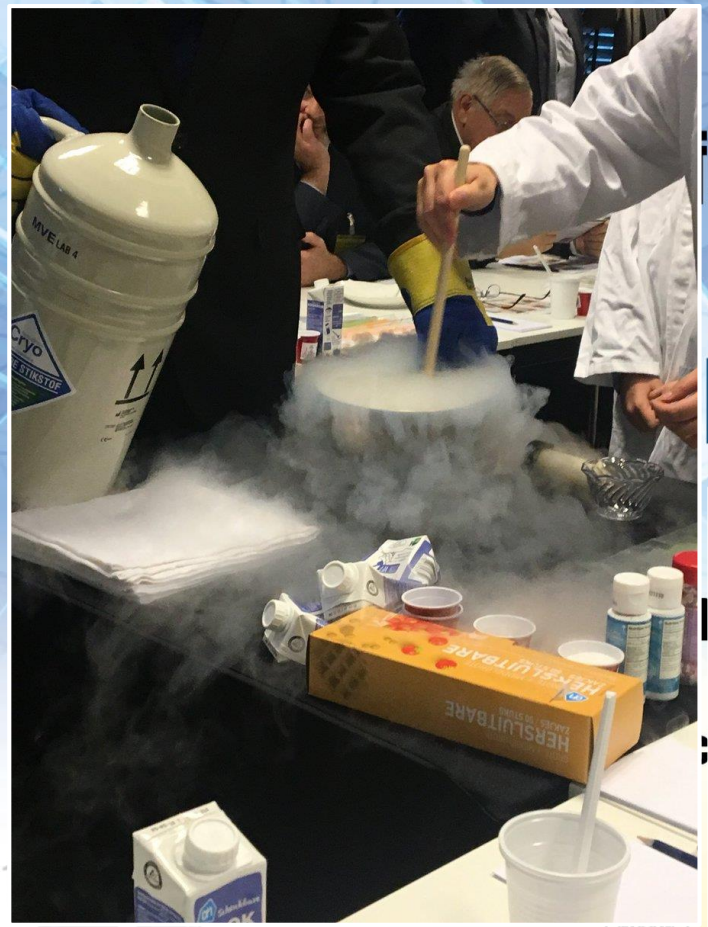
Ooms Room 13:30-14:45

Light Lunch Available At 13:00

OPCW | 1997-2017 OPCW 20 YEARS

or Diplomats at EC-86

Innovation



YEARS

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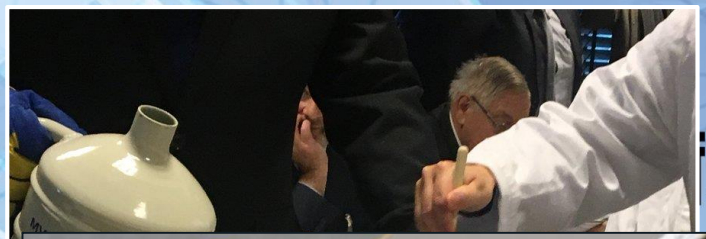

