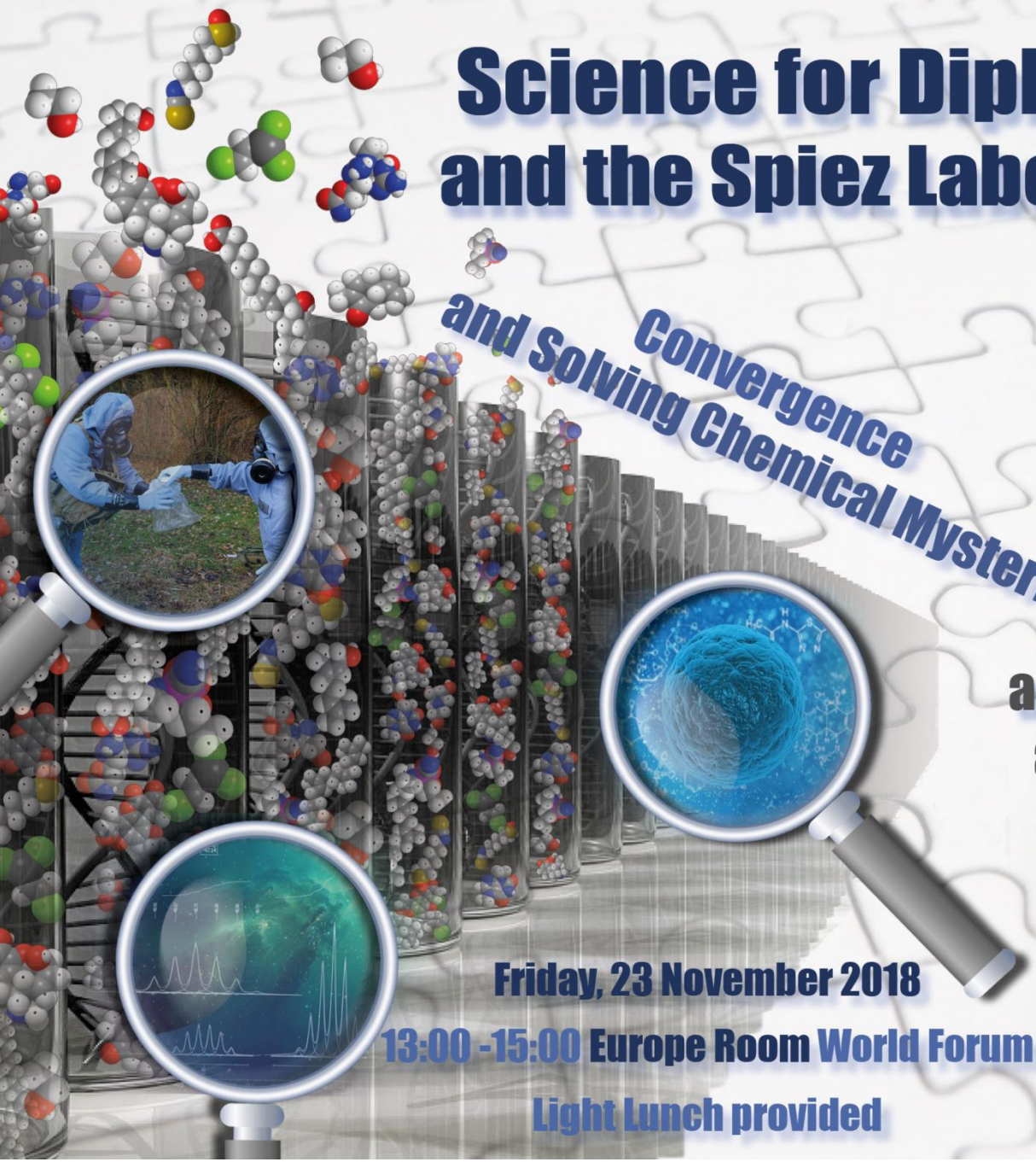
Science for Diplomats at RC-4 and the Spiez Laboratory Present:

Convergence and Solving Chemical Mysteries



a Transdisciplinary Look at Scientific Advances and Problem Solving

Friday, 23 November 2018

13:00 -15:00 Europe Room World Forum

Light Lunch provided

OPCW

Solving the mystery

OPCW Science for Diplomats

Solving a Chemical Mystery

Your task is to determine the provenance of the "sample" before you. Just follow these instructions!

In front of you sit results from a sample analysis provided by our chemical and biological analysis laboratory, along with a puzzle that indicates where your sample may have been collected.
Your task is as follows: Solve the puzzle (we recommend collaboration) and then consider the chemical analysis.

1. Do the chemical analysis results suggest the presence of a chemical weapon agent? If so, which one?
   - This can be determined by recognizing degradation products and/or data that can be found on the "Degradation and Analysis of Scheduled Chemicals" handout.
   - To assist your interpretation of the data, refer to the back of this card.
   - When you are ready, raise your molecule and one of our capable assistants will check your answer and provide you with additional information.

Agent =

2. In addition to the analytical results, other evidence has been collected that requires consideration and perhaps more puzzle building. Use this additional information to match your sample to the site (A-K) from which it was collected.

3. One last question: is your sample actually from a Chemical Weapon agent?

Yes No

A, B, C, D, E, F, G, H, I, J, K

Circle the answer

Good Luck!

This exercise has been brought to you by Sofia Sola Sancho, Maria Hemme, Nadine Gürer and Jonathan Forman, as part of Science for Diplomats at RC4 and the Spiez Laboratory Present: Convergence and Solving Chemical Mysteries, a Transdisciplinary Look at Scientific Advances and Problem Solving

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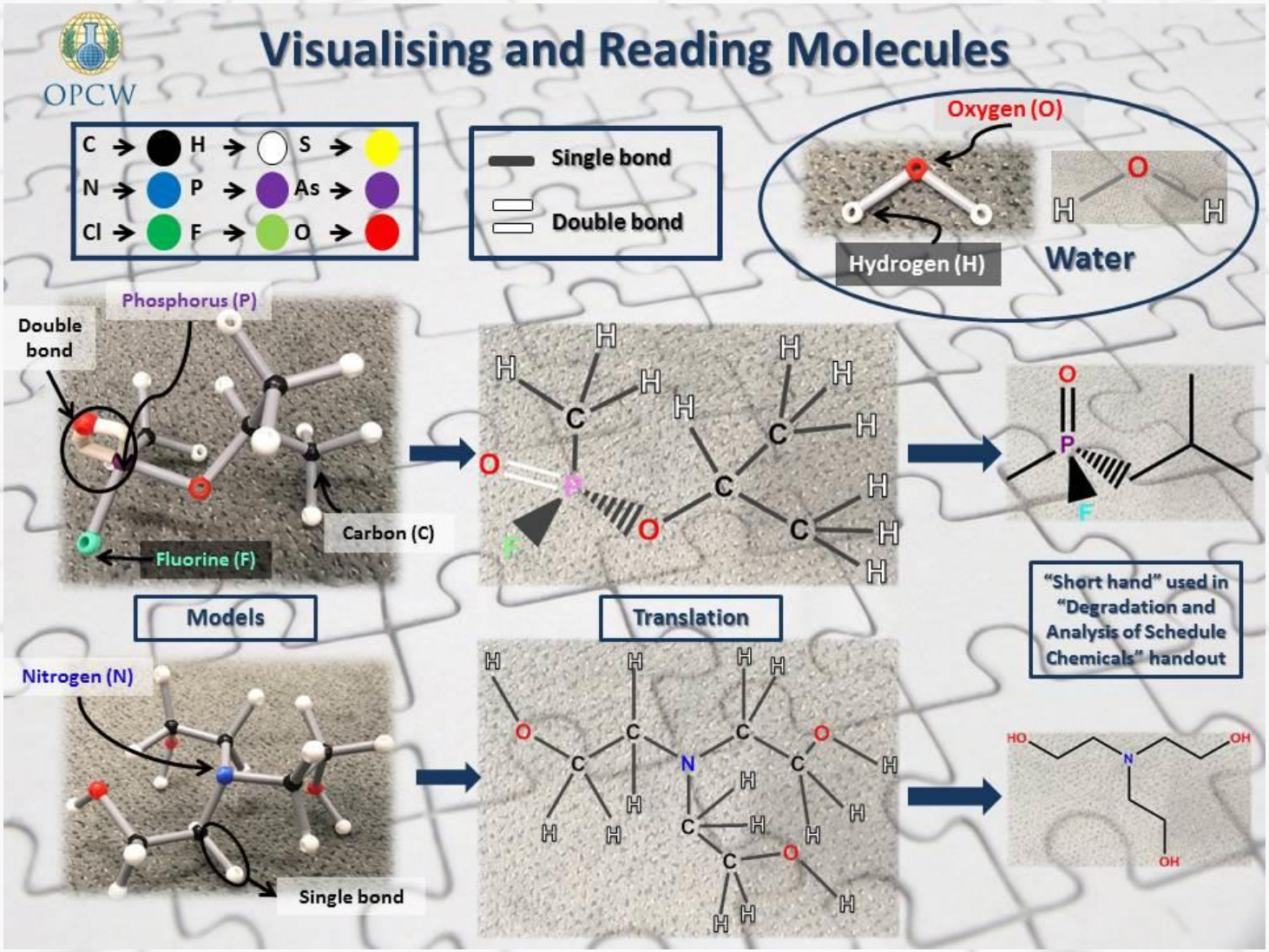
Solving the mystery



