ORGANISATION FOR THE
PROHIBITION OF CHEMICAL WEAPONS

Working together for a world free of chemical weapons

Impact of Science and Technology on the Implementation of the Chemical Weapons Convention

14th Workshop for Diplomatic Personnel Involved in the Work of the OPCW

30 September 2014
OPCW Headquarters
The Hague, The Netherlands

Jonathan E. Forman, Ph.D.
Science Policy Adviser
Office of Strategy and Policy
Organisation for the Prohibition of Chemical Weapons

From 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)*

The Third Review Conference

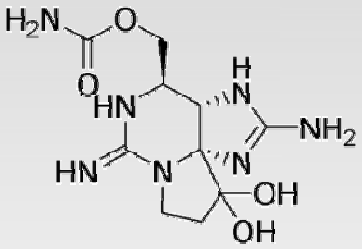
- "**Conviction** that the provisions of the Convention are mutually reinforcing and that the full, effective, and non-discriminatory implementation of all of its provisions, taking into account relevant developments in science, technology and industry, is of critical importance;"

  RC-3/3 paragraph 9.4*

- "**Recognition** that new challenges related to the Convention continue to arise and that its implementation may need to be improved to continue to achieve the object and purpose of the Convention and to stay abreast of developments in science and technology;"

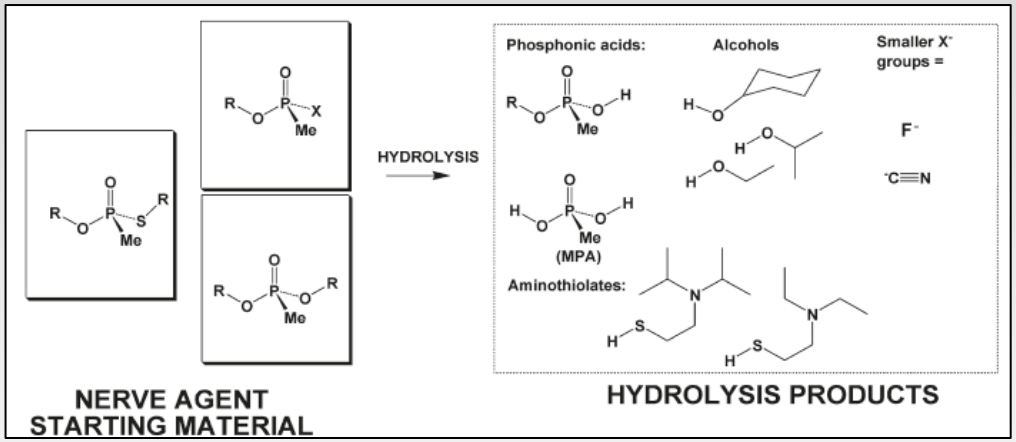
  RC-3/3, paragraph 9.9*

Science and Technology Underpin the CWC



Article II

Article III



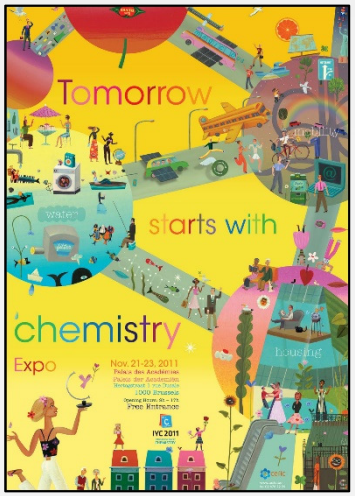
Articles IV and V

Article VI

Article VIII

Articles IX and X

Article VII



Article XI

Open for Signature 1993 - Entry into Force 1997

ORGANISATION FOR THE
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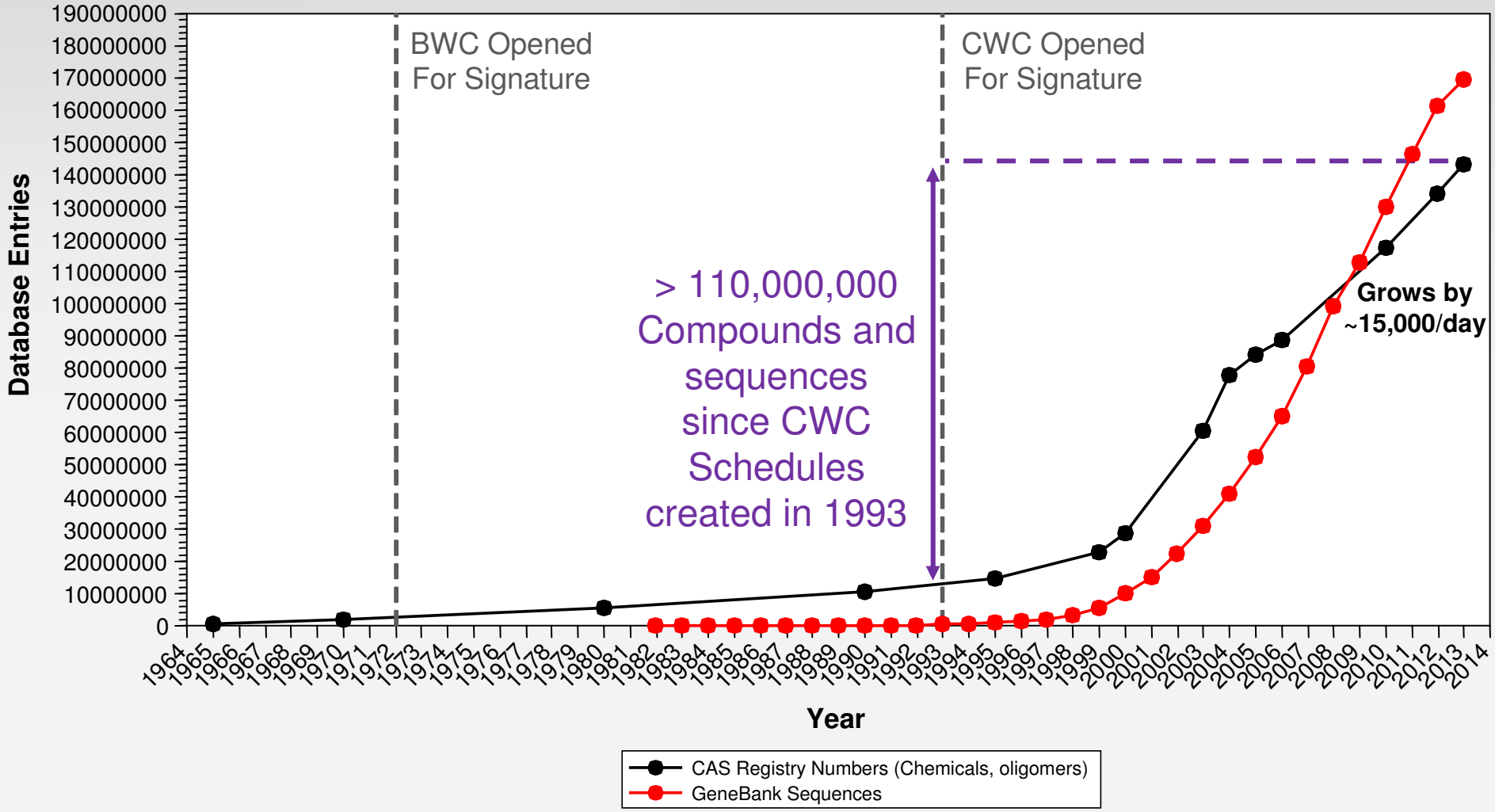
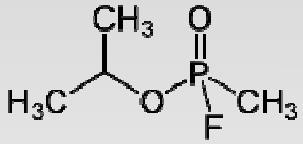
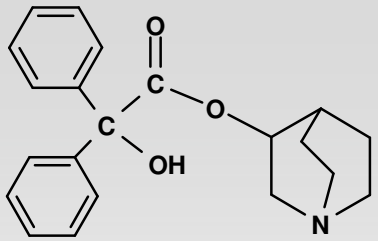
Scientific Knowledge Continues to Grow



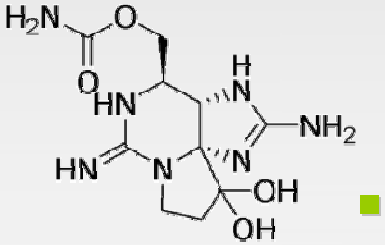
Understanding Chemicals

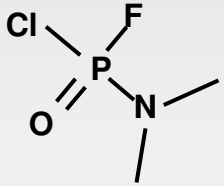




- **> 140 Million CAS Numbers!**
- **How Many Possible Scheduled Chemicals?**

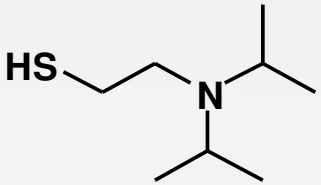
Infinite number of possibilities!
(generic structures in Schedule 1 and Schedule 2)