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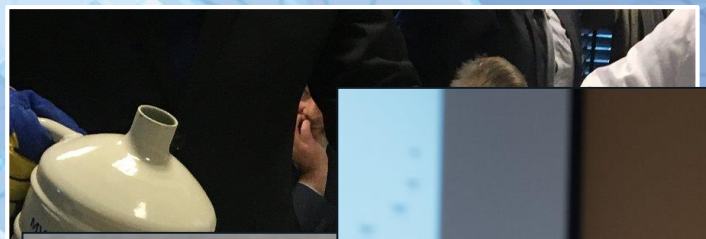
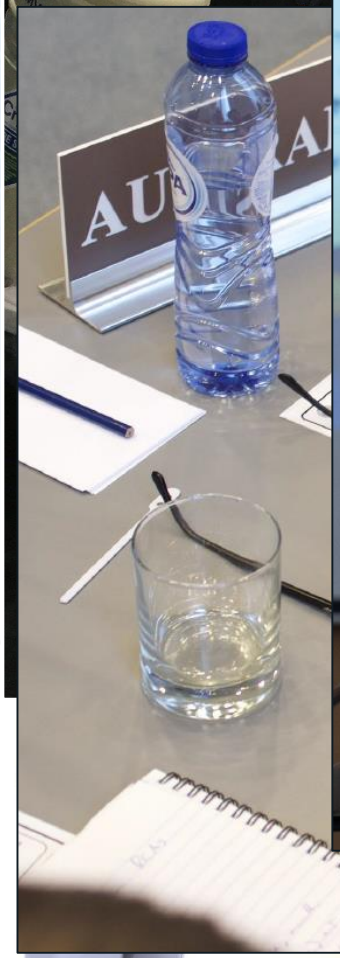
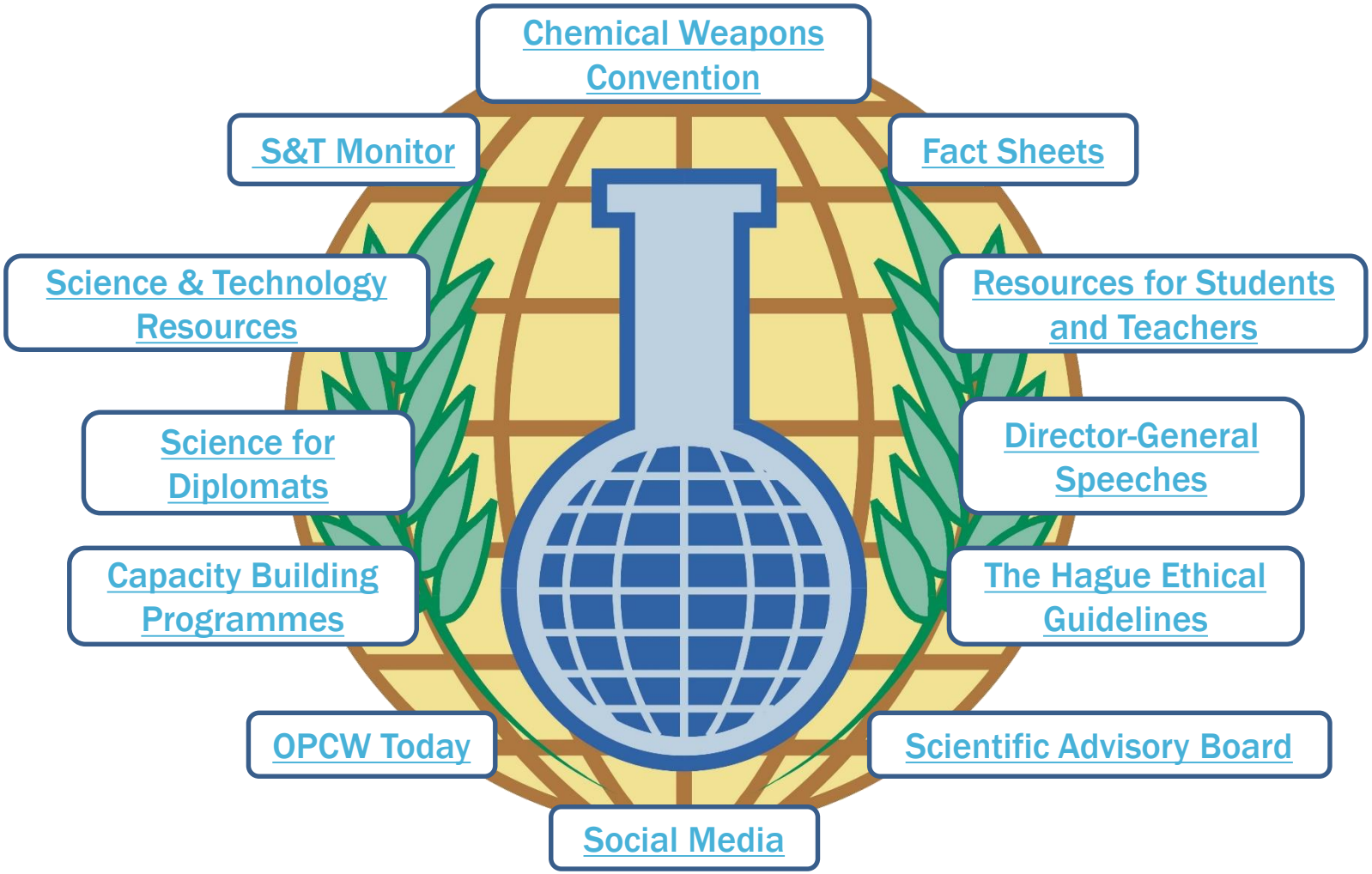
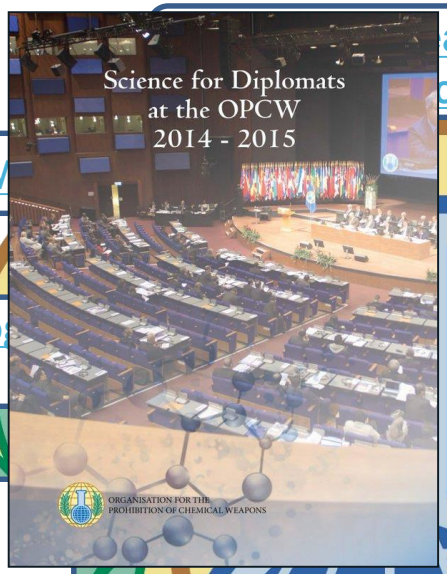


