OPCW

Organisation for the Prohibition of Chemical Weapons

The Chemical Universe: Scheduled and Unscheduled

Science for Diplomats at EC-88
The Hague, 10 July 2018

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Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1

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

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

(b) It poses otherwise a high risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention because one or more of the following conditions are met:

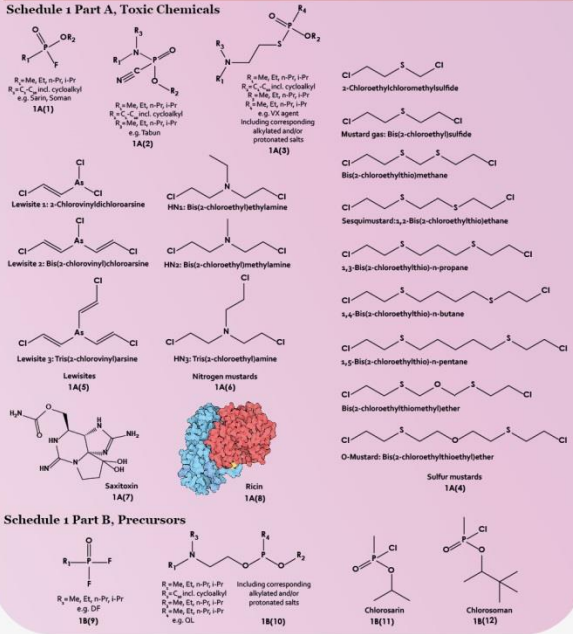
(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparableproperties;

(ii) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;

(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;

(c) It has little or no use for purposes not prohibited under this Convention.

Schedule 1 Part A, Toxic Chemicals



Schedule 1 Part B, Precursors

Schedule 2

Guidelines for Schedule 2

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

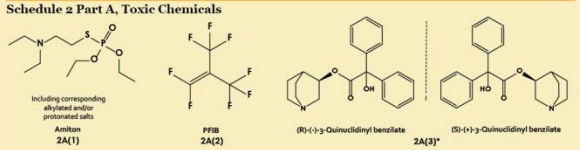
(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;

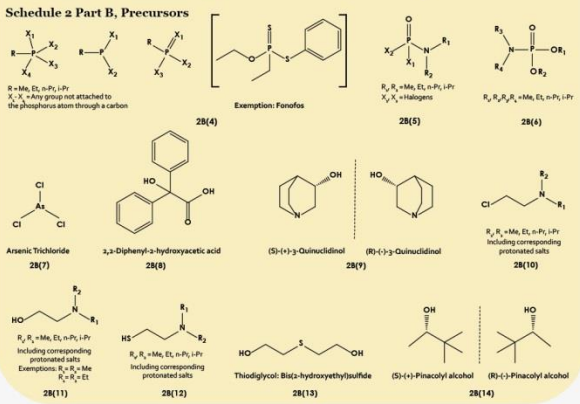
(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2, part A;

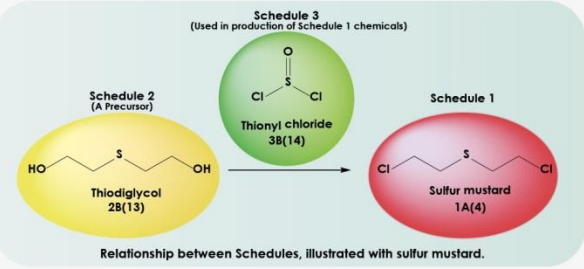
(d) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 2 Part A, Toxic Chemicals



Schedule 2 Part B, Precursors





Schedule 3

Guidelines for Schedule 3

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

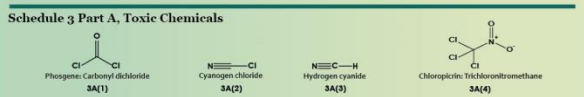
(a) It has been produced, stockpiled or used as a chemical weapon;

(b) It poses otherwise a risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that might enable it to be used as a chemical weapon;

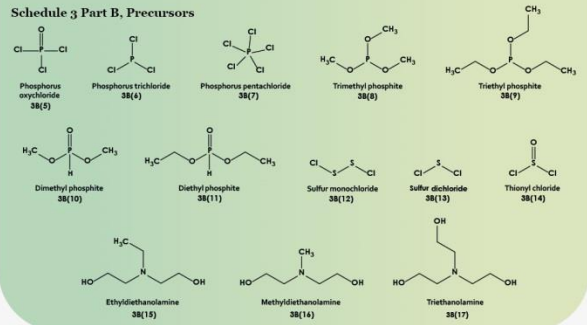
(c) It poses a risk to the object and purpose of this Convention by virtue of its importance in the production of one or more chemicals listed in Schedule 1 or Schedule 2, part B;

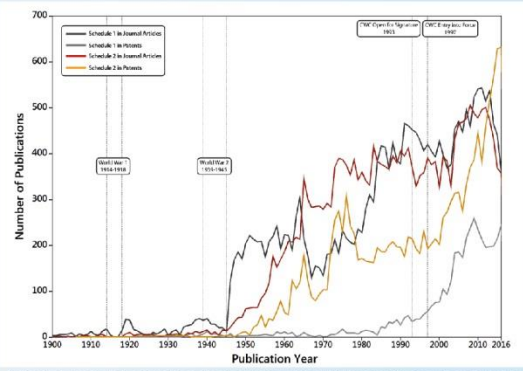
(d) It may be produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 3 Part A, Toxic Chemicals



Schedule 3 Part B, Precursors



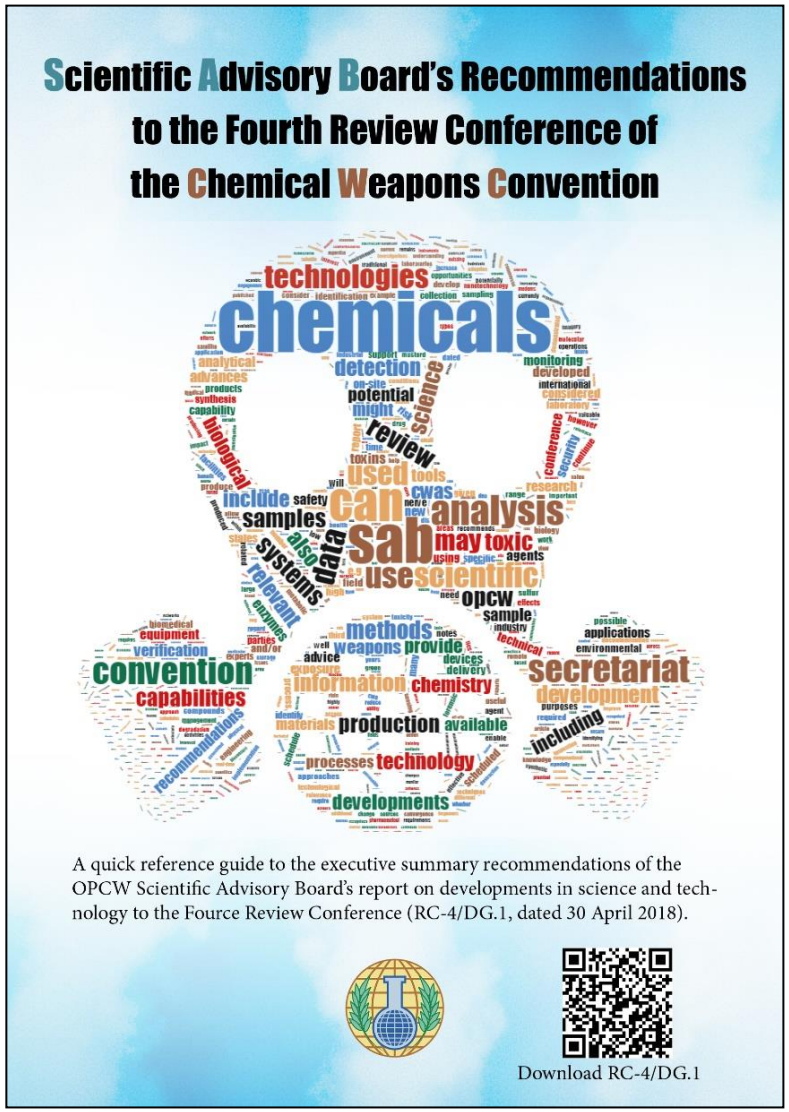


Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.