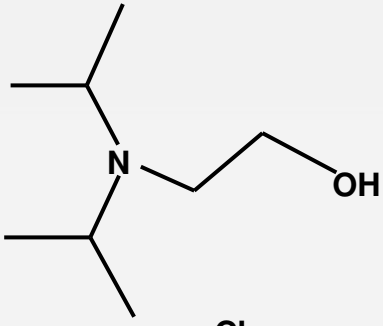




- **How Many Actual Scheduled Chemicals**

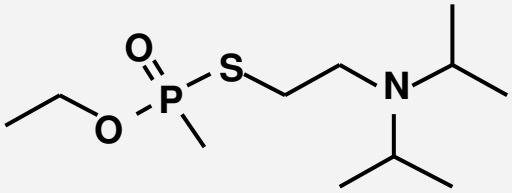
~35,000 CAS Numbers Reported

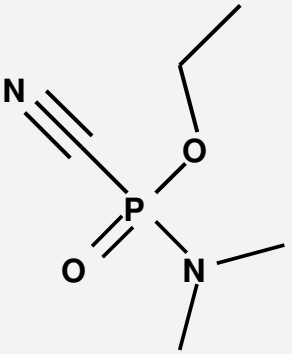


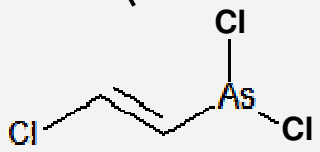


- **How Many Mass Spectra in OCAD?**

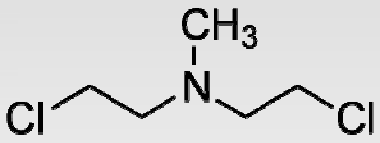
~5,000



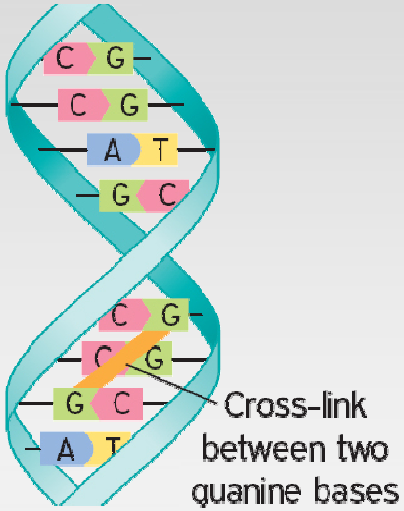




Chemicals Have Multiple Uses



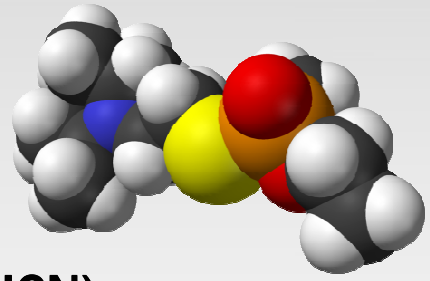
Nitrogen Mustard
Schedule 1A



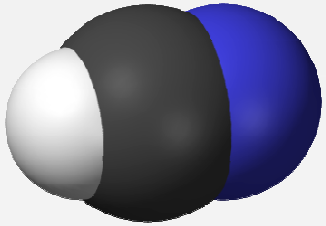
and Anti-Cancer Drug
(as a salt)

Scheduled Chemicals Span a Broad Range of Properties

VX (*O*-ethyl-*S*-[2(diisopropylamino)ethyl] methylphosphonothiolate



Hydrogen Cyanide (HCN)



Ricin

Research On Toxic Substances

THE BACTERIAL TOXIN TOOLKIT

Giampietro Schiavo and F. Gisou van der Goot‡*

Pathogenic bacteria and higher eukaryotes have spent a long time together, leading to a precise understanding of one another's way of functioning. Through rapid evolution, bacteria have engineered increasingly sophisticated weapons to hit exactly where it hurts, interfering with fundamental host functions. However, toxins are not only useful to the bacteria — they have also become an essential asset for life scientists, who can now use them as toolkits to explore cellular processes.

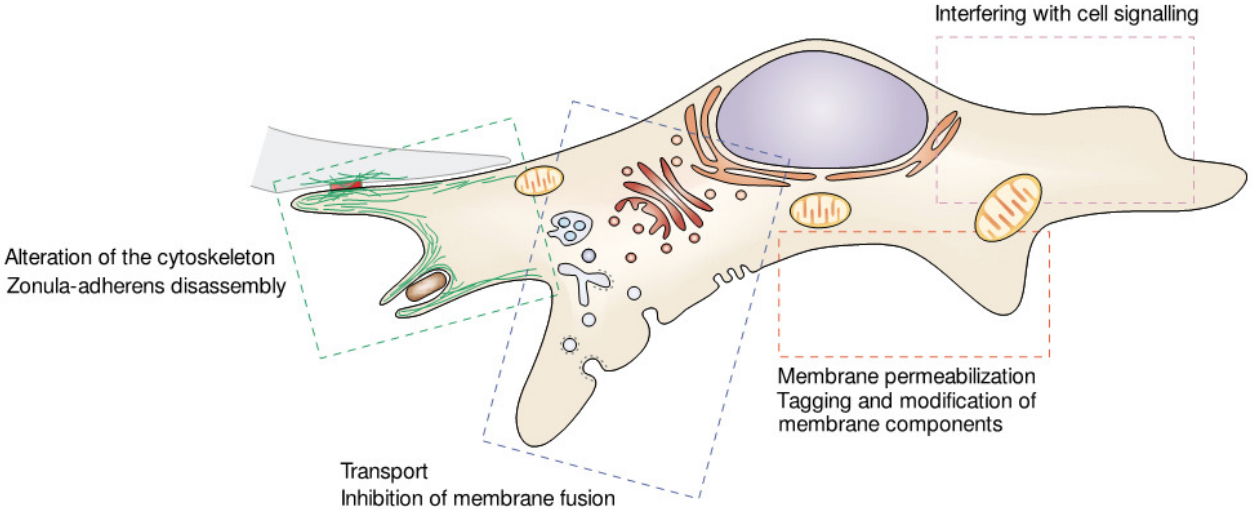


Figure 1 | **Cellular processes targeted by bacterial toxins.** These have been subdivided into four classes, each represented by examples in FIGS 2 to 5.