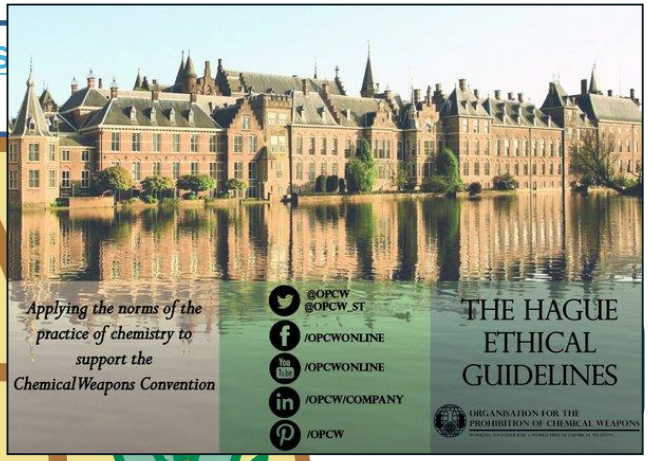


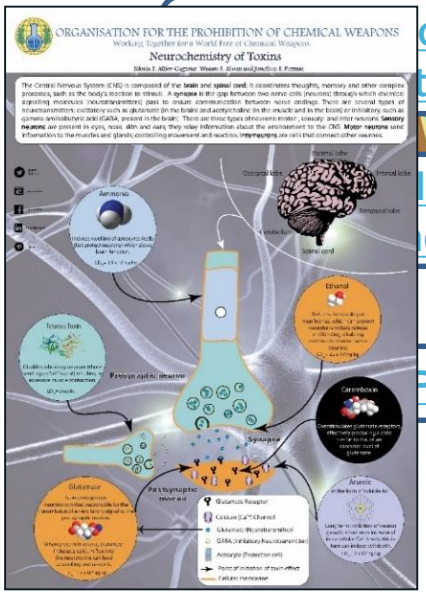

DANGER

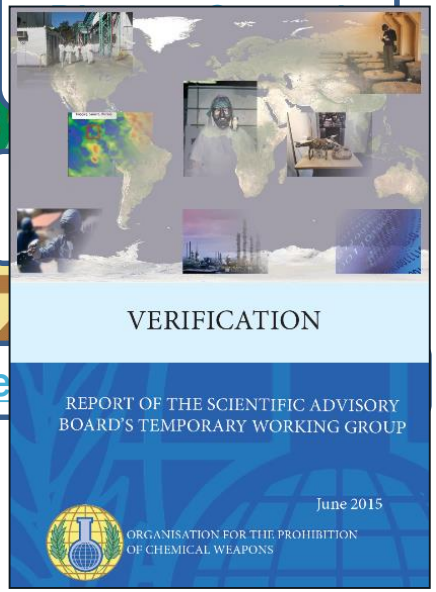


www.opcw.org/special-sections/science-technology/science-technology-resources/









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www.opcw.org/special-sections/science-technology/science-technology-resources/