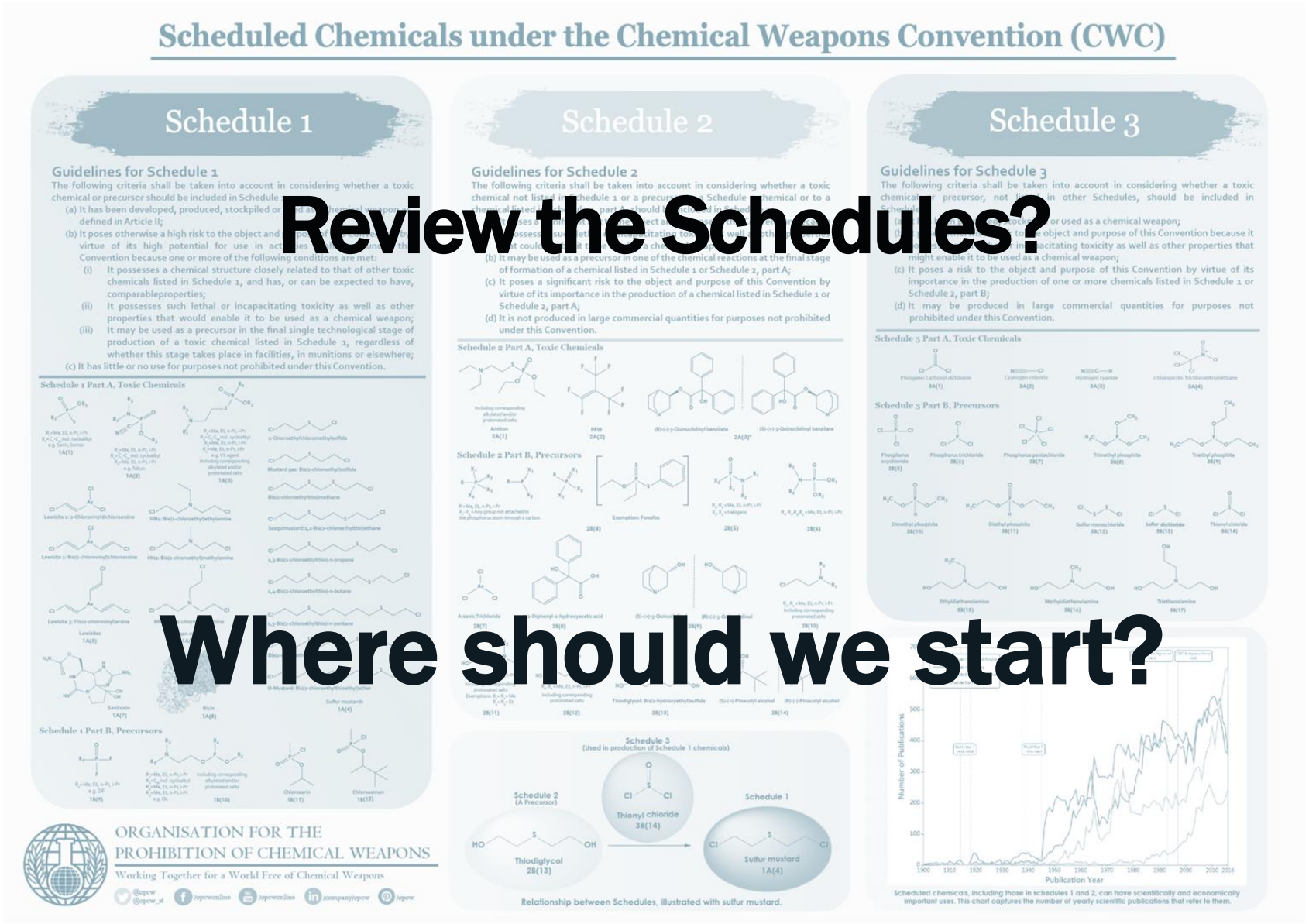
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

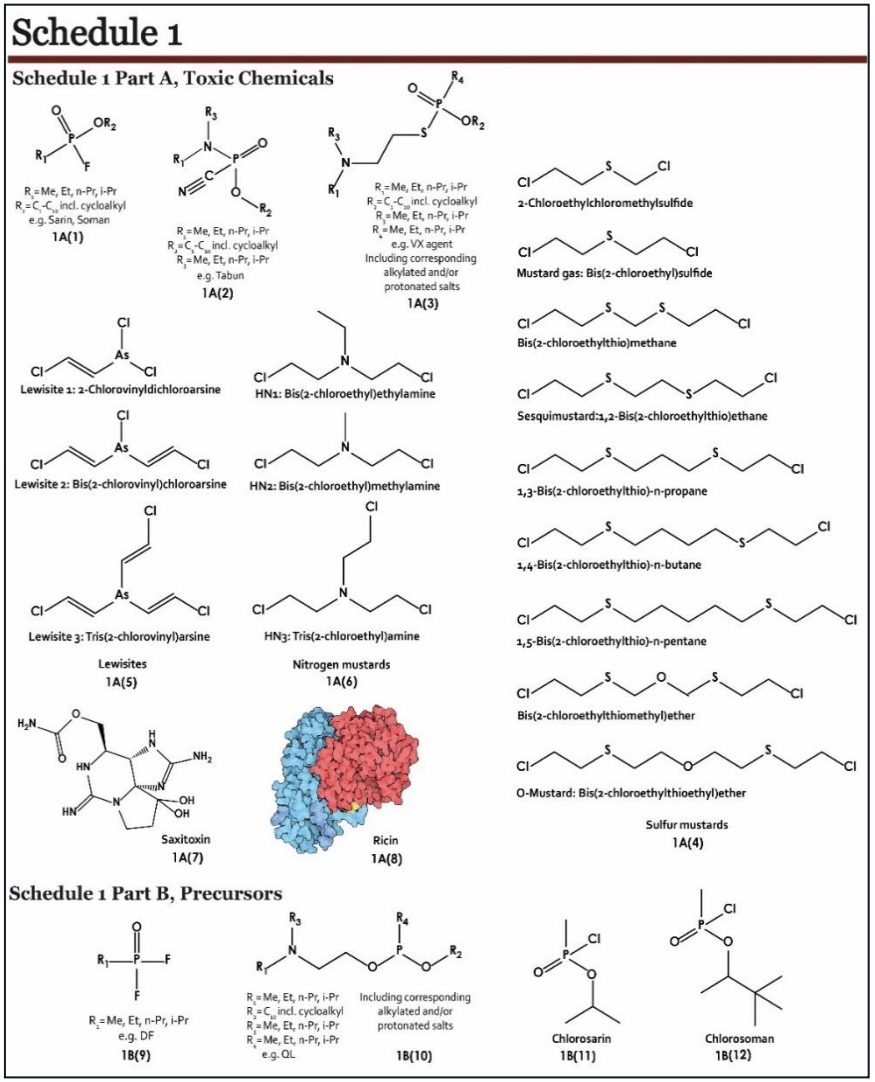
@opcw @opcw_st /opcwonline /opcwonline /company/opcw /opcw



"Given the substantial changes in chemistry and chemical industry since the schedules were finalised a quarter century ago, a review of the schedules should be considered to assess whether: (a) the chemicals currently listed are in the appropriate Schedule, and (b) any toxic chemicals or specific precursors should be added to or removed from the Schedules."