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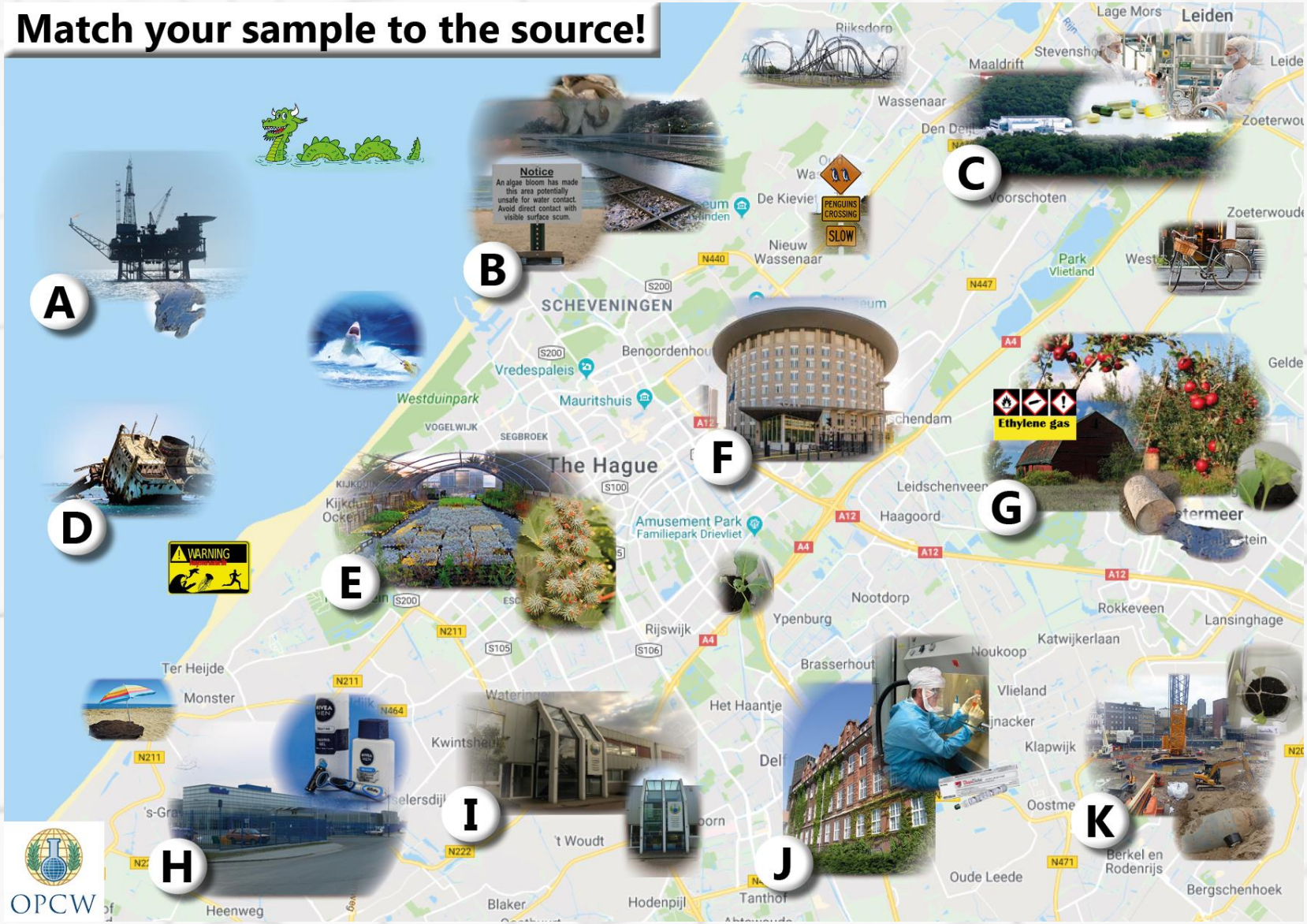
Match your sample to the source!

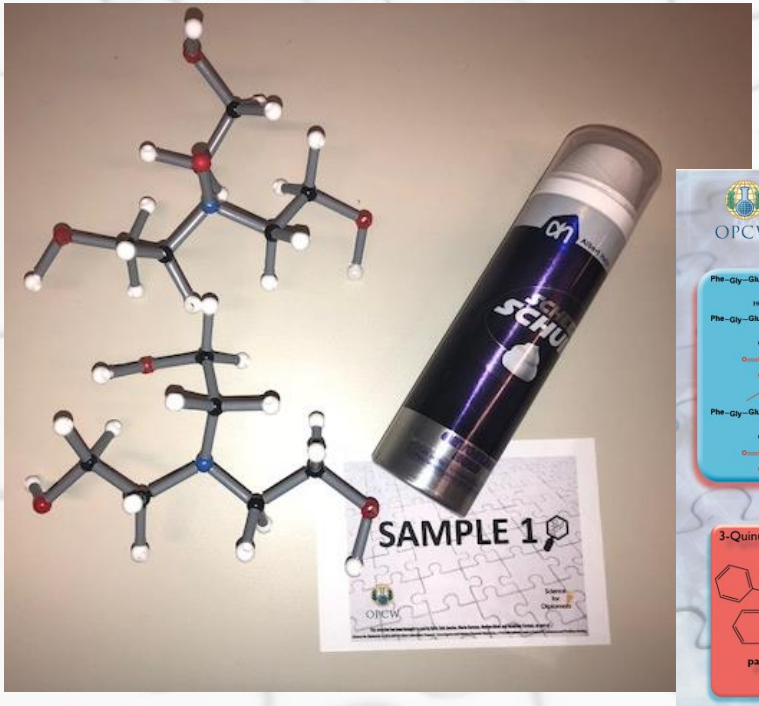


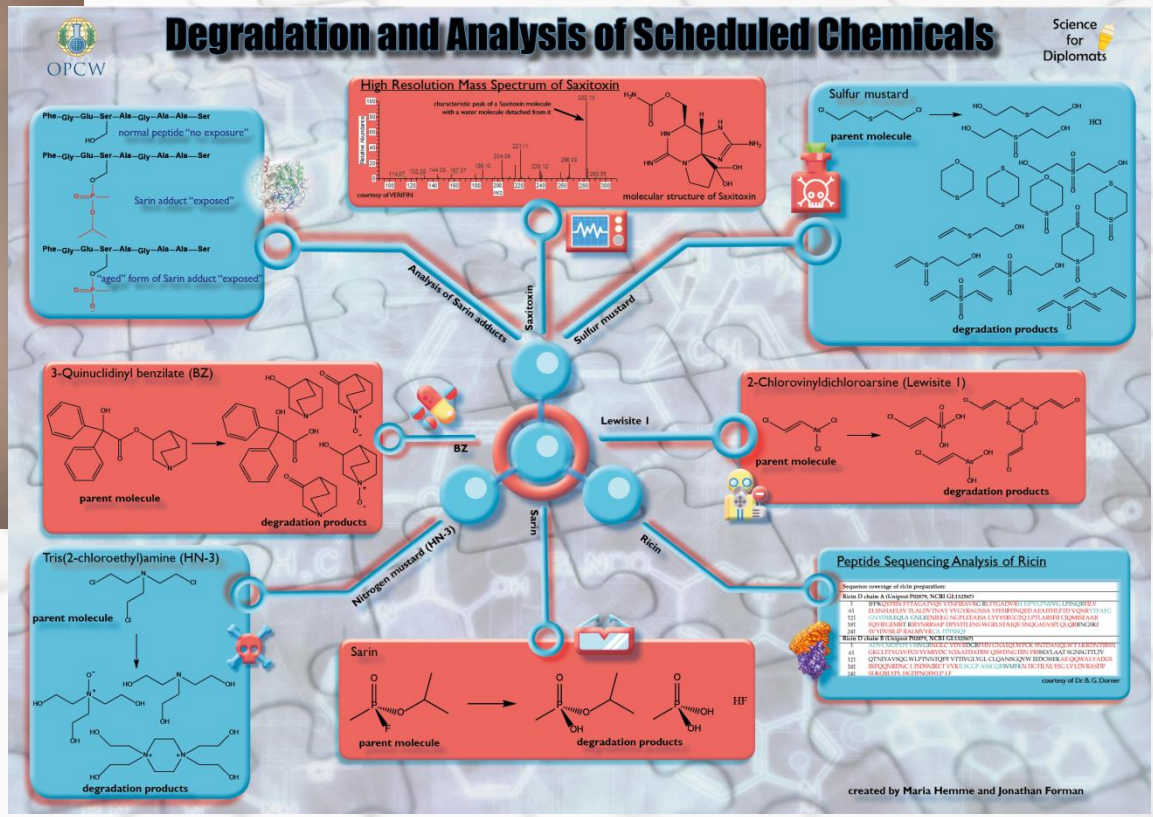
Go to:

- [Sample 1]
- [Sample 2]
- [Sample 3]
- [Sample 4]
- [Sample 5]
- [Sample 6]
- [Sample 7]

Follow the instructions:

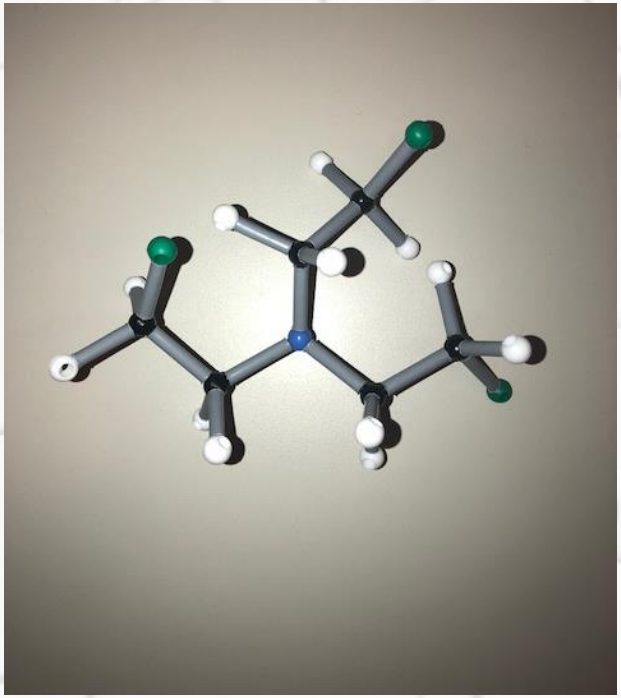
1. Identify Sample 1 on the Degradation and Analysis of Scheduled Chemicals poster. A guide on how to read molecular structures is available here.
2. Is it a degradation product of a chemical weapon? If yes, which one?
3. Open the source location puzzle.
4. Using other clues in the photo, can you determine where your sample was collected?
5. Did it actually come from a Chemical Weapon Agent?





Solution:

Sample 1: Possible degradation products of HN-3



Nitrogen mustard (HN-3)

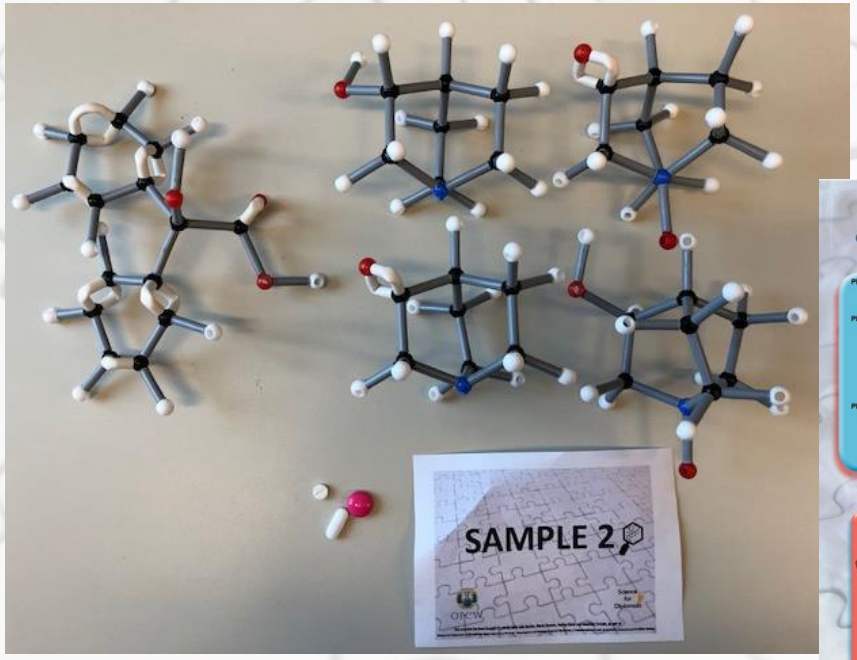
Site H : (shaving cream production facility)

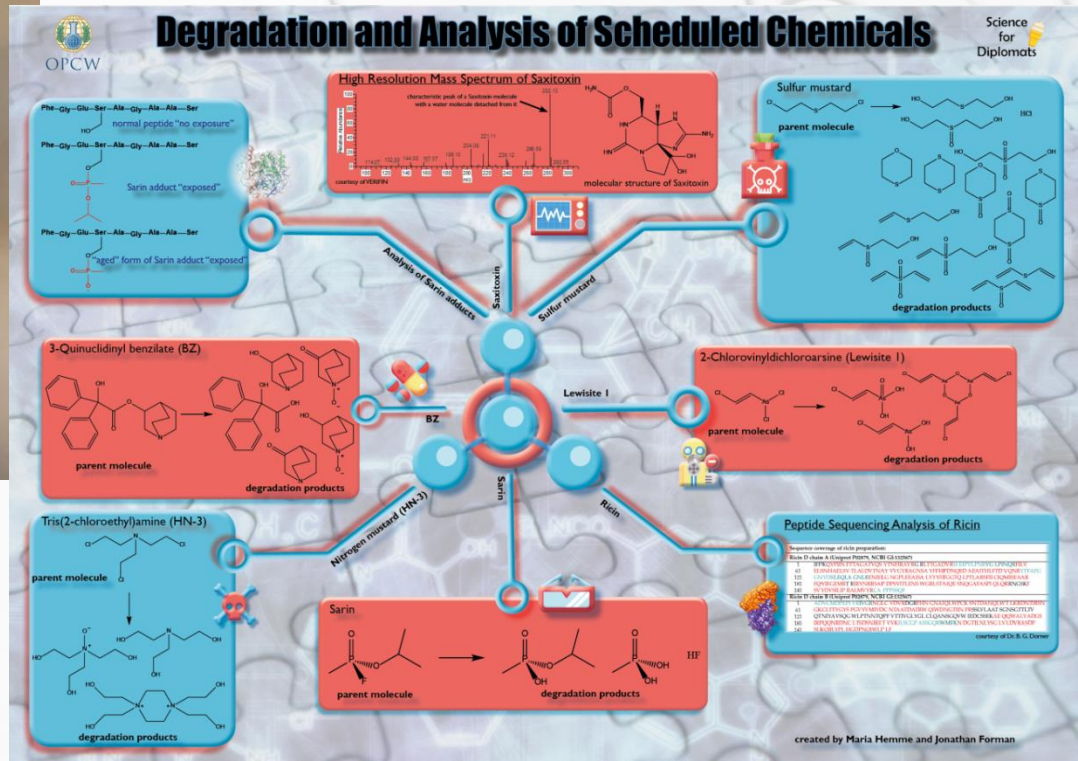
Triethanolamine is used in the manufacture of shaving cream.

Sample 1 is not a Chemical Weapon agent

Follow the instructions:

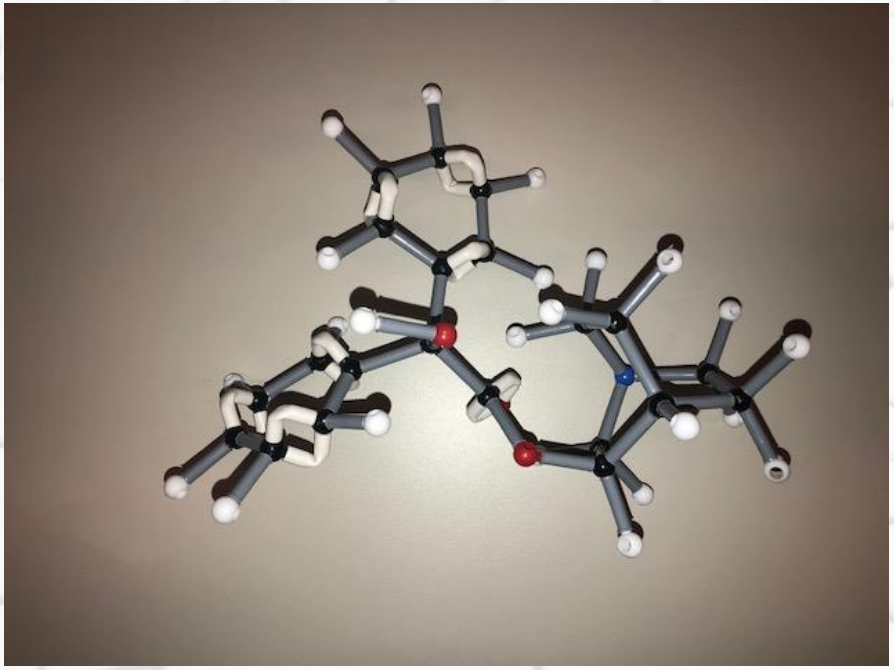
1. Identify Sample 2 on the Degradation and Analysis of Scheduled Chemicals poster. A guide on how to read molecular structures is available here.
2. Is it a degradation product of a chemical weapon? If yes, which one?
3. Open the source location puzzle.
4. Using other clues in the photo, can you determine where your sample was collected?
5. Did it actually come from a Chemical Weapon Agent?