OPCW

Organisation for the Prohibition of Chemical Weapons

1997–2017 OPCW 20 YEARS

OPCW Industry Engagement

Alexander Kelle, OSP

OPCW Technical Secretariat

NOVEMBER 1997

CHEMICAL INDUSTRY AN ESSENTIAL PARTNER

Chemical industry's contributions to achieving a world free of chemical weapons have proven essential and include: participating in the negotiations of the Convention, implementing fully the Convention's provisions, and ensuring a functioning and trusted verification regime through declarations submissions and on-site inspections.

The first OPCW industry inspection took place in November 1997 in Italy. As of the end of 2016, 3,322 inspections of industrial chemical facilities on the territory of 82 States Parties have been conducted since entry into force and 241 industry inspections are anticipated for 2017. During these inspection missions, OPCW inspectors confirm that no chemicals are being produced or used for prohibited purposes and that the activities at inspected sites are in compliance with the Convention. This is how industry does its part to make sure chemical weapons do not re-emerge.

The successful completion of so many chemical industry inspections represents meaningful progress in achieving universal compliance with the Chemical Weapons Convention. Chemical industry inspections help promote confidence that States Parties to the Convention are adhering to their obligation to prevent the re-emergence of chemical weapons.

The relationship between the OPCW and the chemical industry has evolved over time. OPCW is no longer only seen as an auditor and regulator, but instead OPCW is seen as a partner for improving the verification regime that ensures chemicals are not used for prohibited purposes, and improving the capacity of States Parties through international cooperation programmes.

Building on years of cooperative work between the OPCW and chemical industry, the partnership has taken new form. In 2015, a coordination mechanism was established with the International Council of Chemical Associations (ICCA) in 2015 through the creation of the OPCW–ICCA Joint Steering Committee, as well as the establishment of the Chemical Industry Coordination Group (CICG). Areas of cooperation with ICCA cover verification activities as well as education and outreach, and chemical safety and security.