Scheduled Chemicals under the Chemical Weapons Convention (CWC)
Schedule 1
Guidelines for Schedule 1
Schedule 1 Part A, Toxic Chemicals
Schedule 1 Part B, Precursors
Schedule 2
Guidelines for Schedule 2
Schedule 2 Part A, Toxic Chemicals
Schedule 2 Part B, Precursors
Schedule 3
Guidelines for Schedule 3
Schedule 3 Part A, Toxic Chemicals
Schedule 3 Part B, Precursors
Review the Schedules?
Where should we start?
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS
Working Together for a World Free of Chemical Weapons
Schedule 3 (Used in production of Schedule 1 chemicals)
Schedule 2 (A Precursor)
Thiodiglycol 2B(13)
Thionyl chloride 3B(14)
Schedule 1
Sulfur mustard 1A(4)
Relationship between Schedules, illustrated with sulfur mustard.
Number of Publications
Publication Year
Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.

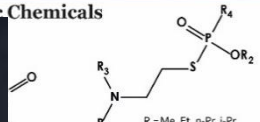
Schedule 1


Schedule 1
Schedule 1 Part A, Toxic Chemicals
R1=Me, Et, n-Pr, i-Pr
R2=C-C10 incl. cycloalkyl
e.g. Sarin, Soman
1A(1)
R1=Me, Et, n-Pr, i-Pr
R2=C2-C10 incl. cycloalkyl
R3=Me, Et, n-Pr, i-Pr
e.g. Tabun
1A(2)
R1=Me, Et, n-Pr, i-Pr
R2=C-C10 incl. cycloalkyl
R3=Me, Et, n-Pr, i-Pr
R4=Me, Et, n-Pr, i-Pr
e.g. VX agent
Including corresponding alkylated and/or protonated salts
1A(3)
2-Chloroethylchloromethylsulfide
Mustard gas: Bis(2-chloroethyl)sulfide
Bis(2-chloroethylthio)methane
Sesquimustard:1,2-Bis(2-chloroethylthio)ethane
1,3-Bis(2-chloroethylthio)-n-propane
1,4-Bis(2-chloroethylthio)-n-butane
1,5-Bis(2-chloroethylthio)-n-pentane
Bis(2-chloroethylthiomethyl)ether
O-Mustard: Bis(2-chloroethylthioethyl)ether
Sulfur mustards
1A(4)
Lewisite 1: 2-Chlorovinyldichloroarsine
Lewisite 2: Bis(2-chlorovinyl)chloroarsine
Lewisite 3: Tris(2-chlorovinyl)arsine
Lewisites
1A(5)
HN1: Bis(2-chloroethyl)ethylamine
HN2: Bis(2-chloroethyl)methylamine
HN3: Tris(2-chloroethyl)amine
Nitrogen mustards
1A(6)
Saxitoxin
1A(7)
Ricin
1A(8)
Schedule 1 Part B, Precursors
R1=Me, Et, n-Pr, i-Pr
e.g. DF
1B(9)
R1=Me, Et, n-Pr, i-Pr
R2=C5 incl. cycloalkyl
R3=Me, Et, n-Pr, i-Pr
R4=Me, Et, n-Pr, i-Pr
e.g. QL
Including corresponding alkylated and/or protonated salts
1B(10)
Chlorosarin
1B(11)
Chlorosoman
1B(12)

Schedule 1

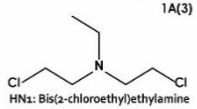
Schedule 1

Schedule 1 Part A, Toxic Chemicals

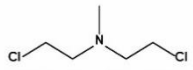


R_1=Me, Et, n-Pr, i-Pr
R_2=C_1-C_{10} incl. cycloalkyl
R_3=Me, Et, n-Pr, i-Pr
R_4=Me, Et, n-Pr, i-Pr
e.g. VX agent
Including corresponding alkylated and/or protonated salts

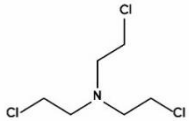
1A(3)



HN1: Bis(2-chloroethyl)ethylamine

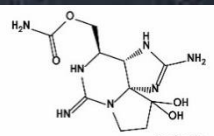


HN2: Bis(2-chloroethyl)methylamine

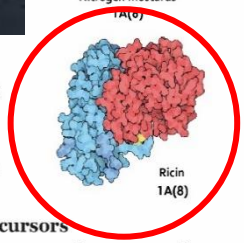


HN3: Tris(2-chloroethyl)amine

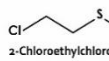
Nitrogen mustards
1A(6)



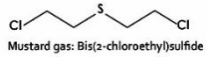
Saxitoxin
1A(7)



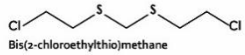
Ricin
1A(8)



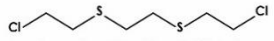
2-Chloroethylchloromethylsulfide



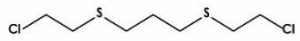
Mustard gas: Bis(2-chloroethyl)sulfide



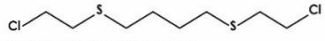
Bis(2-chloroethylthio)methane



Sesquimustard:1,2-Bis(2-chloroethylthio)ethane

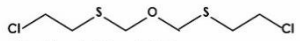


1,3-Bis(2-chloroethylthio)-n-propane

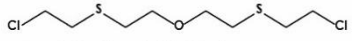


1,4-Bis(2-chloroethylthio)-n-butane

1,5-Bis(2-chloroethylthio)-n-pentane



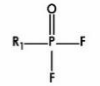
Bis(2-chloroethylthiomethyl)ether



O-Mustard: Bis(2-chloroethylthioethyl)ether

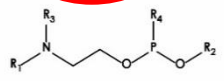
Sulfur mustards
1A(4)

Schedule 1 Part B, Precursors



R_1=Me, Et, n-Pr, i-Pr
e.g. DF

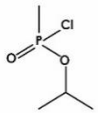
1B(9)



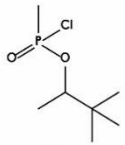
R_1=Me, Et, n-Pr, i-Pr
R_2=C_1-C_{10} incl. cycloalkyl
R_3=Me, Et, n-Pr, i-Pr
R_4=Me, Et, n-Pr, i-Pr
e.g. QL

Including corresponding alkylated and/or protonated salts

1B(10)