From: Nature Reviews, Molecular cell Biology, 2001, 531-537

Can This be Easily Discussed?

The Convergence of Chemistry and Biology

Chemistry Underpins Biology

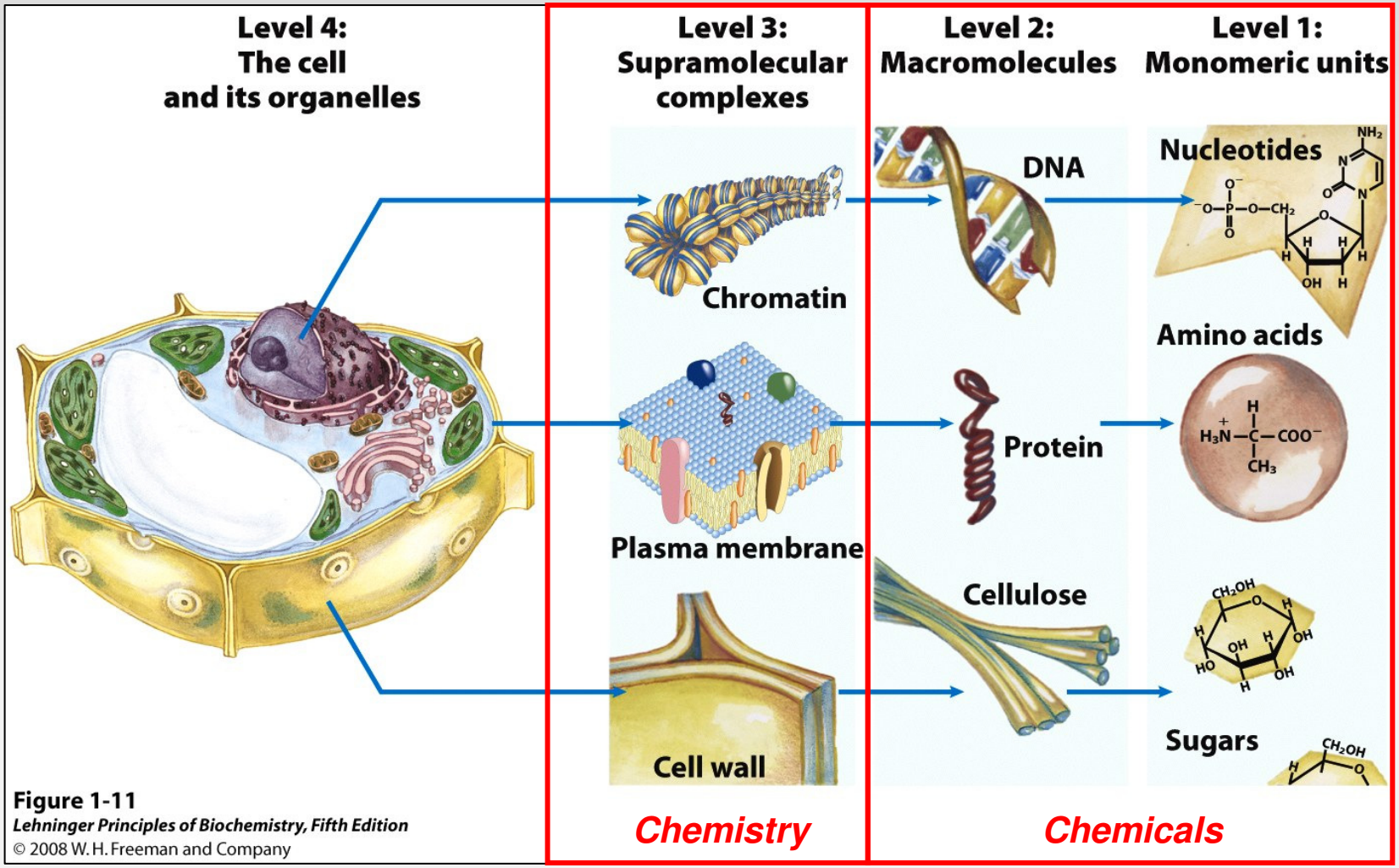
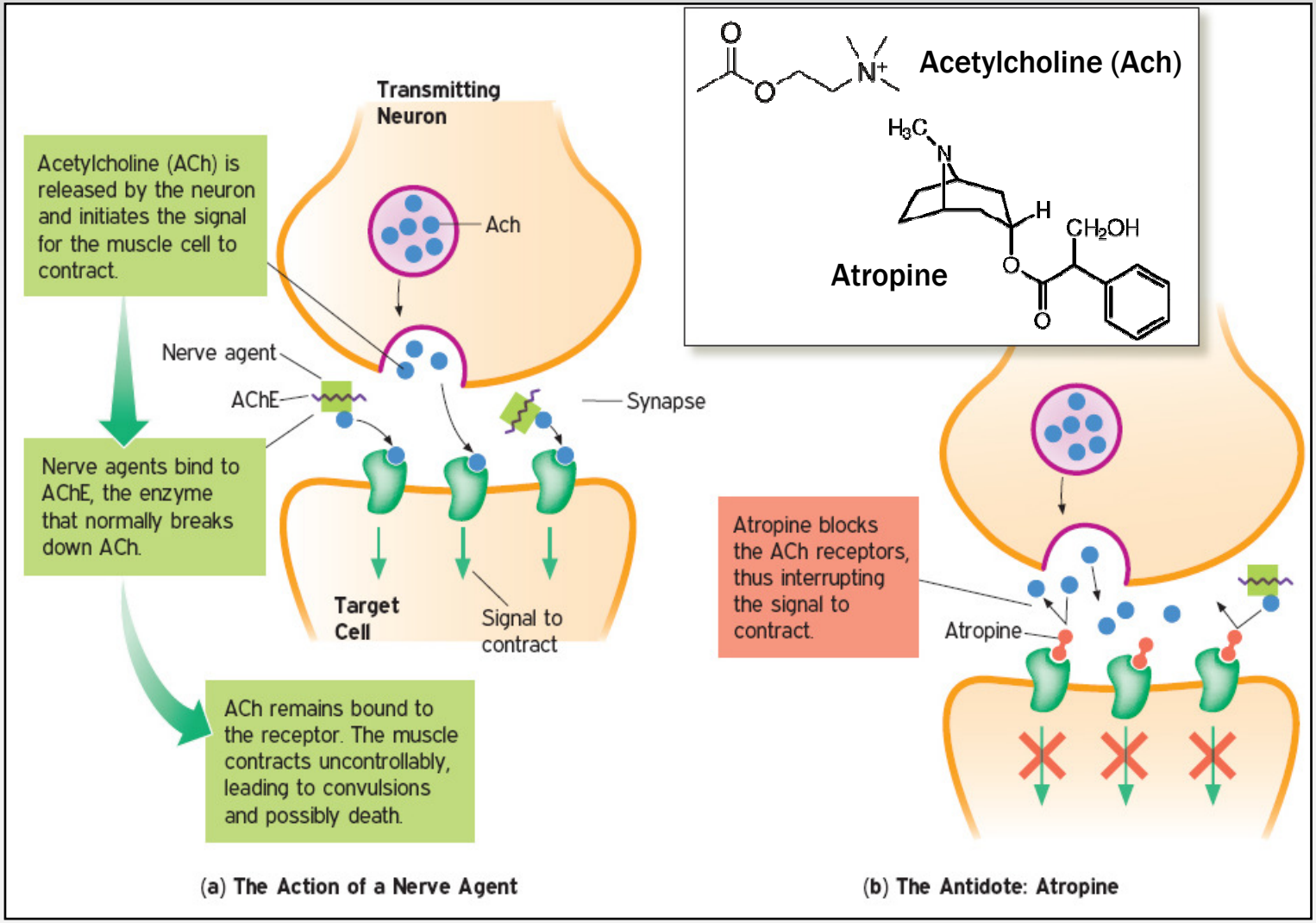