NOVEMBER 1997

CHEMICAL INDUSTRY
AN ESSENTIAL PARTNER

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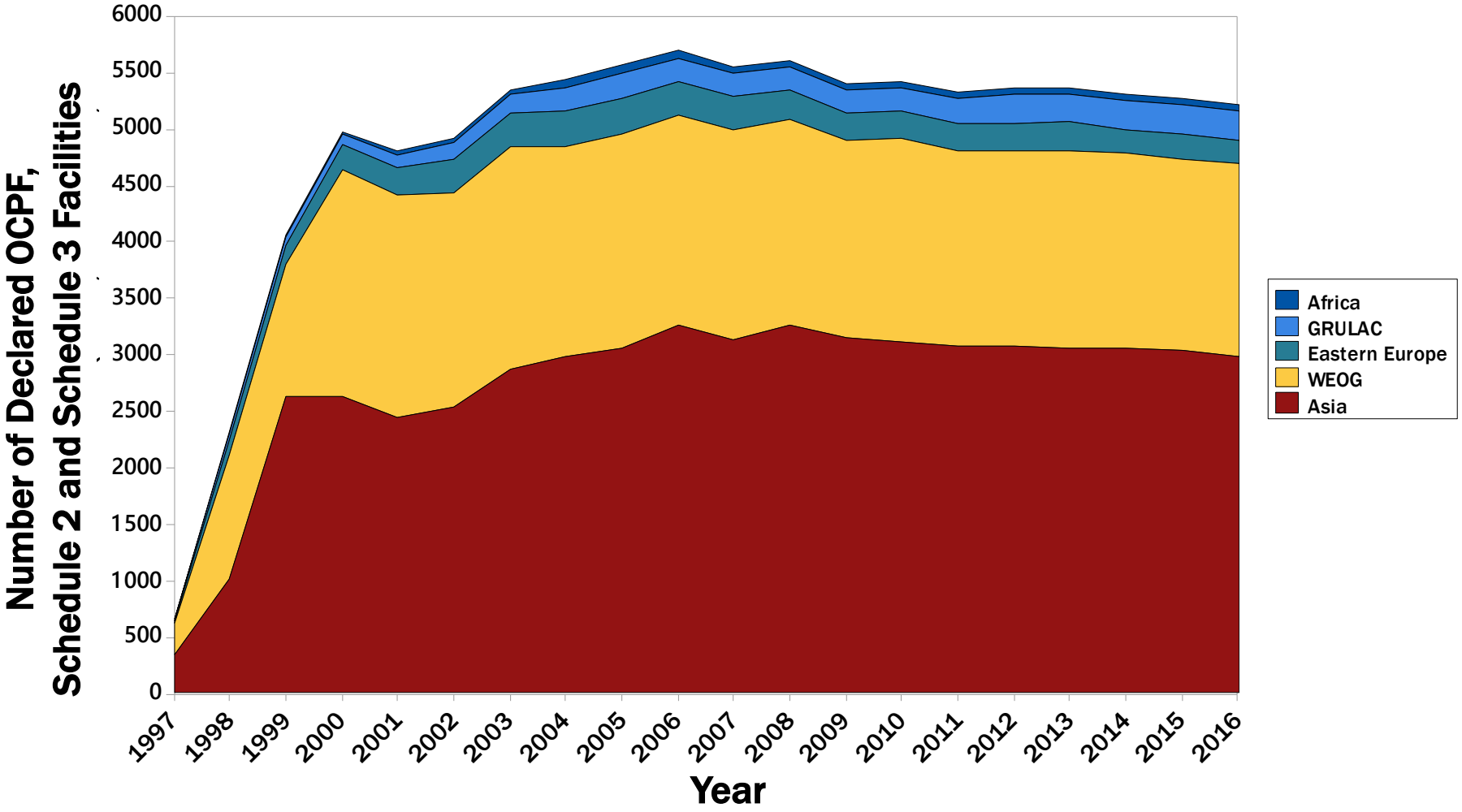
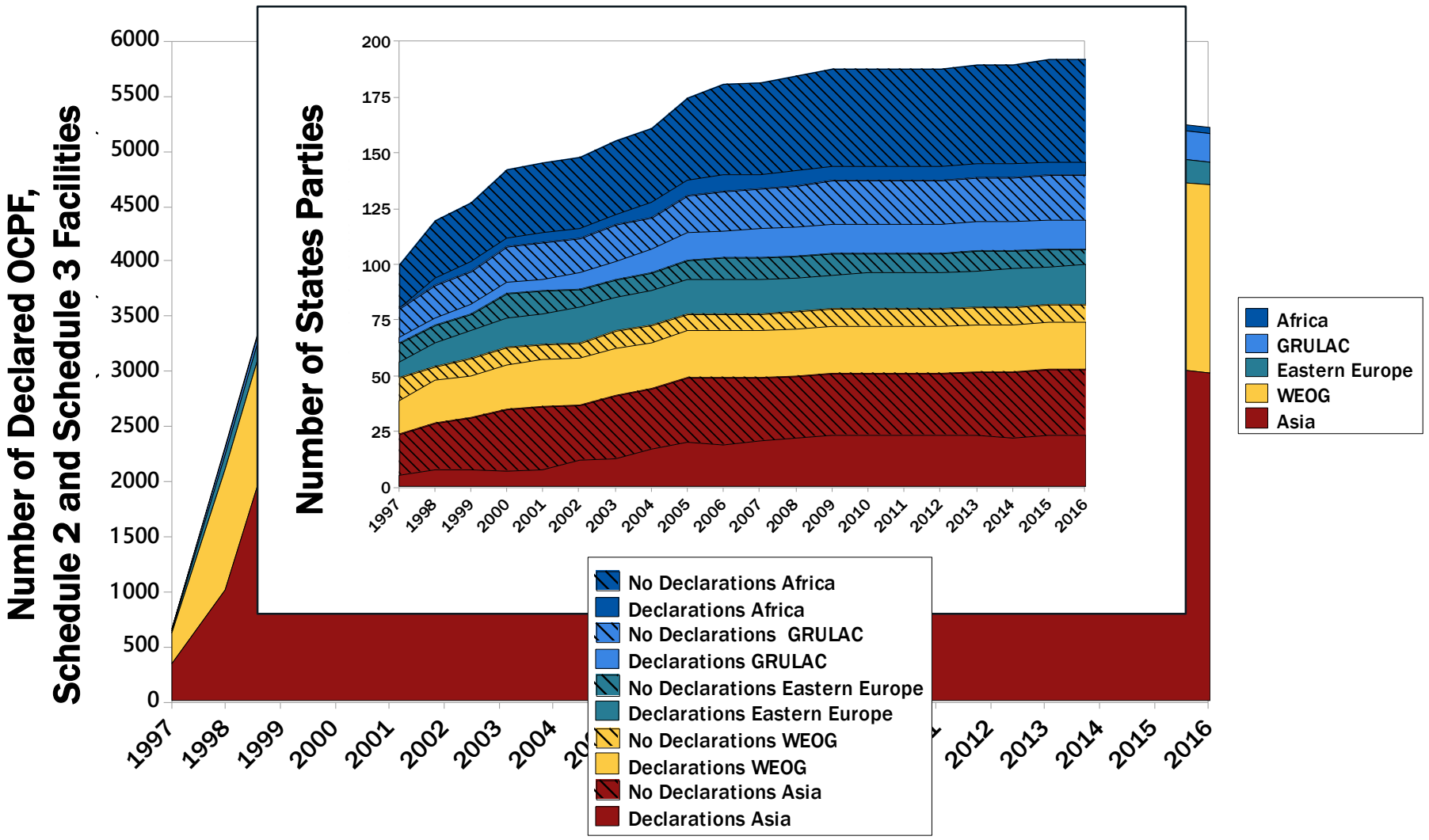
Declared Article VI Facilities