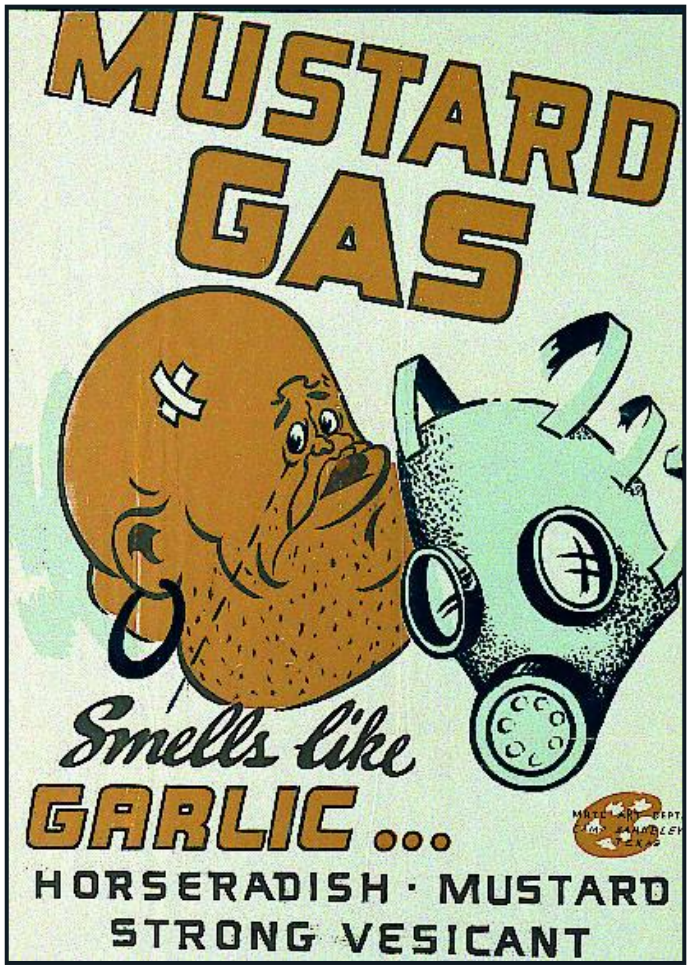
Chlorosarin
1B(11)



Chlorosoman
1B(12)

Schedule 1

Nitrogen mustard

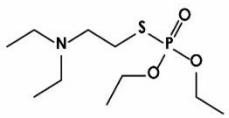


Sulfur mustard

Schedule 2

Schedule 2

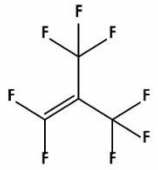
Schedule 2 Part A, Toxic Chemicals



Including corresponding alkylated and/or protonated salts

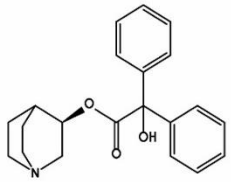
Amiton

2A(1)

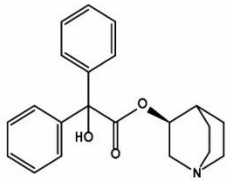


PFIB

2A(2)



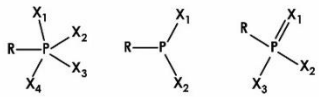
(R)-(-)-3-Quinuclidinyl benzilate



(S)-(-)-3-Quinuclidinyl benzilate

2A(3)*

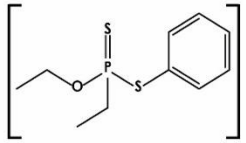
Schedule 2 Part B, Precursors



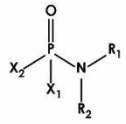
R = Me, Et, n-Pr, i-Pr

X_2- X_4 = Any group not attached to the phosphorus atom through a carbon

2B(4)



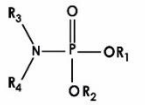
Exemption: Fonofos



R_1, R_2 = Me, Et, n-Pr, i-Pr

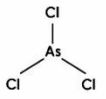
X_1, X_2 = Halogens

2B(5)



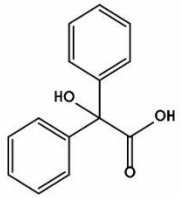
R_1, R_2, R_3, R_4 = Me, Et, n-Pr, i-Pr

2B(6)



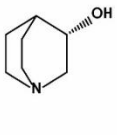
Arsenic Trichloride

2B(7)

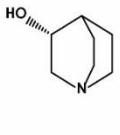


2,2-Diphenyl-2-hydroxyacetic acid

2B(8)

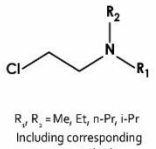


(S)-(+)-3-Quinuclidinol



(R)-(+)-3-Quinuclidinol

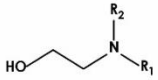
2B(9)



R_1, R_2 = Me, Et, n-Pr, i-Pr

Including corresponding protonated salts

2B(10)



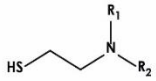
R_1, R_2 = Me, Et, n-Pr, i-Pr

Including corresponding protonated salts

Exemptions: R_1 = R_2 = Me

R_1 = R_2 = Et

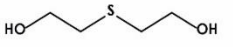
2B(11)



R_1, R_2 = Me, Et, n-Pr, i-Pr

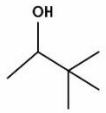
Including corresponding protonated salts

2B(12)



Thiodiglycol: Bis(2-hydroxyethyl)sulfide

2B(13)



Pinacolyl alcohol

2B(14)