Solution:

Sample 2: Possible degradation products of BZ



BZ

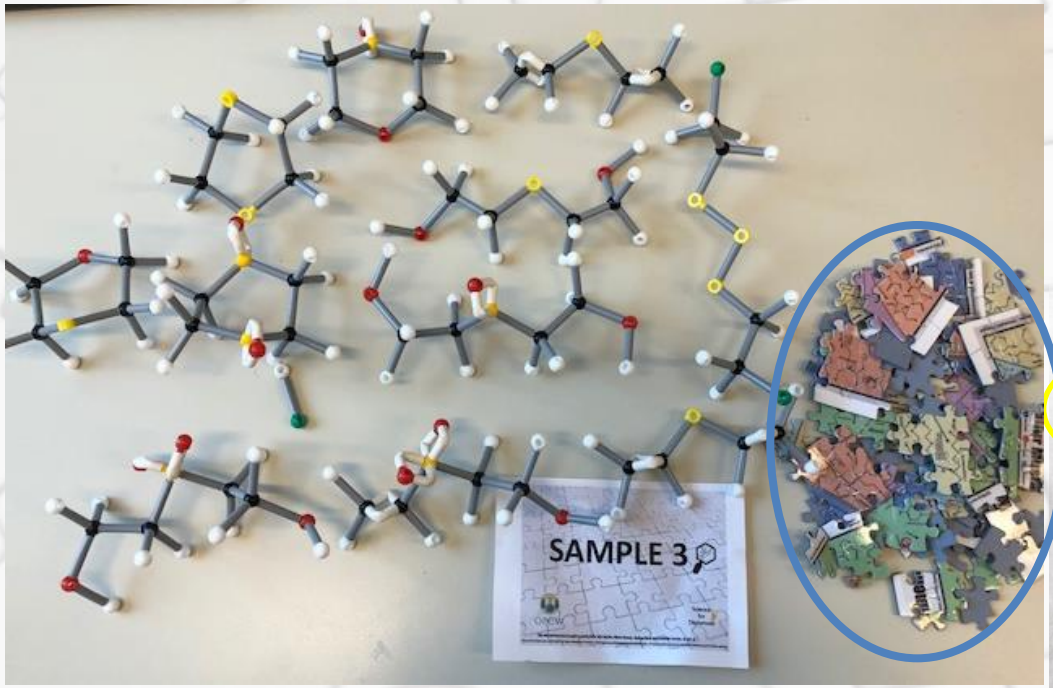
Site C (Pharmaceutical Production Facility)

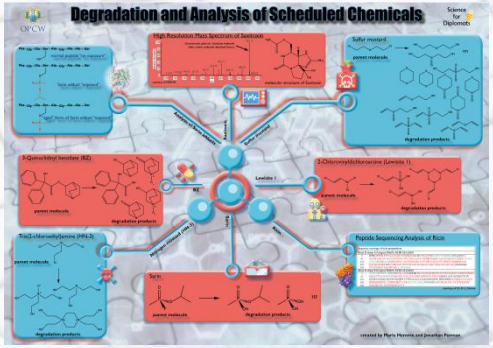
BZ precursors are used in the manufacturing of pharmaceuticals.

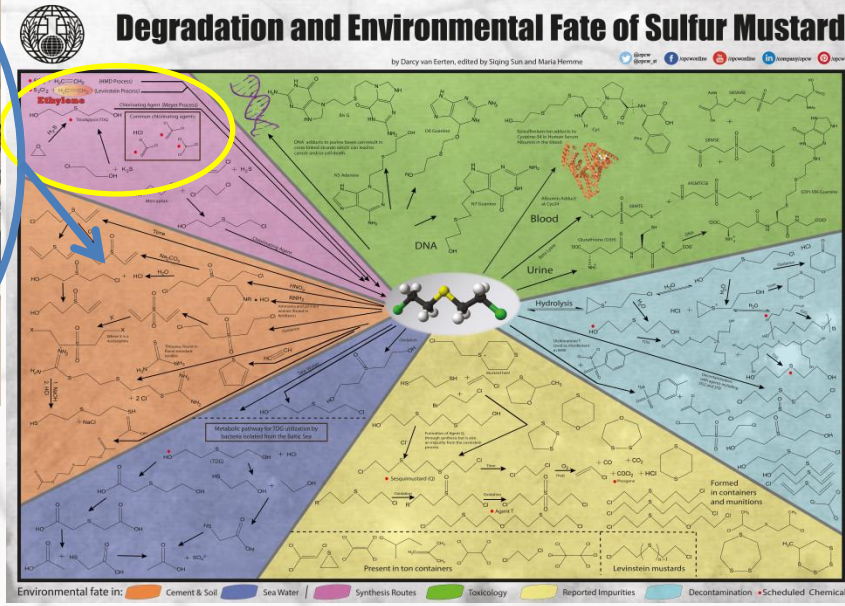
Sample 2 is not a Chemical Weapon Agent

Follow the instructions:

1. Identify Sample 3 on the Degradation and Analysis of Scheduled Chemicals poster. A guide on how to read molecular structures is available here.
2. Is it a degradation product of a chemical weapon? If yes, which one?
3. Open the source location puzzle.
4. Using other clues in the photo, can you determine where your sample was collected?
5. Did it actually come from a Chemical Weapon Agent?

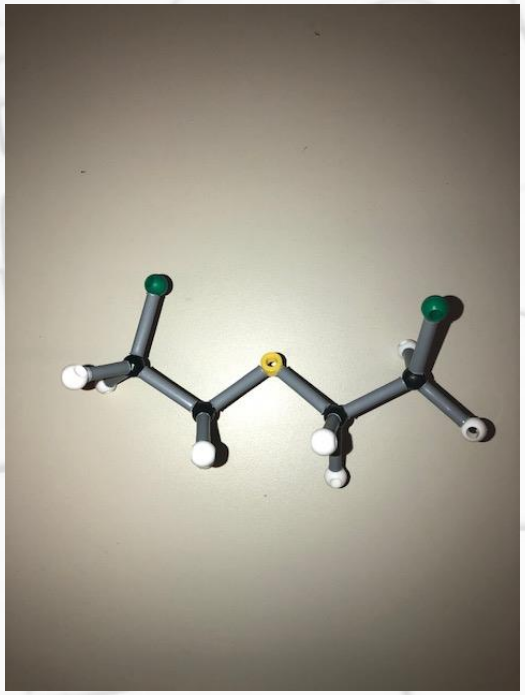






Solution:

Sample 3: Possible degradation products of Sulfur mustard



Sulfur Mustard

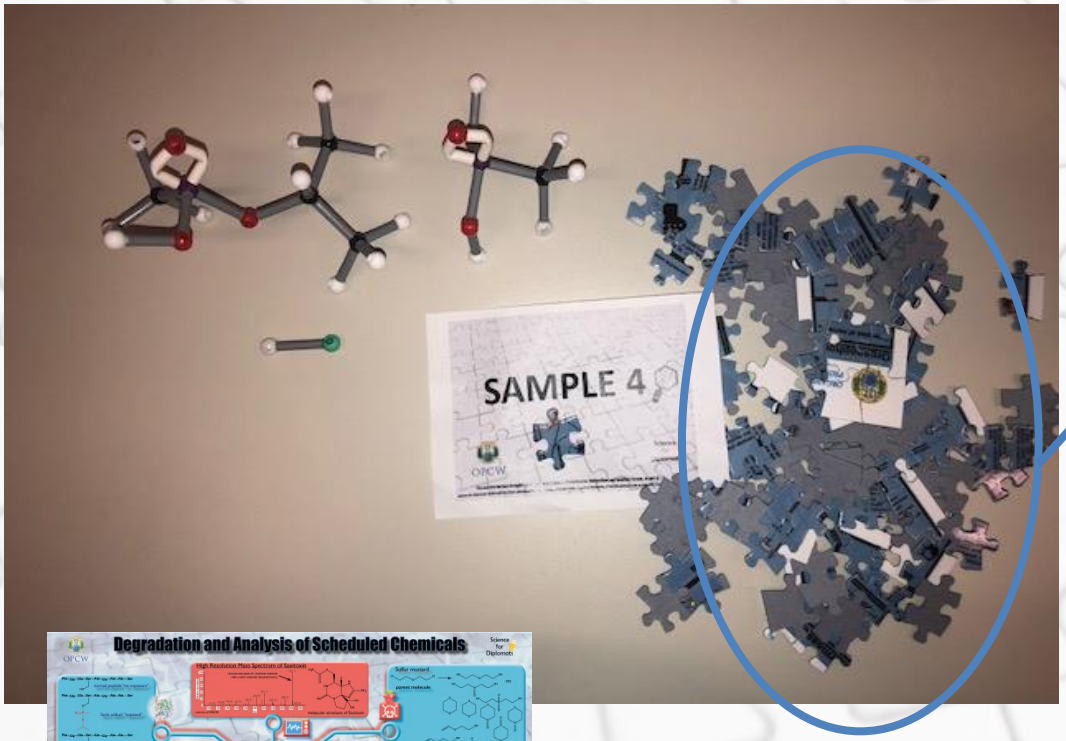
Site G (barn at the orchard)