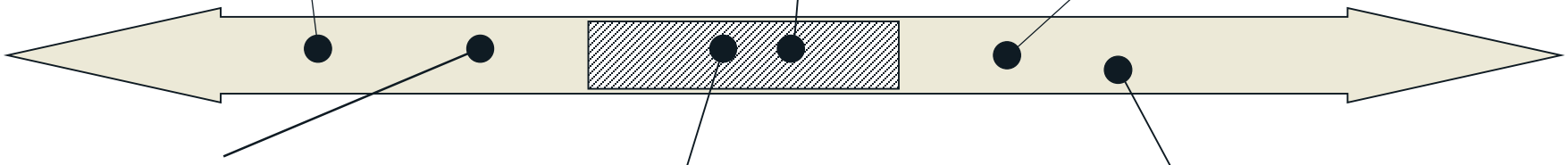


Declared Article VI Facilities



Formalisation of the cooperation between the ICCA and OPCW

International Council of Chemical Associations



11 Sept 2013 - Meeting between the ICCA & TS : Set of practical actions identified

16 Oct 2014 - Technical Secretariat invited to participate to ICCA Steering Committee (Paris)

Nov - Dec 2014 – Exchange of letters

1 Dec 2014 – Decision C-19/DEC.2

5 Mar 2015 (Brussels) Meeting between the ICCA & TS: Working modalities clarified

1 July 2015 - S/1293/2015

Formalisation of the cooperation

Coordination mechanism

2 meetings so far

- OPCW-ICCA joint Steering committee (JSC):
  - Decision-making level (decide on common initiatives/projects)
  - 3-4 members from both TS and ICCA (director level)
  - Meeting once a year
- Chemical industry Coordination Group (CICG)
  - Technical working level (running projects) reports to JSC
  - 4-5 individuals from both ICCA and TS (maximum of 10 members). Composition may vary (with the exception of the Head of the CICG) depending on the issues to be discussed
  - Meeting twice a year at least