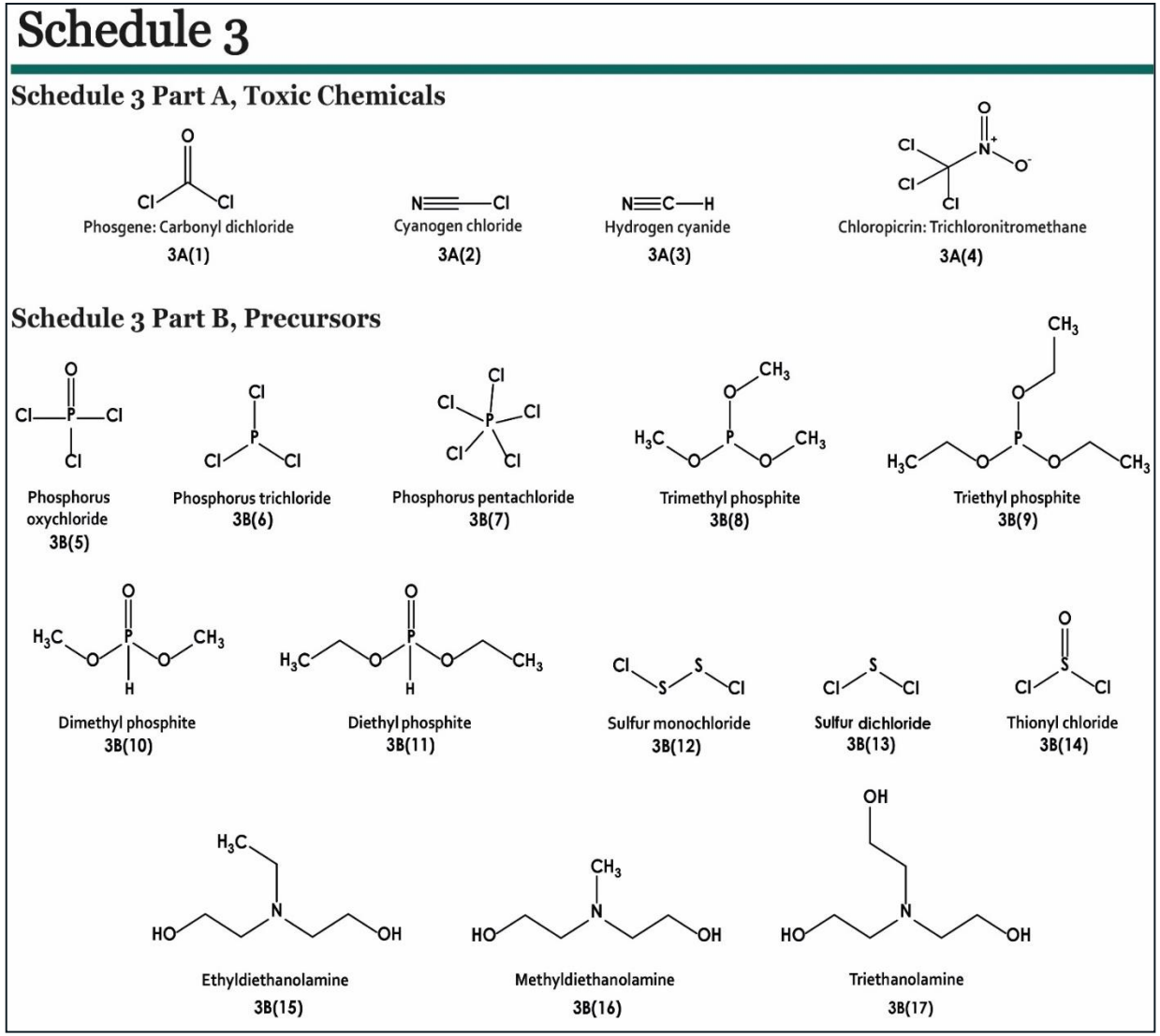
Schedule 2

Chemical warfare agent precursors and ...

Fire retardants

Pharmaceutical precursors

Schedule 3

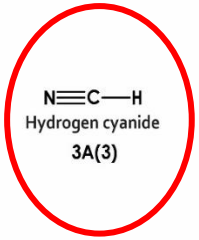


Industrial dual-use chemicals

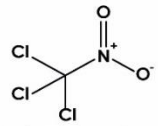
Schedule 3

Schedule 3

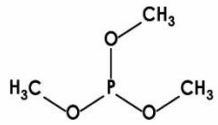
Schedule 3 Part A, Toxic Chemicals



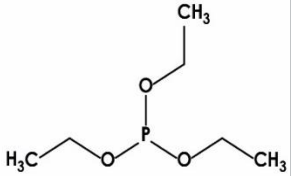
Hydrogen cyanide
3A(3)



Chloropicrin: Trichloronitromethane
3A(4)

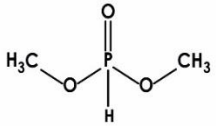


Trimethyl phosphite
3B(8)

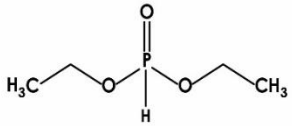


Triethyl phosphite
3B(9)

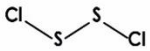
3B(5)



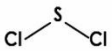
Dimethyl phosphite
3B(10)



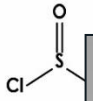
Diethyl phosphite
3B(11)



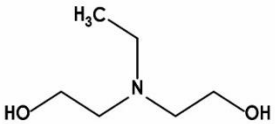
Sulfur monochloride
3B(12)



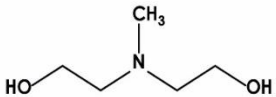
Sulfur dichloride
3B(13)



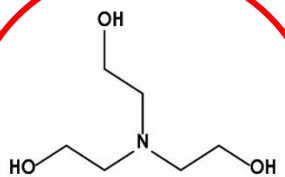
Thionyl chlo
3B(14)



Ethyldiethanolamine
3B(15)



Methyldiethanolamine
3B(16)

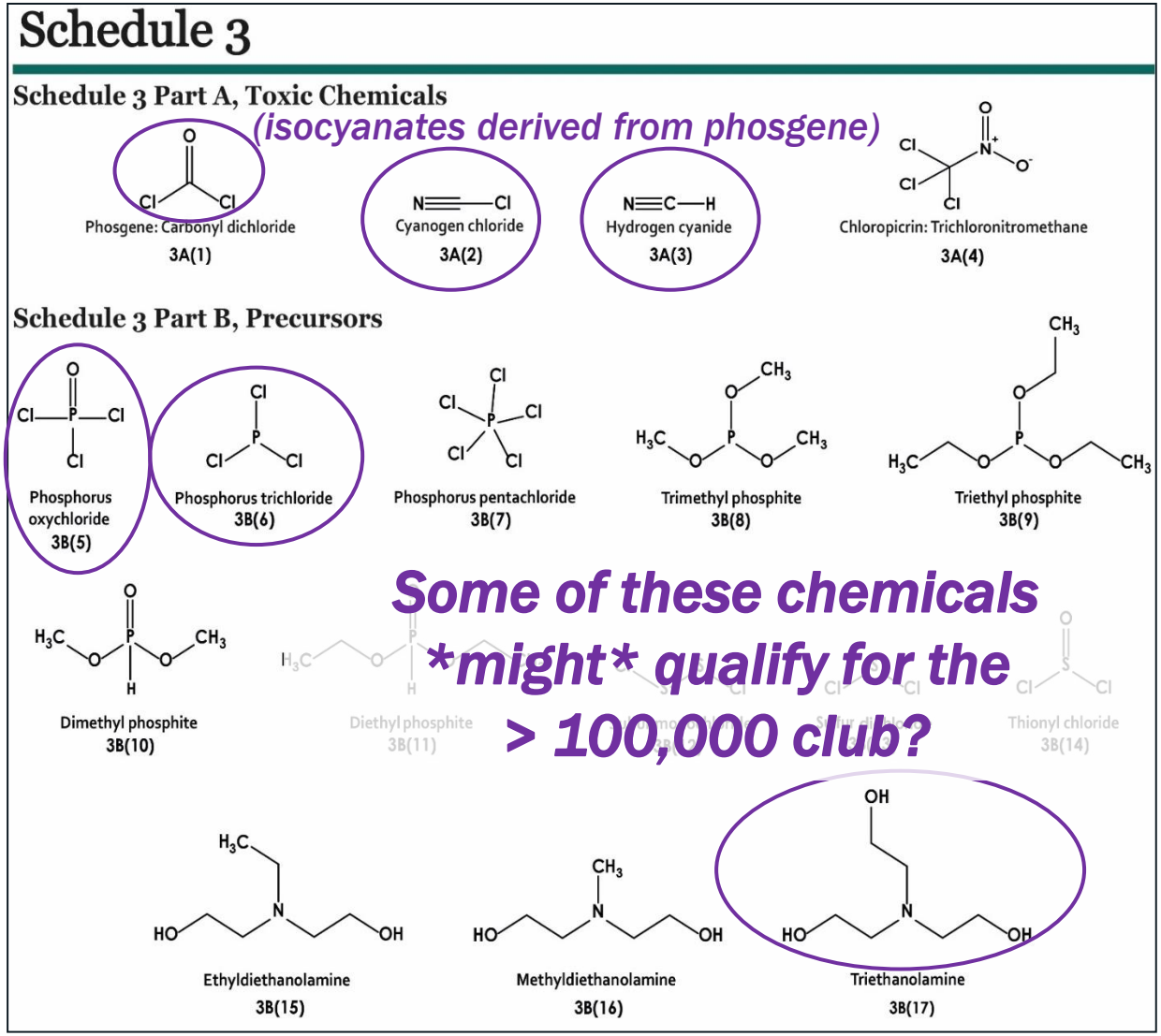


Triethanolamine
3B(17)

Schedule 3

"Given the substantial changes in chemistry and chemical industry since the schedules were finalised a quarter century ago, a review of the schedules should be considered to assess whether: (a) the chemicals currently listed are in the appropriate Schedule, and (b) any toxic chemicals or specific precursors should be added to or removed from the Schedules. In this connection, it should be considered whether it is technically feasible to accurately monitor Schedule 3 chemicals that are produced in very large quantities (e.g. over 100,000 tons/year)."