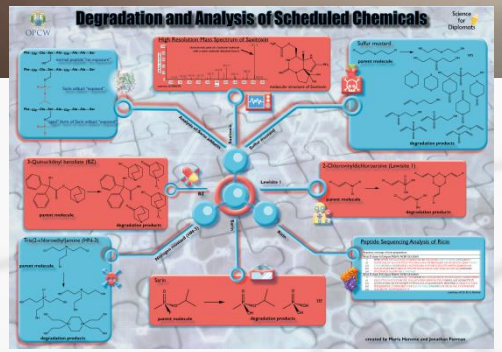
The fruit ripening gas Ethylene can be used to produce Sulfur Mustard by the Levenstein process.

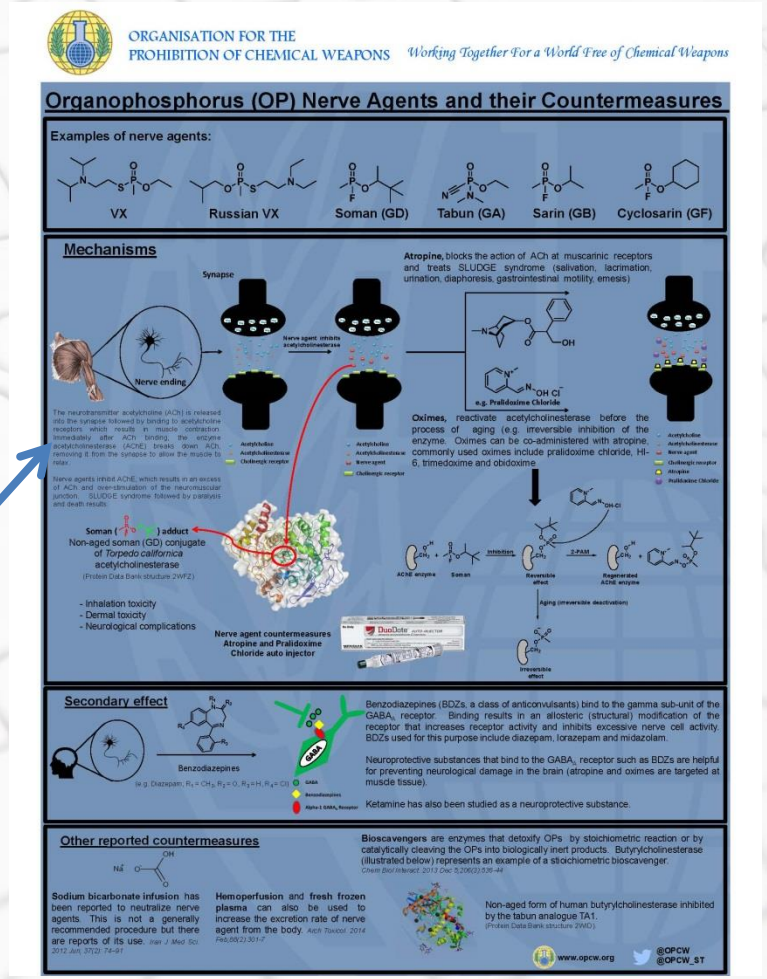
Sample 3 is from a Chemical Weapon Agent

Follow the instructions:

1. Identify Sample 4 on the Degradation and Analysis of Scheduled Chemicals poster. A guide on how to read molecular structures is available here.
2. Is it a degradation product of a chemical weapon? If yes, which one?
3. Open the source location puzzle.
4. Using other clues in the photo, can you determine where your sample was collected?
5. Did it actually come from a Chemical Weapon Agent?

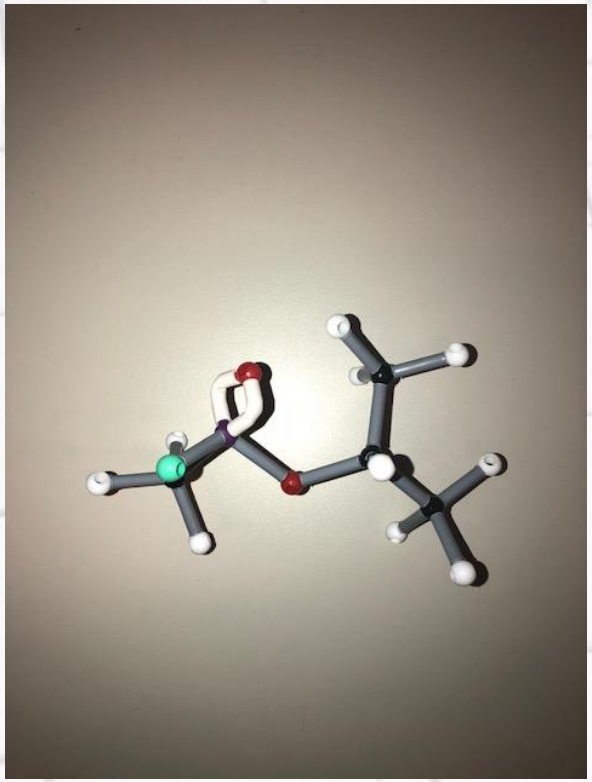






Solution:

Sample 4: Possible degradation products of Sarin



Sarin

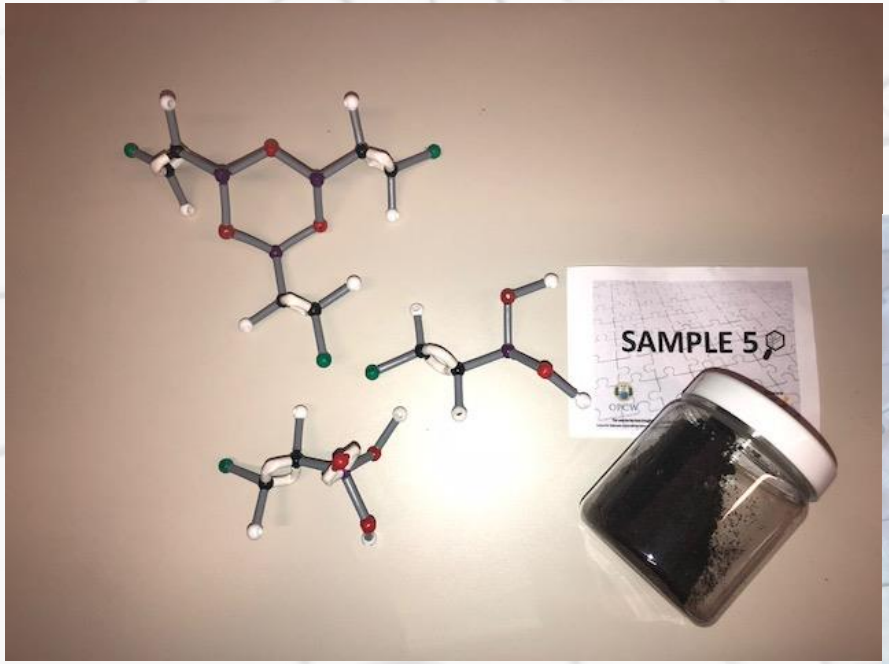
Site J (biomedical research facility)