Figure 1-11
Lehninger Principles of Biochemistry, Fifth Edition

Chemistry Influences Biology



Chemical Production

Chemistry is a Science of Change

Technology is the Integration of functional components into Multifunctional Tools

Production Technology: Production by Synthesis?

From Petroleum

Distillation

Reactor

Separation

Raw Material *(Bulk Chemical)*

Pre-Process

Chemical Formation (Synthesis?)

Separate (Purify)

Product *(Bulk Chemical)*

From Biomass

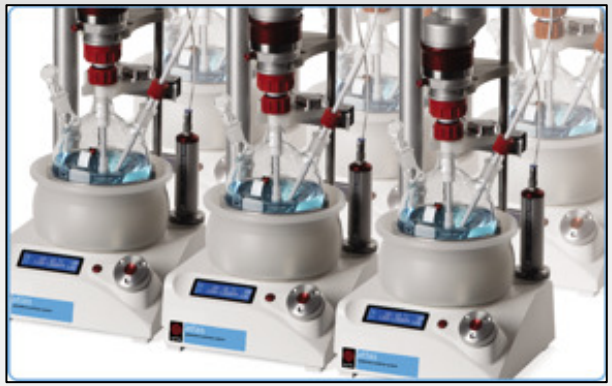
Milling
Mashing
Digestion

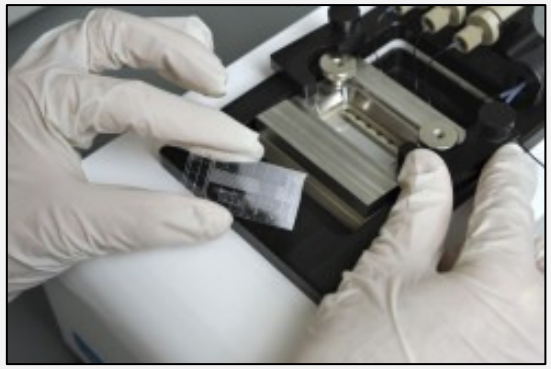
and/or Fermentor

DOC

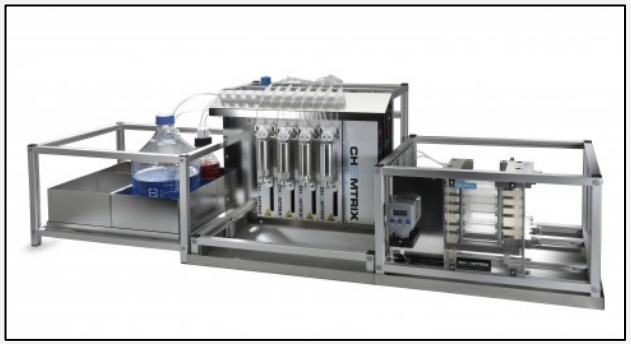
The Complexity of Scale

Laboratory Scale Chemistry





Pilot Scale Chemistry



Industrial Scale Chemistry

Scientific and Technological Development

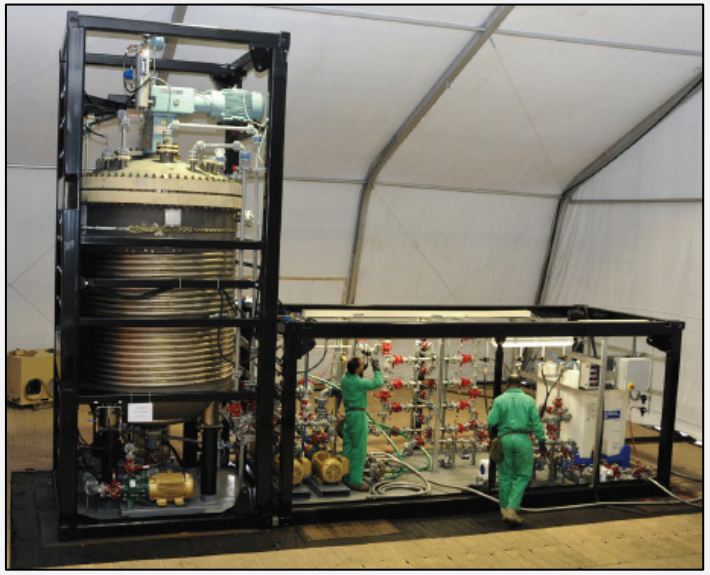
Basic Research vs. Fieldable Applications

Clever ideas – but are they practical and effective?

~150,000/ml ~ 200 rpm mechanical stirring in 15 ml volume using H_2O_2 as both fuel for stirrers and neutralization agent

Angewandte Chemie International Edition, 2013, 50, p13276

Portable systems adopted for use in 2013



How Do Ideas and Research Results Become Realities?

?

Converging Science is the Norm, Not the Exception!

Chemistry – Biology – Physics – Engineering – Informatics and More…

What Does It Mean and How Applicable Is it?