Schedule 3


Schedule 3
Schedule 3 Part A, Toxic Chemicals
(isocyanates derived from phosgene)
Phosgene: Carbonyl dichloride
3A(1)
Cyanogen chloride
3A(2)
Hydrogen cyanide
3A(3)
Chloropicrin: Trichloronitromethane
3A(4)
Schedule 3 Part B, Precursors
Phosphorus oxychloride
3B(5)
Phosphorus trichloride
3B(6)
Phosphorus pentachloride
3B(7)
Trimethyl phosphite
3B(8)
Triethyl phosphite
3B(9)
Dimethyl phosphite
3B(10)
Diethyl phosphite
3B(11)
Thionyl chloride
3B(14)
Some of these chemicals *might* qualify for the > 100,000 club?
Ethyldiethanolamine
3B(15)
Methyldiethanolamine
3B(16)
Triethanolamine
3B(17)

The Scheduled chemicals explicitly specified in the Convention for monitoring purposes, include chemical warfare agents and their key precursors

Scheduled chemicals are associated with historical chemical warfare programmes – *this does not mean they are chemical weapons*...

A 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 purposes (Article II).

MOST TRADED SCHEDULED CHEMICALS 2017

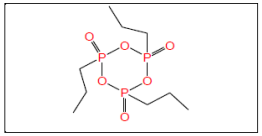
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Most Traded Scheduled Chemicals ordered by Schedule

Schedule 2	CAS RN	Chemical Name	Page
2B04	129788-86-9	Product from the reaction of Methylphosphonic acid and 1,3,5-Triazine-2,4,6-triamine	1
2B04	170836-68-7	Mixture of (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate (CAS RN 41203-81-0) and Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl]methylphosphonate (CAS RN 42595-45-9)	2
2B04	18755-43-6	Dimethyl propylphosphonate	3
2B04	294675-51-7	Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560 TP)	4
2B04	3001-98-7	3,9-Dimethyl-2,4,8,10-tetraoxa-3,9-diphosphaspiro[5.5]undecane 3,9-dioxide	5
2B04	363626-50-0	Bis(polyoxyethylene) methylphosphonate	6
2B04	41203-81-0	(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate	7
2B04	42595-45-9	Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate	8
2B04	4708-04-7	Propylphosphonic dichloride	9
2B04	63747-58-0	Poly(1,3-phenylene methyl phosphonate)	10
2B04	663176-00-9	Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560)	11
2B04	676-97-1	Methylphosphonic dichloride	12
2B04	68957-9		
2B04	70715-0		
2B04	7526-26		
2B04	756-79-6		

Chemical Name:	**2,4,6-Tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide**
CAS RN:	68957-94-8
Schedule:	2B04
HS code:	2931.35
Molecular Formula:	C9H21O6P3
CAS Index Name:	1,3,5,2,4,6-Trioxatriphosphorinane, 2,4,6-tripropyl-, 2,4,6-trioxide
IUPAC Name:	2,4,6-Tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide
Synonyms:	Propylphosphonic anhydride n-Propylphosphonic cyclic anhydride 1-Propanephosphonic acid cyclic anhydride, 50% in ethyl acetate 1-Propanephosphonic acid cyclic anhydride

Chemical Structure

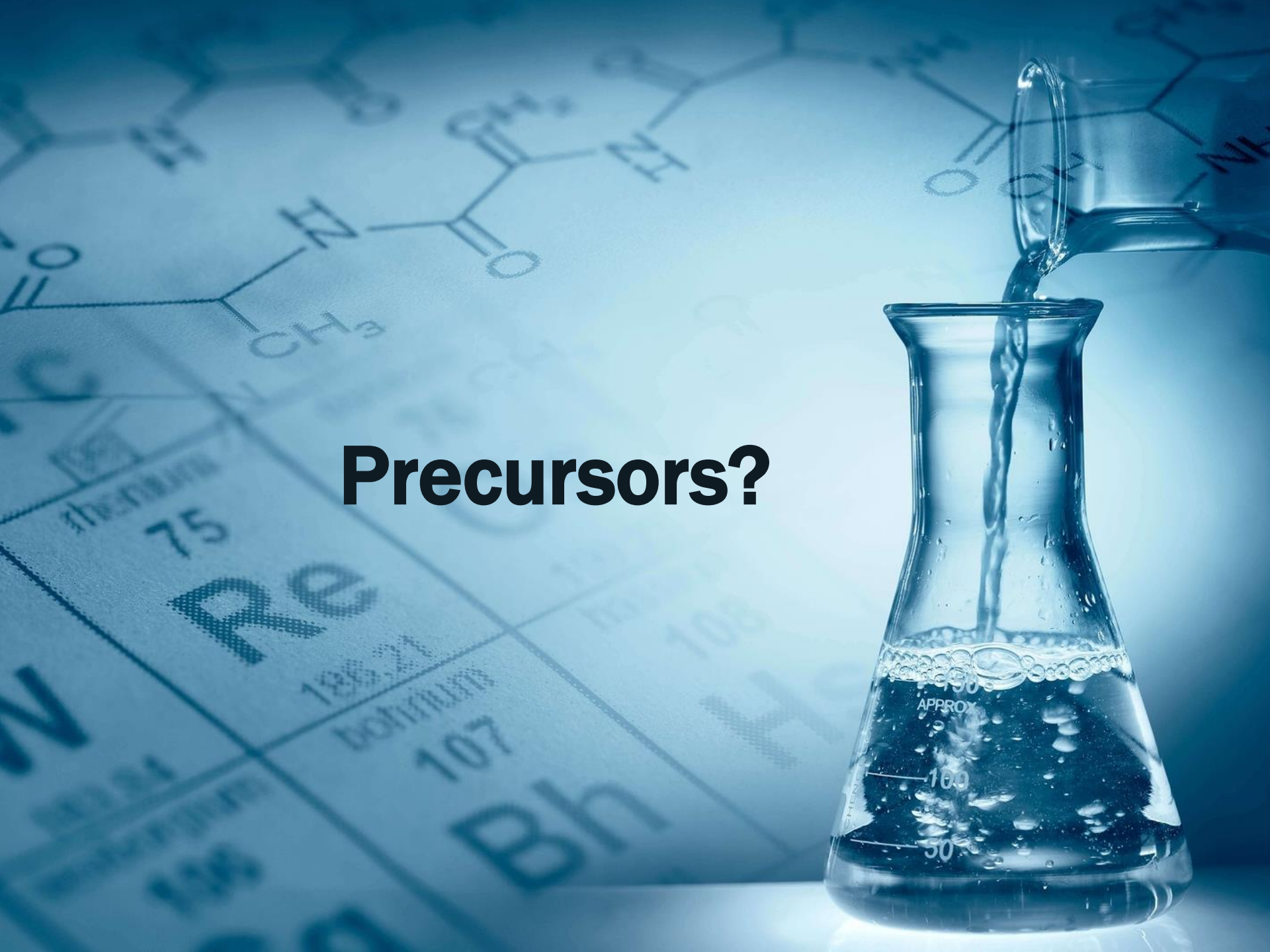


Commercial Applications & Industrial Uses

Used in: paper industry, pharmaceutical industry, plastics and synthetic resin industries, and peptide synthesis.