5 meetings so far

Conferences & meetings

Cooperation activities

- Three areas:
  - Education and Outreach
  - Chemical Safety and Security
  - Cooperation activities related to verification

DG Note C-19/DG.14, dated 3 October 2014

DG Note C-20/DG.15, dated 16 November 2015

DG Note C-21/DG.15, dated 3 October 2016

DG Note C-22/DG.18, dated 10 October 2017

Associate Programme Industry Segment (3 weeks)

3-week placements of the participants in chemical plant sites in Member States to gain exposure to modern practices in chemical industries, with a focus on chemical safety

18 chemical plant sites in 15 countries in 2017

Chemical safety and security management programme

Industry Outreach a
Programme in Korea f
- 2

South Africa
2014

Safety and Security Programme in Vietnam for ASEAN and SAARC Member States - 2015

Safety and Security Programme in Sri Lanka for SAARC Member States - 2014

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

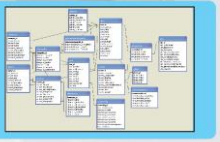
The Secretariat should consider adopting a comprehensive, more analytical approach to verification utilising all available and verifiable information.

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.

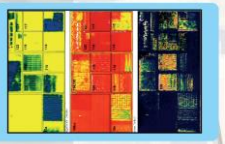


Recommendation 4

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 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

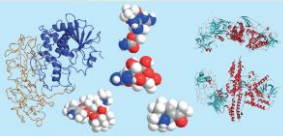
Lessons on chemical sampling and analysis from the OPCW's support to the 2013 United Nations Mission to Investigate the Use of Chemical Weapons in the Syrian Arab Republic, and all subsequent OPCW activities in relation to the Syrian Arab Republic must be identified and implemented.

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

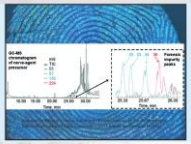
Continuous additions to the OPCW Central Analytical Database (OCAD) are recommended to allow the OPCW to meet all its mandated inspection aims, including IAU.

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/special-sections/science-technology/science-technology-monitor/

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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

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

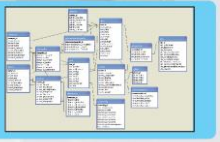
The Secretariat should consider adopting a comprehensive, more analytical approach to verification utilising all available and verifiable information.

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.

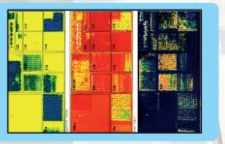


Recommendation 4

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 inde
review of all activities pertaining to the
carried out in the Syrian Arab Republic.

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ion and on-site

Recommendation 10

The verification thresholds for OCPFs produci
evant chemicals, and the possibility of revisio
uct group codes, should be addressed by the S
the industry cluster.

sis from the
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n the Syrian
nt OPCW
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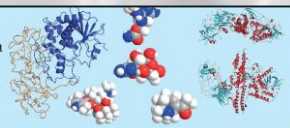
Recommendation 13

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.



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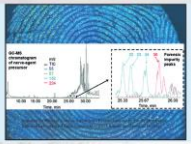

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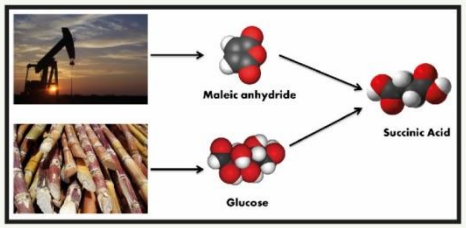
Taking into consideration the convergence of chemistry and biology as it relates to the synthesis of chemicals, the TWG was of the view that any process designed for the formation of a chemical substance should be covered by the term "produced by synthesis".



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