The Scientific Advisory Board

- 25 Members, nominated by States Parties and appointed by the DG

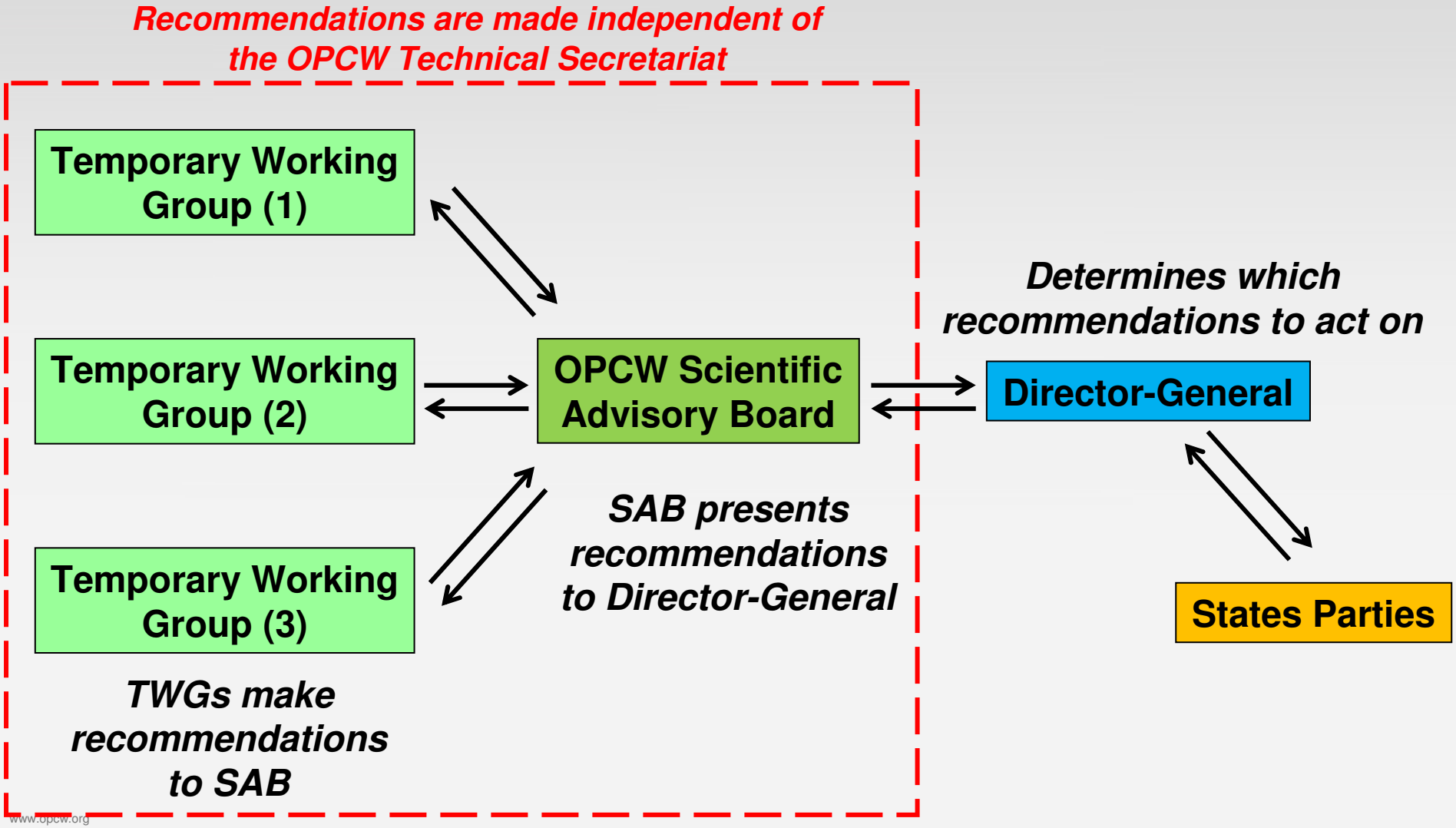
SAB Terms of Reference

- **Independent Experts**
- **Assess developments** in science and technology
  - Emerging technologies
  - Methodologies for verification
- **Provide advice** on proposed changes to the Annex on **Chemicals**
- **Provide scientific and technological advice** relevant to the Convention, including in relation to co-operation and assistance

SAB Temporary Working Groups (TWGs)

- Main work of the SAB is conducted by its working groups
- Chaired by a member of the SAB; additional experts appointed by the Director-General
- TWG recommendations considered by SAB and submitted to the Director-General
- Current TWGs:
  - **Verification**
  - **Education and outreach** – TOR ends in 2014
  - **Convergence** of chemistry and biology – TOR ended in 2013

Mechanism for Bringing SAB Recommendations Forward



SAB Recommandations

- **SAB Report on Developments in S&T to The Third review Conference**

  RC-3/DG.1, Dated 29 October 2012
  www.opcw.org/index.php?eID=dam_frontend_push&docID=15865

- **Director General's Recommendations**

  RC-3/DG.2, Dated 31 January 2013
  www.opcw.org/index.php?eID=dam_frontend_push&docID=16090
  EC=77/DG.11, Dated 5 September 2014
  www.opcw.org/index.php?eID=dam_frontend_push&docID=16090

- **Report of the TWG on the Convergence of Chemistry and Biology**

  SAB/REP/1/14, Dated 26 June 2014
  www.opcw.org/index.php?eID=dam_frontend_push&docID=17438

- **Director General's Response to Report of SAB-21**

  Includes recommendations from Convergence report
  EC-77/DG.10, Dated 5 September 2014
  www.opcw.org/index.php?eID=dam_frontend_push&docID=17603