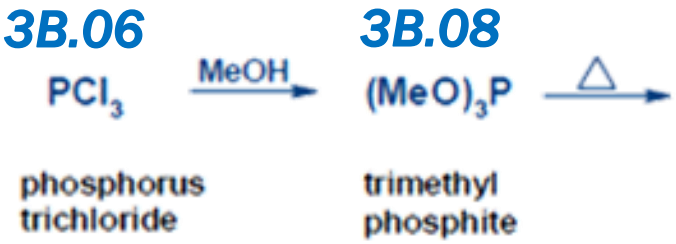
Used as flame retardant and paper making auxiliaries.

Precursors?



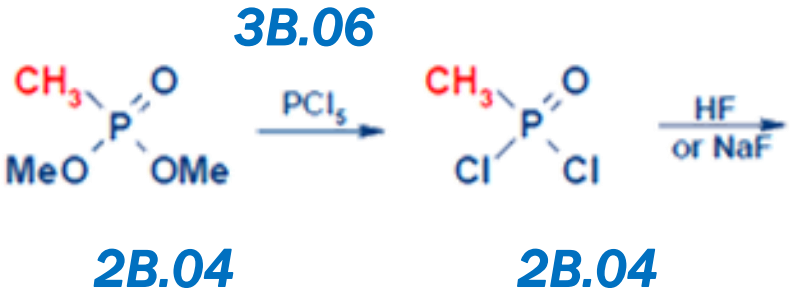
Chemical Warfare Agents and Precursors

Schedule 3



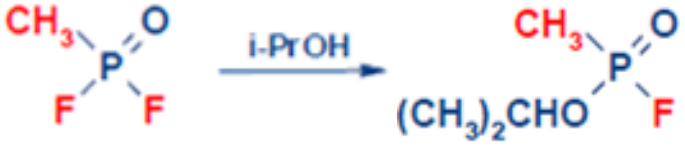
"Chemical weapon" (historical or potential)
Key precursor to S1 or S2(A)
Produced in large commercial quantities

Schedule 2



Potential chemical weapon;
Final stage or key precursor to S1 or S2(A)
Not produced in large commercial quantities

Schedule 1

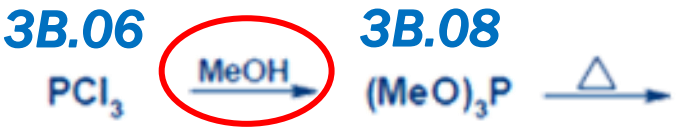


"Chemical weapon" (historical or potential)
Closely related chemical structure to S1(A)
Comparable properties to S1(A)
Final stage precursor to S1(A)
No (or limited) non-prohibited uses

Sarin (1A.01) chemical warfare agent

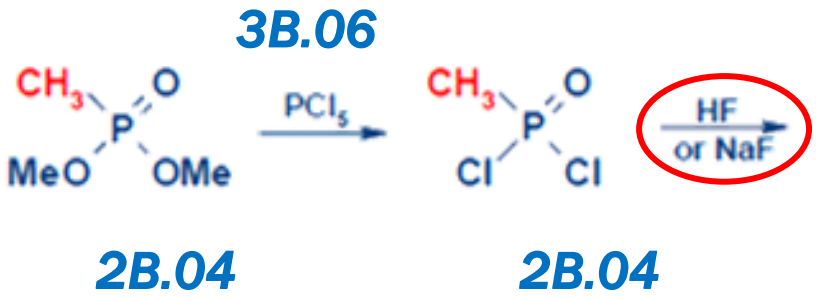
Chemical Warfare Agents and Precursors

Schedule 3



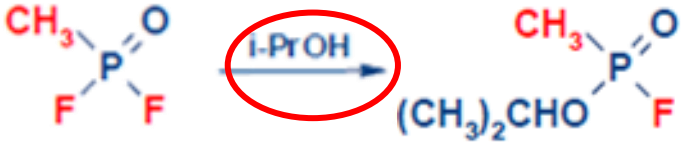
"Chemical weapon" (historical or potential)
Key precursor to S1 or S2(A)
Produced in large commercial quantities

Schedule 2



Potential chemical weapon;
Final stage or key precursor to S1 or S2(A)
Not produced in large commercial quantities

Schedule 1



"Chemical weapon" (historical or potential)
Closely related chemical structure to S1(A)
Comparable properties to S1(A)
Final stage precursor to S1(A)
No (or limited) non-prohibited uses

Sarin (1A.01) chemical warfare agent

Chemical Warfare Agents and Precursors

MeOH (methanol), *i*-PrOH (iso-propyl alcohol), HF (hydrogen fluoride), and NaF (sodium fluoride) are unscheduled "precursors" *(they are not considered "key" precursors)*

If making sarin for prohibited uses, under Article II, these chemicals would be classed as:
"unscheduled chemical weapons"

How Many Chemicals are Contained within the Schedules?

B. SCHEDULES OF CHEMICALS

The following Schedules list toxic chemicals and their precursors. For the purpose of implementing this Convention, these Schedules identify chemicals for the application of verification measures according to the provisions of the Verification Annex. Pursuant to Article II, subparagraph 1 (a), these Schedules do not constitute a definition of chemical weapons.

(Whenever reference is made to groups of dialkylated chemicals, followed by a list of alkyl groups in parentheses, all chemicals possible by all possible combinations of alkyl groups listed in the parentheses are considered as listed in the respective Schedule as long as they are not explicitly exempted. A chemical marked "*" on Schedule 2, part A, is subject to special thresholds for declaration and verification, as specified in Part VII of the Verification Annex.)

Schedule 1

		(CAS registry number)
A.	Toxic chemicals:	
(1)	O-Alkyl ($\leq C_{10}$, incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridates	
	e.g. Sarin: O-Isopropyl methylphosphonofluoridate	(107-44-8)
	Soman: O-Pinacolyl methylphosphonofluoridate	(96-64-0)
(2)	O-Alkyl ($\leq C_{10}$, incl. cycloalkyl) N,N-dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidocyanidates	
	e.g. Tabun: O-Ethyl N,N-dimethyl phosphoramidocyanidate	(77-81-6)
(3)	O-Alkyl (H or $\leq C_{10}$, incl. cycloalkyl) S-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonothiolates and corresponding alkylated or protonated salts	
	e.g. VX: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate	(50782-69-9)
(4)	Sulfur mustards:	
	2-Chloroethylchloromethylsulfide	(2625-76-5)
	Mustard gas: Bis(2-chloroethyl)sulfide	(505-60-2)
	Bis(2-chloroethylthio)methane	(63869-13-6)
	Sesquimustard: 1,2-Bis(2-chloroethylthio)ethane	(3563-36-8)
	1,3-Bis(2-chloroethylthio)-n-propane	(63905-10-2)
	1,4-Bis(2-chloroethylthio)-n-butane	(142868-93-7)
	1,5-Bis(2-chloroethylthio)-n-pentane	(142868-94-8)
	Bis(2-chloroethylthiomethyl)ether	(63918-90-1)
	O-Mustard: Bis(2-chloroethylthioethyl)ether	(63918-89-8)
(5)	Lewisites:	
	Lewisite 1: 2-Chlorovinyldichloroarsine	(541-25-3)
	Lewisite 2: Bis(2-chlorovinyl)chloroarsine	(40334-69-8)
	Lewisite 3: Tris(2-chlorovinyl)arsine	(40334-70-1)
(6)	Nitrogen mustards:	
	HN1: Bis(2-chloroethyl)ethylamine	(538-07-8)
	HN2: Bis(2-chloroethyl)methylamine	(51-75-2)
	HN3: Tris(2-chloroethyl)amine	(555-77-1)
(7)	Saxitoxin	(35523-89-8)
(8)	Ricin	(9009-86-3)
B.	Precursors:	
(9)	Alkyl (Me, Et, n-Pr or i-Pr) phosphonyldifluorides	
	e.g. DF: Methylphosphonyldifluoride	(676-99-3)
(10)	O-Alkyl (H or $\leq C_{10}$, incl. cycloalkyl) O-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonites and corresponding alkylated or protonated salts	
	e.g. QL: O-Ethyl O-2-diisopropylaminoethyl methylphosphonite	(57856-11-8)
(11)	Chlorosarin: O-Isopropyl methylphosphonochloridate	(1445-76-7)
(12)	Chlorosoman: O-Pinacolyl methylphosphonochloridate	(7040-57-5)