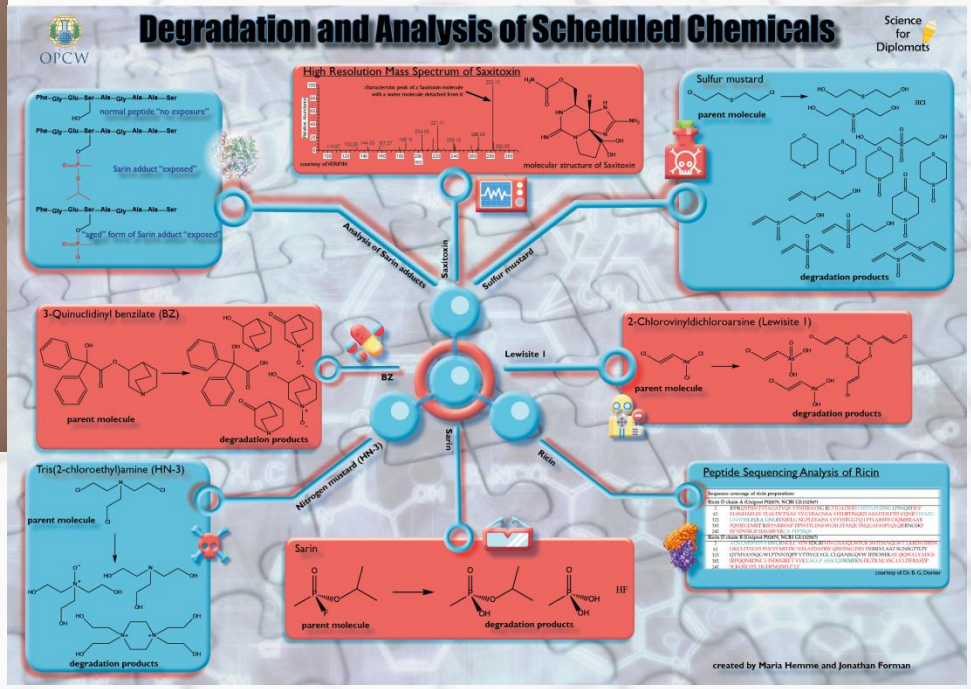
Sarin is used at this site for research on medical countermeasures.

Sample 4 is a Chemical Weapon Agent used for non-prohibited purposes

Follow the instructions:

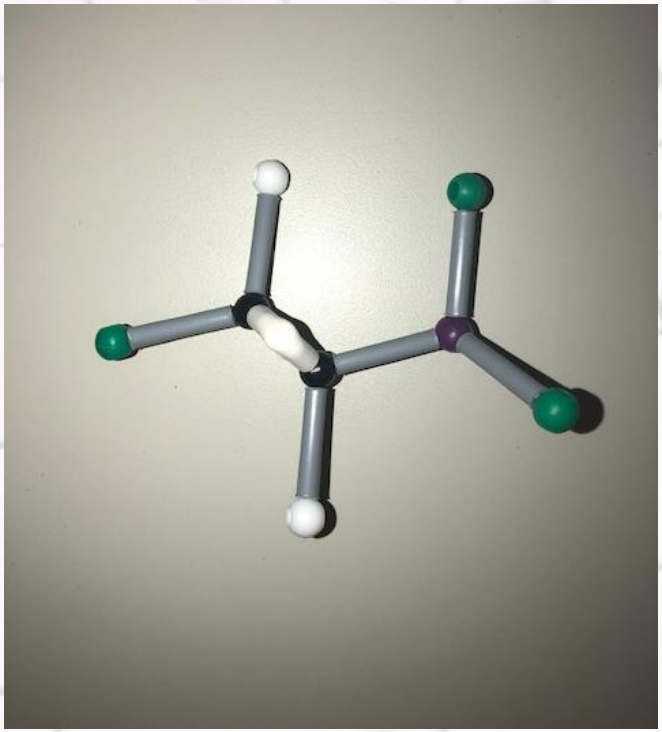
1. Identify Sample 5 on the Degradation and Analysis of Scheduled Chemicals poster. A guide on how to read molecular structures is available here.
2. Is it a degradation product of a chemical weapon? If yes, which one?
3. Open the source location puzzle.
4. Using other clues in the photo, can you determine where your sample was collected?
5. Did it actually come from a chemical weapon agent?





Solution:

Sample 5: Possible degradation products of Lewisite 1



Lewisite 1

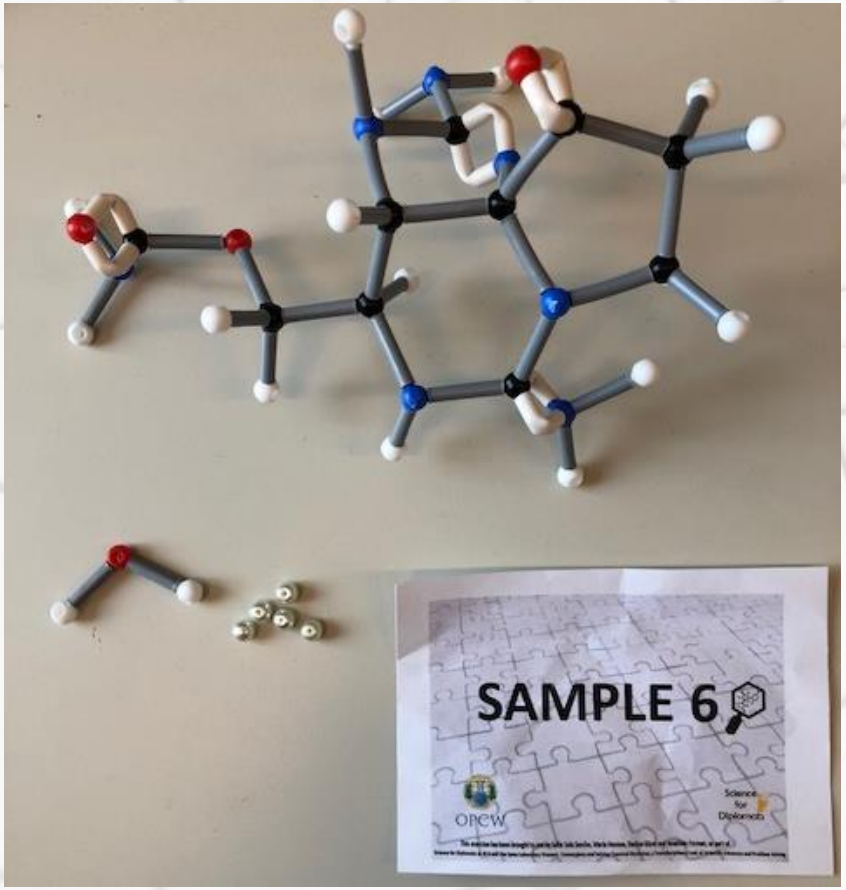
Site K (dig site)

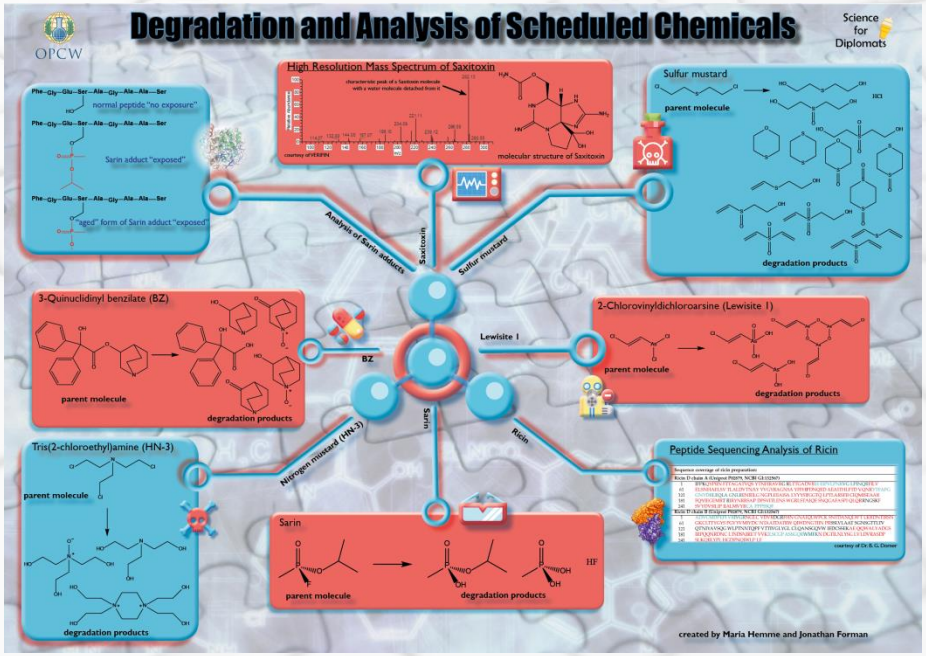
An old munition containing Lewisite 1 was found in the K dig site.

