

On the Convergence of Chemistry and Biology

**BWC Meeting of Experts
Lunchtime Side Event, 14 August 2013**

Outline

- **SAB TWG on Convergence in B+C**
- What was the TWG supposed to do ?
- What has the TWG learned – Findings ?
- Questions

SAB TWG Convergence in B+C

Composition

- Chairs Bill Kane, Robert Mathews (1st Mtg), 13 Members (and guest speakers)

Meetings

- Nov. 2011, Sept. 2012, April 2013, **Nov. 2013**

Reports

- TWG reports are attached to SAB reports following TWG meeting
 - Available under: <http://www.opcw.org/about-opcw/subsidiary-bodies/scientific-advisory-board/documents/reports/>

Outline

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- **What was the TWG supposed to do ?**
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Terms of Reference TOR

TOR from OPCW Director-General

- **Biologically Mediated Synthesis** of Chemicals (BMS)
 - Processes used
 - Extent of use in commercial chemical production
 - Application to synthesis of toxic chemicals
 - Application for production of toxins and bioregulators
- **Chemical Synthesis** of agents of bio-origin (e.g. toxins, bioregulators) and of replicating systems

Terms of Reference...

- **Other bio-technological processes** than BMS relevant to CWC
- The **meaning** of 'Production by Synthesis'; CWC VA.IX
- **Benefits** for CWC from Convergence in B+C
- Other disciplines converging in significant way
 - Trigger, warning indicators for game changing events

Outline

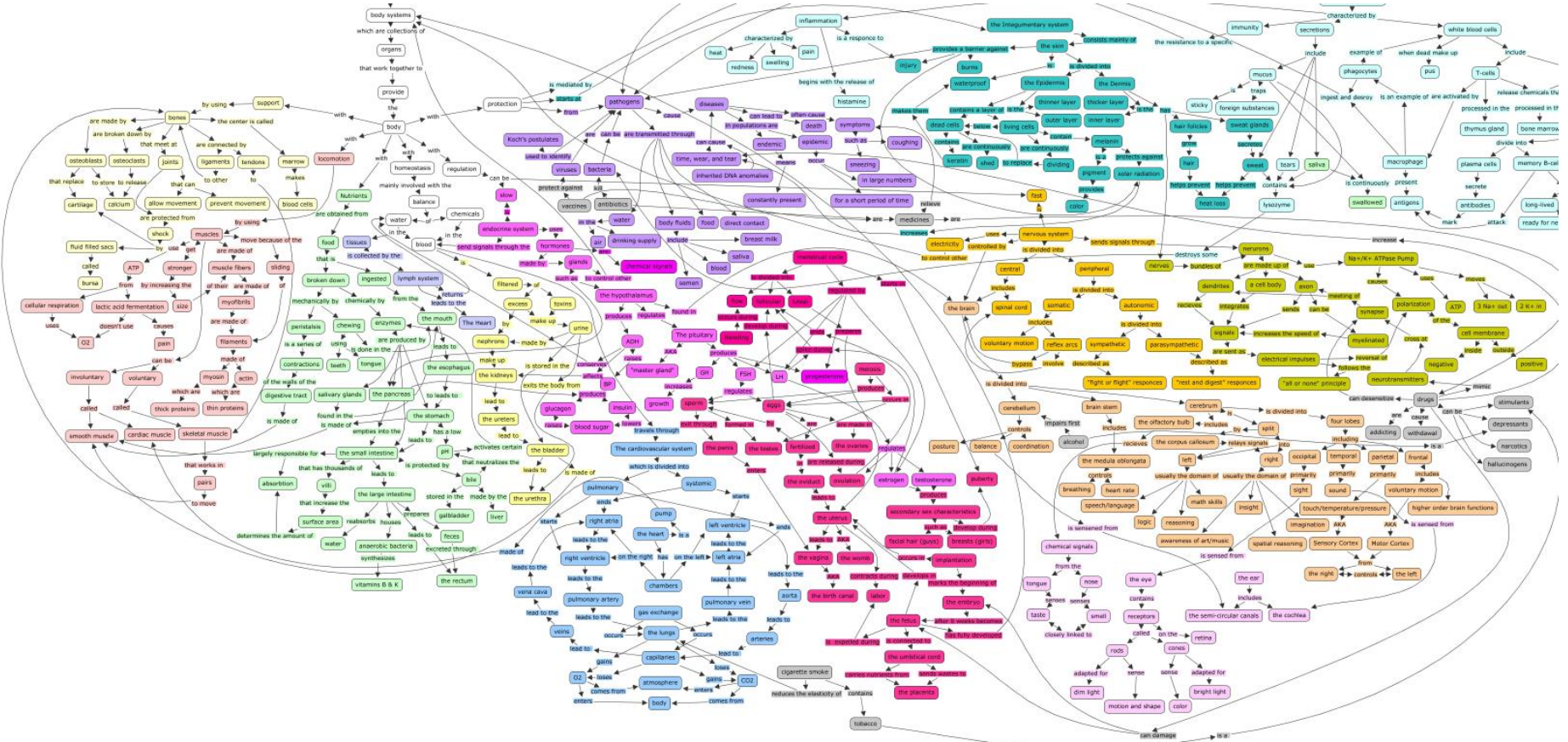
- SAB TWG on Convergence in B+C
- What was the TWG supposed to do ?
- **What has the TWG achieved – Findings ?**
- Questions