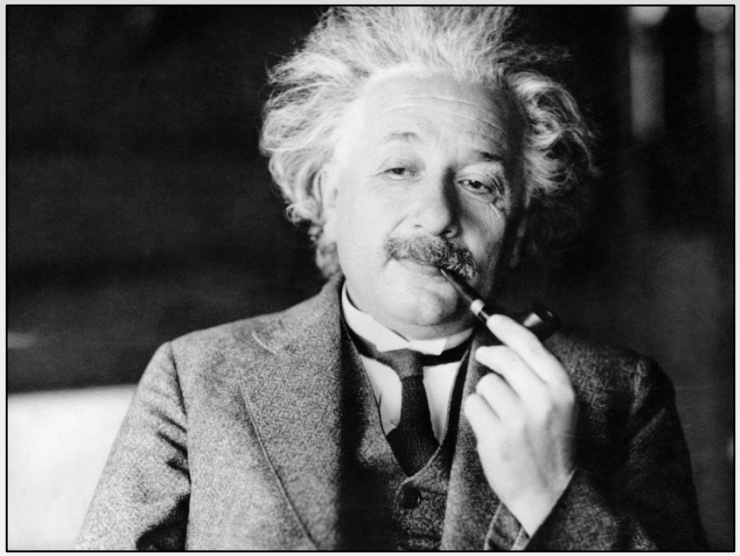
Keeping Abreast of S&T Developments

On Going Activities

- Follow-up activities to SAB Recommendations

- The Secretariat and the SAB continue to augment the capacity to monitor relevant developments in S&T
  - Reviewing scientific literature
  - Engaging with national and international scientific societies and relevant international organisations
  - Developments in S&T Report for RC-4

The Nuances of Science Advice for Policy

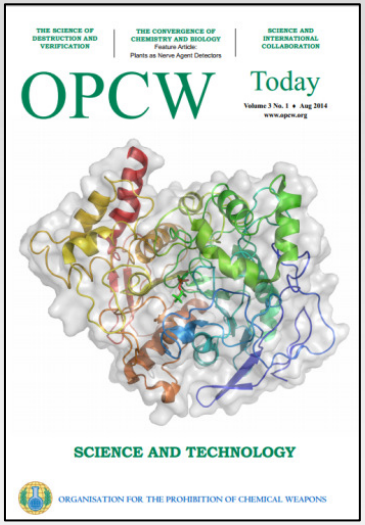


Scientists	Policy Makers
Ask Questions	Seek Answers
Analyze Data	Present Conclusions
Uncertainty	Certainty
Create Solutions	Find Solutions

Science advice is most effective when...

- Questions are clearly phrased and strictly related to S&T
- Technical considerations and are not politicized
- All relevant information (from all sources) is considered
- Sufficient funding is available
  - General Budget
  - Voluntary contributions (Trust Fund)
  - EU Joint Action/Council Decision

Stimulating Greater Engagement with States Parties



- **August Issue of *OPCW Today***
  - Special issue on S&T

- **"Science and Technology for Diplomats"**
  - Next discussion 10 October 2014, 13:30 in the Ooms Room
    - Biomedical sample analysis
    - Previous topics: introduction and chemical analysis
  - On-going series of events on relevant S&T topics
    - Videos of presentations forthcoming
    - December event at CSP-19, convergence themed

Links to SAB Reports and S&T Relevant Information

- Report of the SAB and TWGs

  www.opcw.org/about-opcw/subsidiary-bodies/scientific-advisory-board/documents/reports/

- SAB Related Documents

  www.opcw.org/about-opcw/subsidiary-bodies/scientific-advisory-board/documents/related-documents/

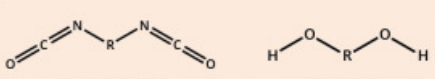
- OPCW Reading Section – often features S&T related content

  www.opcw.org/our-work/readings/

THE CHEMISTRY OF THE WORLD CUP BALL

POLYURETHANE COVERING

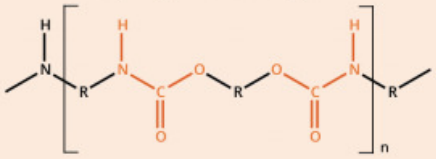
The surface covering of a football is composed of synthetic leather; in professional footballs, this is made from polyurethane polymers. The World Cup ball is made from six polyurethane panels, which are thermally bonded together. This covering protects the ball and minimises water absorption. In cheaper footballs, the coating can be made from PVC.



ISOCYANATE

POLYOL

R represents the portion of the organic molecule that can be varied depending on the specific polyurethane that is being synthesised.

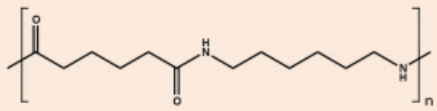


POLYURETHANE
(urethane linkages in orange)

Polyurethane is a polymer - a very large molecule built up from many smaller units bonded together. The basic synthesis of polyurethanes involves the addition reaction of isocyanate and polyol molecules to form urethane groups.

NYLON LINING

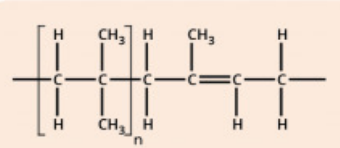
Several layers of lining are used between the covering of the football and the bladder to improve the bounce and strength of the ball. This lining is made of nylon, another class of polymers also known as polyamides. Polyesters can also be used for this purpose.



NYLON 6-6

BUTYL BLADDER

The bladder is the part of the ball in which the air is contained. Butyl rubber is often used because it retains the air better than the other option, latex. However, latex bladders can provide better surface tension.



BUTYL RUBBER