Sample 5 is from a Chemical Weapon Agent

Follow the instructions:

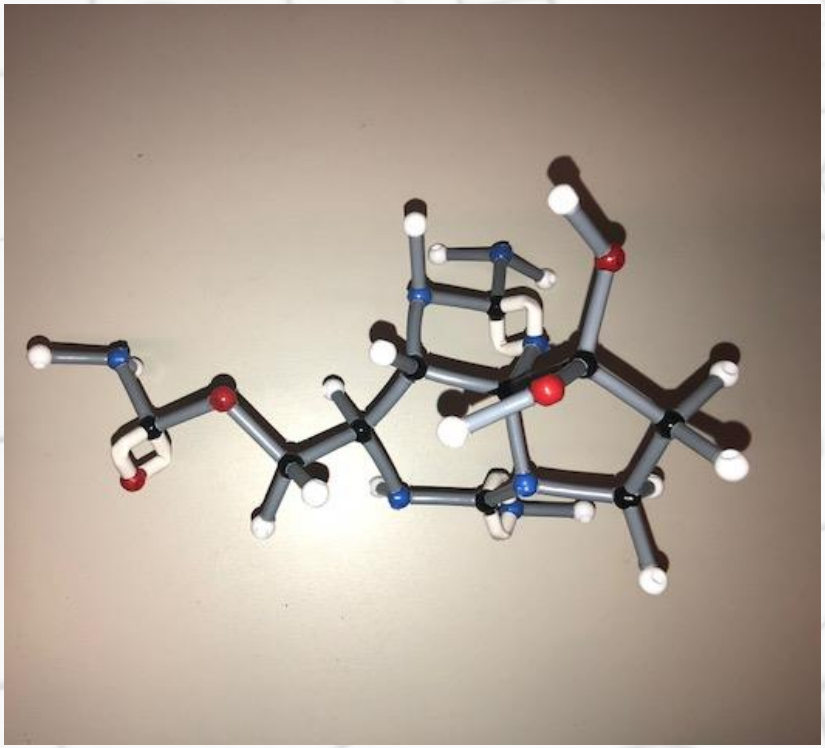
1. Identify Sample 6 on the Degradation and Analysis of Scheduled Chemicals poster. A guide on how to read molecular structures is available here.
2. Is it a degradation product of a chemical weapon? If yes, which one?
3. Open the source location puzzle.
4. Using other clues in the photo, can you determine where your sample was collected?
5. Did it actually come from a Chemical Weapon Agent?





Solution:

Sample 6: Characteristic molecular ion seen in a Mass Spectrum of Saxitoxin



Saxitoxin

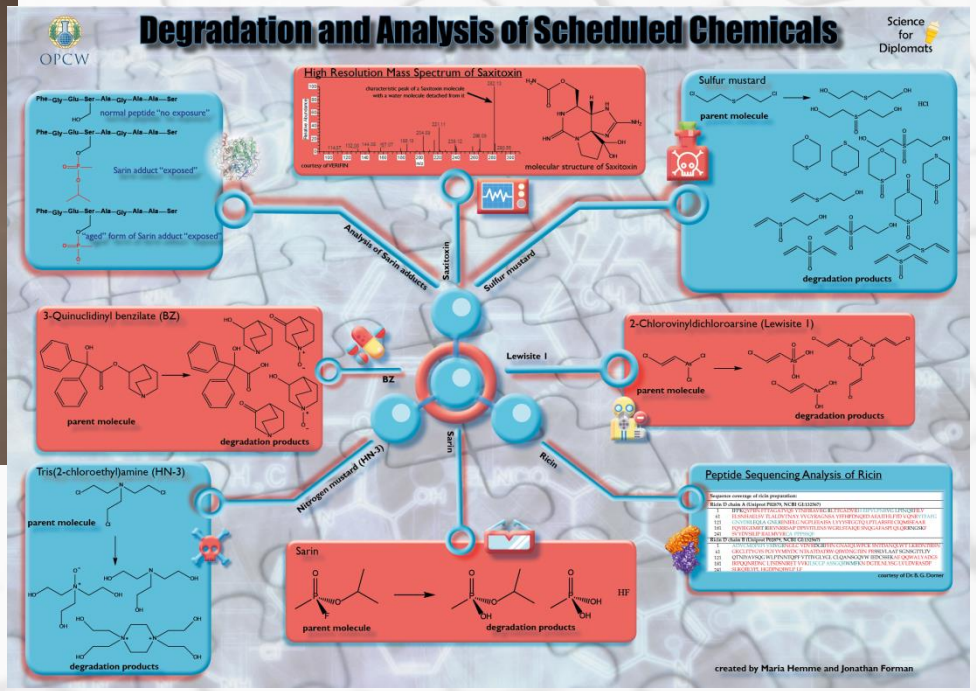
Site B (red algae contamination in oyster farm)

Saxitoxin (STX) is a potent neurotoxin and the best-known paralytic shellfish toxin (PST). Saxitoxin is naturally produced by red algae.

While Sample 6 could be considered a Chemical Weapon. However, the red algae are not producing it with intent to proliferate chemical weapons use by humans.

Follow the instructions:

1. Identify Sample 7 on the Degradation and Analysis of Scheduled Chemicals poster by solving the cube puzzles.
2. Is it a degradation product of a chemical weapon? If yes, which one?
3. Open the source location puzzle.
4. Using other clues in the photo, can you determine where your sample was collected?
5. Did it actually come from a Chemical Weapon Agent?



Solution:

Sample 7: Peptide Sequencing Analysis of Ricin

Site E (castor plant nursery)

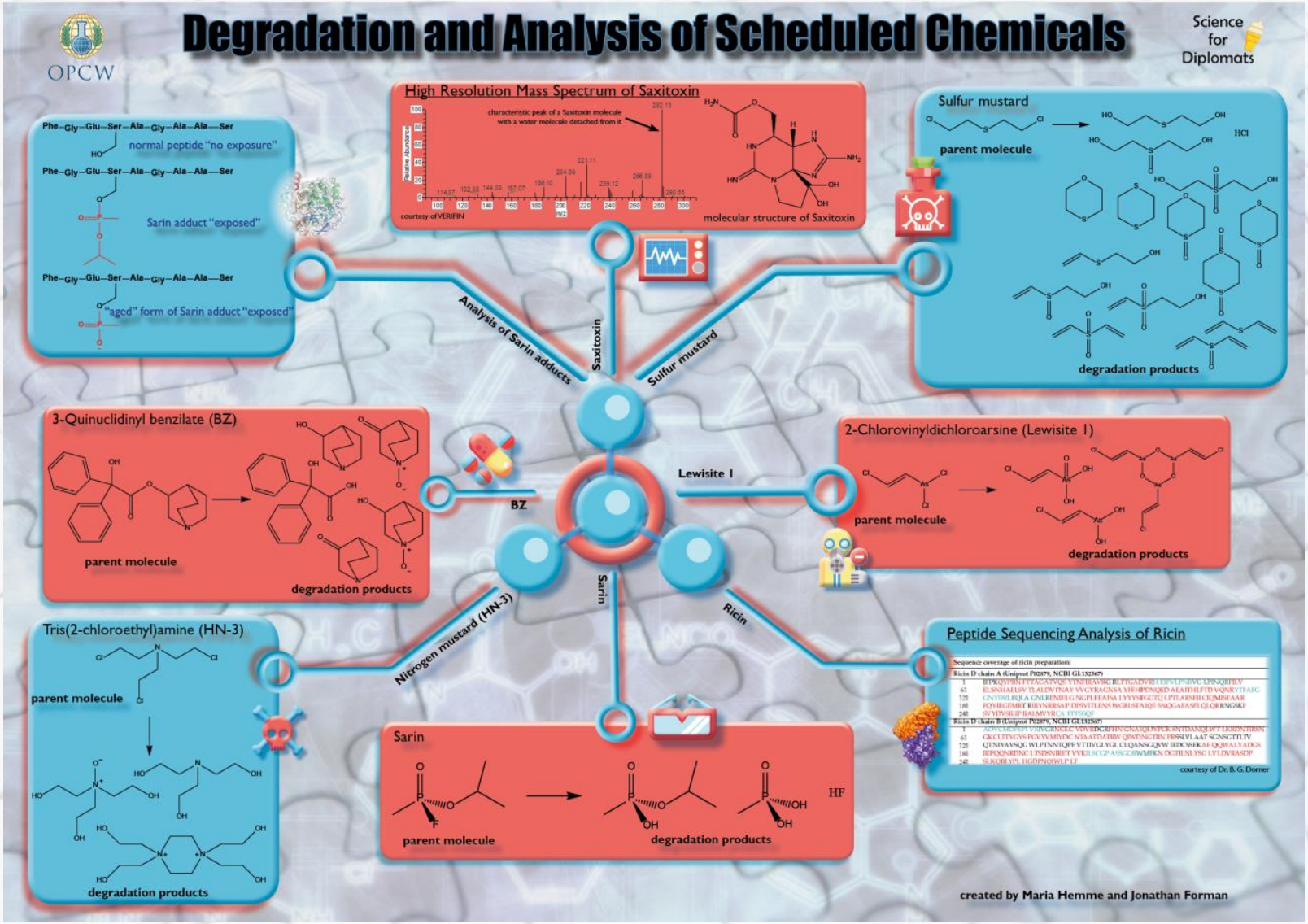
Sequence 1 = LEQLAGNLR

Sequence 2 = YTFAFGGNYDR

Characteristic peptide sequences of Ricin D Chain A

Ricin is a lectin produced in the seeds of the castor oil plant, Ricinus communis.