Diversity of Discussion



Stefan Mogl
Head of Chemistry, SPIEZ LABORATORY

Complexity of Issues



Stefan Mogl
Head of Chemistry, SPIEZ LABORATORY

Bio-med. Synthesis of Chemicals

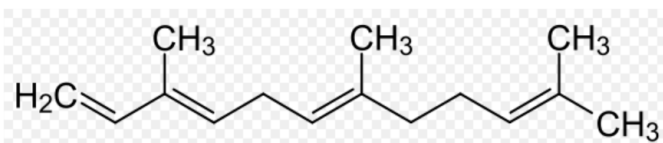
- What is the definition of 'Biologically Mediated'
 - Understanding is that it includes all biological elements in the production of chemicals
- Processes used
 - Metabolic engineering for fermentation based production
 - Enzymes as biocatalysts
 - Industry example: automated process for yeast cell engineering using random mutagenesis
 - Application of microfluids and automation reduce time for identification of scale up candidates

Bio-med. Synthesis of Chemicals

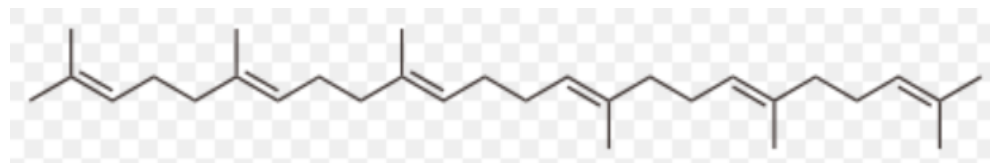
- Extent of use in commercial chemical production
 - Oil price increase and volatility drive growth in bio-based feed stock production routes
 - Large scale production facilities for different alcohols and organic acids and other chemicals

Bio-med. Synthesis of Chemicals

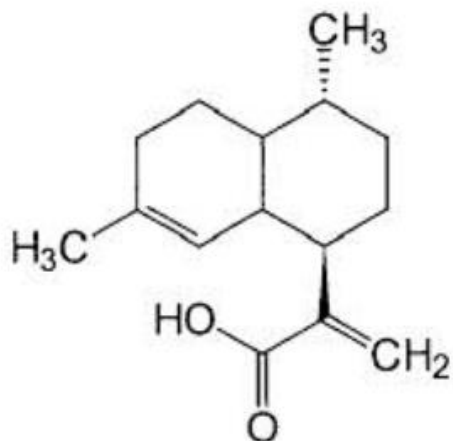
- Extent of use in commercial chemical production...



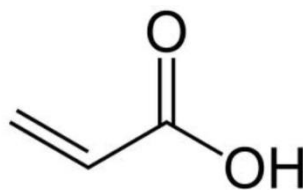
Farnesene



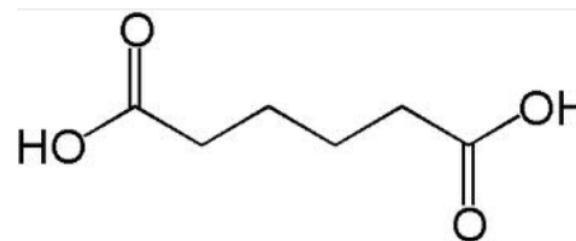
Squalene



Artemisinic acid



Acrylic acid



Adipic acid

Bio-med. Synthesis of Chemicals

- Extent of use in commercial chemical production...
 - Large plants requires: capital investment, process development, scale-up
 - Years pass from lab to operating production plant

Use of BMS for Synthesis of Toxic Chemicals

- BMS currently offers no significant advantage for production of classic chemical warfare agents (CWC, Schedule 1)
 - Assessment may change based on new advances i.e. halogenation by bio-based process
- BMS may offer advantages for new types of toxic chemicals
 - TWG did not study specific examples of new toxic chemicals

Chem. Synthesis of Agents of Biological Origin (e.g. Toxin, bioregulators) and of Replicating Systems

- Significant advances in systems and synthetic biology
- ...as well as in biocatalysis, metabolic pathway engineering, biopharming, chemical DNA synthesis of biological molecules
- TWG concluded that technical capability exists to chemically synthesize with some practical limitations: toxins, bioregulators, peptides
- Concrete example looked at ricin and found that it could be produced by BMS
 - But extraction from castor beans still far easier

Meaning of 'Produced by Synthesis'

CWC, VA.IX

- Relevant for selection of facilities for CWC DOC inspections
- TWG recommends that '**any process designed for the formation of a chemical substance**' should be covered
 - Further discussion necessary to develop technical guidance for identification of relevant facilities

Benefits from Convergence for Countermeasures

- Medical countermeasures
 - Protein based drugs for prophylactic treatment
 - Nano carriers to improve penetration of antidotes through blood brain barrier
- Agent detection
 - Based on molecular recognition similar to antibodies and antigens

Benefits from Convergence for Countermeasures

- Personal protection
 - Nanomaterials to improve effectiveness of canisters and protective suits
- Decontamination
 - Use of enzymes for decontamination of nerve agents

Future Work

- TWG 4th meeting in November 2013
 - Enzyme design
 - Use of engineered plants for vaccine production
 - Summary report with recommendations for OPCW DG
 - ...
- Structured process to continue monitoring effects of convergence on BWC and CWC
 - Possibly inside and outside of regimes