While Sample 7 could be considered as coming from a Chemical Weapon Agent, the nursery growing casot plants for non-prohibited purposes (plants to decorate gardens)



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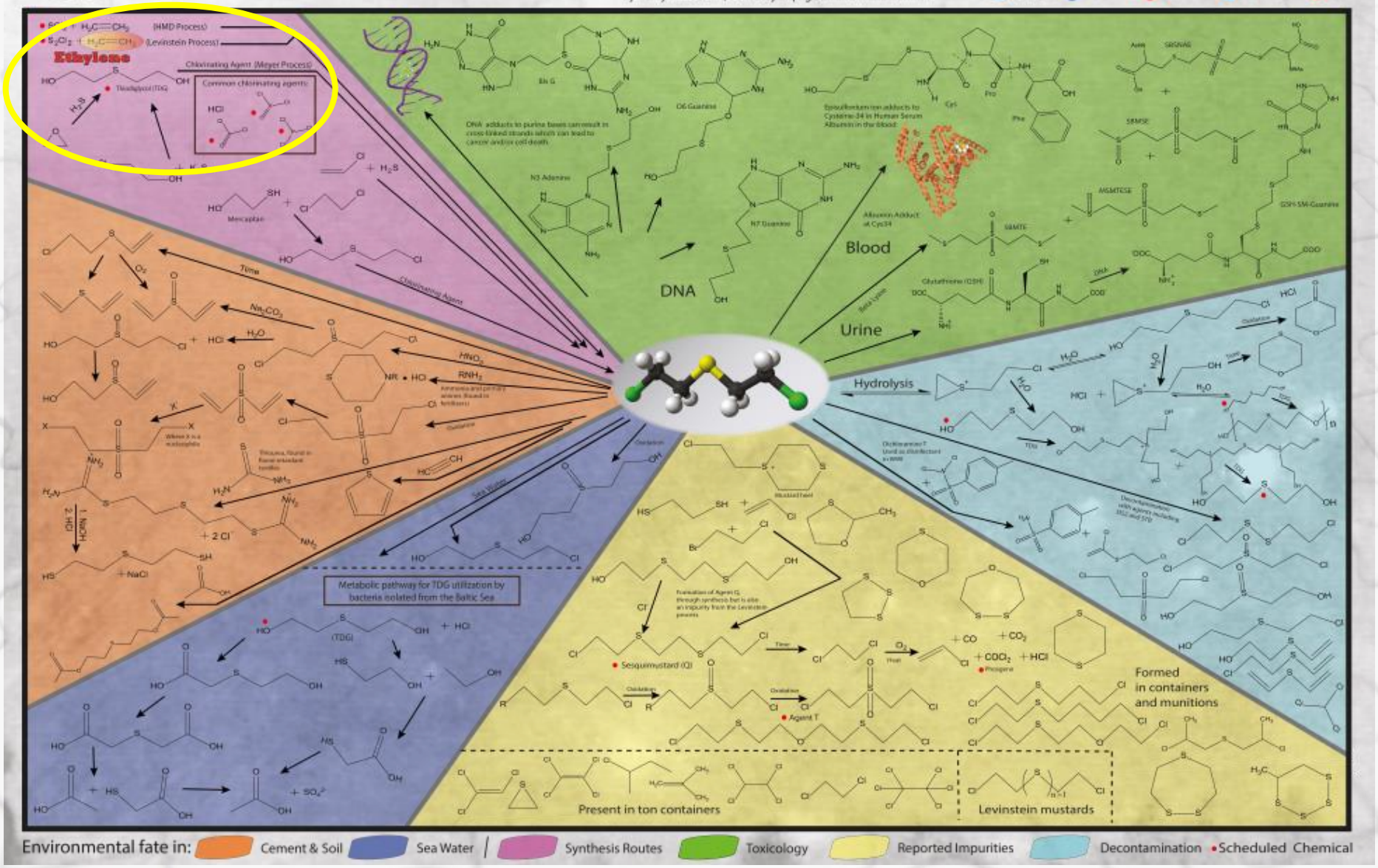
Degradation and Environmental Fate of Sulfur Mustard

by Darcy van Eerten, edited by Siqing Sun and Maria Hemme



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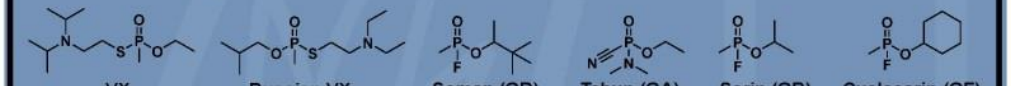
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

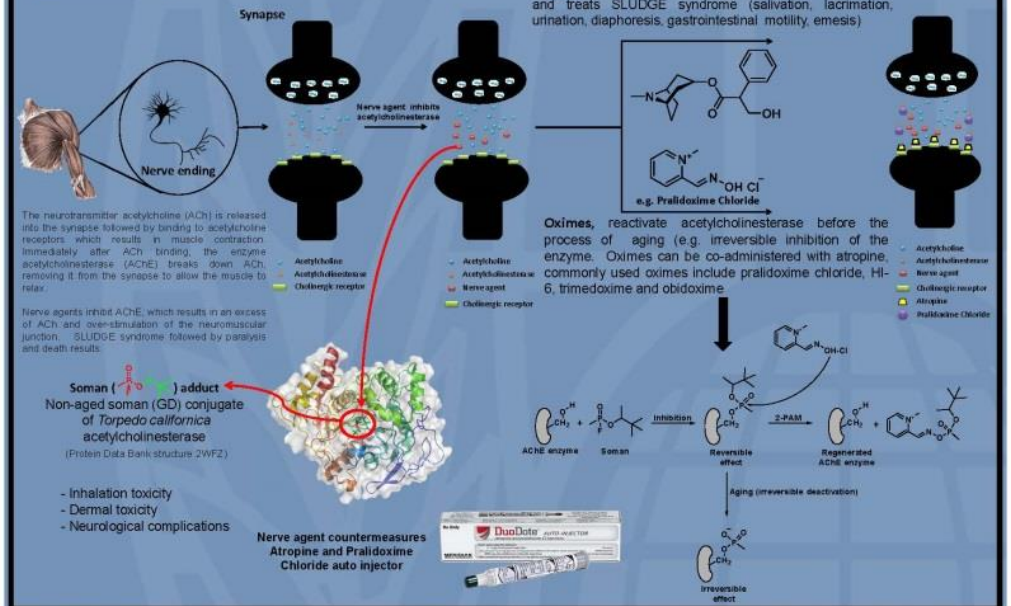
Working Together For a World Free of Chemical Weapons

Organophosphorus (OP) Nerve Agents and their Countermeasures

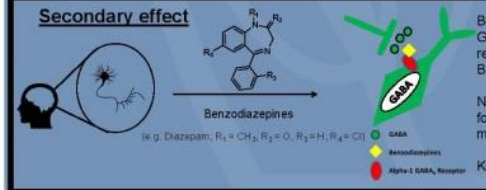
Examples of nerve agents:



Mechanisms



Secondary effect

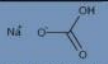


Benzodiazepines (BDZs, a class of anticonvulsants) bind to the gamma sub-unit of the $GABA_A$ receptor. Binding results in an allosteric (structural) modification of the receptor that increases receptor activity and inhibits excessive nerve cell activity. BDZs used for this purpose include diazepam, lorazepam and midazolam.

Neuroprotective substances that bind to the $GABA_A$ receptor such as BDZs are helpful for preventing neurological damage in the brain (atropine and oximes are targeted at muscle tissue).

Ketamine has also been studied as a neuroprotective substance.

Other reported countermeasures



Sodium bicarbonate infusion has been reported to neutralize nerve agents. This is not a generally recommended procedure but there are reports of its use. *Iran J Med Sci. 2012 Jun; 37(2): 74–81*

Hemoperfusion and **fresh frozen plasma** can also be used to increase the excretion rate of nerve agent from the body. *Arch Toxicol. 2014 Feb;88(2):301-7*

Bioscavengers are enzymes that detoxify OPs by stoichiometric reaction or by catalytically cleaving the OPs into biologically inert products. Butyrylcholinesterase (illustrated below) represents an example of a stoichiometric bioscavenger. *Chem Biol Interact. 2013 Dec 5;206(3):536-44*

Non-aged form of human butyrylcholinesterase inhibited by the tabun analogue TA1.
(Protein Data Bank structure 2WID).

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