51 Schedules of Chemicals

Schedule 2

A.	Toxic chemicals:	
(1)	Amiton: O,O-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate and corresponding alkylated or protonated salts	(78-53-5)
(2)	PFIB: 1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene	(382-21-8)
(3)	BZ: 3-Quinuclidinyl benzilate (*)	(6581-06-2)
B.	Precursors:	
(4)	Chemicals, except for those listed in Schedule 1, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms,	
	e.g. Methylphosphonyl dichloride	(676-97-1)
	Dimethyl methylphosphonate	(756-79-6)
	Exemption: Fonofos: O-Ethyl S-phenyl ethylphosphonothiolothionate	(944-22-9)
(5)	N,N-Dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidic dihalides	
(6)	Dialkyl (Me, Et, n-Pr or i-Pr) N,N-dialkyl (Me, Et, n-Pr or i-Pr)-phosphoramidates	
(7)	Arsenic trichloride	(7784-34-1)
(8)	2,2-Diphenyl-2-hydroxyacetic acid	(76-93-7)
(9)	Quinuclidin-3-ol	(1619-34-7)
(10)	N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethyl-2-chlorides and corresponding protonated salts	
(11)	N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-ols and corresponding protonated salts	
	Exemptions: N,N-Dimethylaminoethanol and corresponding protonated salts	(108-01-0)
	N,N-Diethylaminoethanol and corresponding protonated salts	(100-37-8)
(12)	N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-thiols and corresponding protonated salts	
(13)	Thiodiglycol: Bis(2-hydroxyethyl)sulfide	(111-48-8)
(14)	Pinacolyl alcohol: 3,3-Dimethylbutan-2-ol	(464-07-3)

53 Schedules of Chemicals

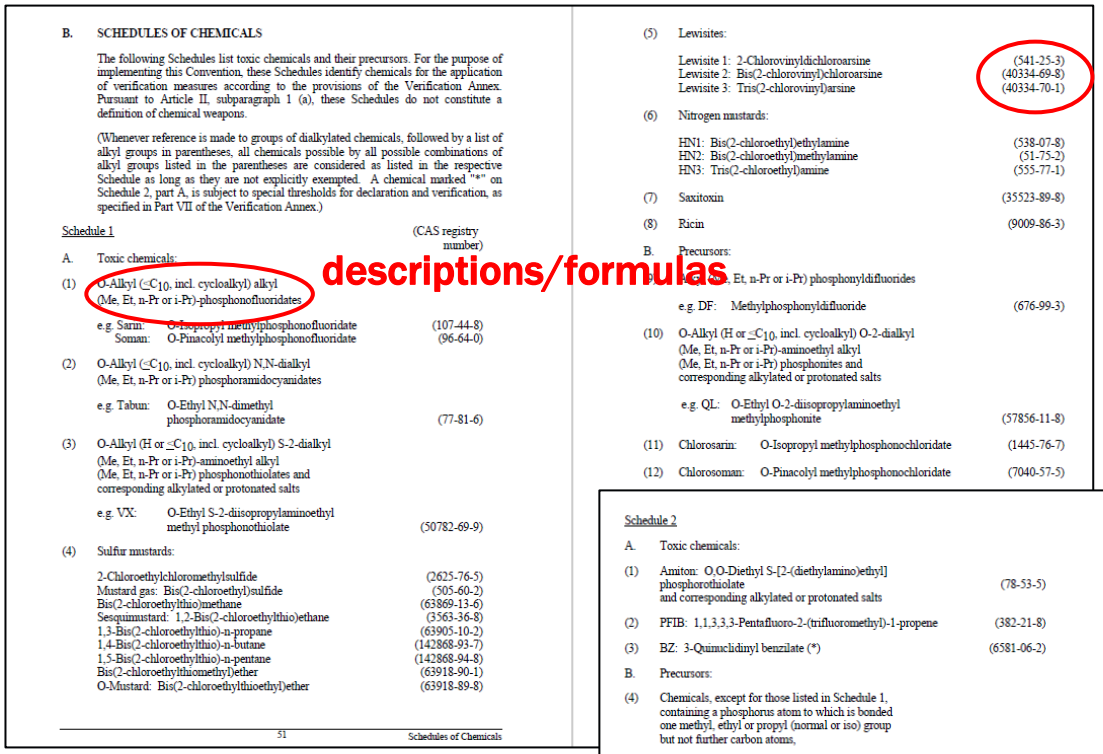
Schedule 3

A.	Toxic chemicals:	
(1)	Phosgene: Carbonyl dichloride	(75-44-5)
(2)	Cyanogen chloride	(506-77-4)
(3)	Hydrogen cyanide	(74-90-8)
(4)	Chloropicrin: Trichloronitromethane	(76-06-2)
B.	Precursors:	
(5)	Phosphorus oxychloride	(10025-87-3)
(6)	Phosphorus trichloride	(7719-12-2)
(7)	Phosphorus pentachloride	(10026-13-8)
(8)	Trimethyl phosphite	(121-45-9)
(9)	Triethyl phosphite	(122-52-1)
(10)	Dimethyl phosphite	(868-85-9)
(11)	Diethyl phosphite	(762-04-9)
(12)	Sulfur monochloride	(10025-67-9)
(13)	Sulfur dichloride	(10545-99-0)
(14)	Thionyl chloride	(7719-09-7)
(15)	Ethyldiethanolamine	(139-87-7)
(16)	Methyldiethanolamine	(105-59-9)
(17)	Triethanolamine	(102-71-6)

Schedules of Chemicals 54

OPCW

How Many Chemicals are Contained within the Schedules?



B. SCHEDULES OF CHEMICALS

The following Schedules list toxic chemicals and their precursors. For the purpose of implementing this Convention, these Schedules identify chemicals for the application of verification measures according to the provisions of the Verification Annex. Pursuant to Article II, subparagraph 1 (a), these Schedules do not constitute a definition of chemical weapons.

(Whenever reference is made to groups of dialkylated chemicals, followed by a list of alkyl groups in parentheses, all chemicals possible by all possible combinations of alkyl groups listed in the parentheses are considered as listed in the respective Schedule as long as they are not explicitly exempted. A chemical marked "*" on Schedule 2, part A, is subject to special thresholds for declaration and verification, as specified in Part VII of the Verification Annex.)

Schedule 1 (CAS registry number)

A. Toxic chemicals:

(1) O-Alkyl (≤C_{10}, incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridates

e.g. Sarin: O-Isopropyl methylphosphonofluoridate (107-44-8)
Soman: O-Pinacolyl methylphosphonofluoridate (96-64-0)

(2) O-Alkyl (≤C_{10}, incl. cycloalkyl) N,N-dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidocyanidates

e.g. Tabun: O-Ethyl N,N-dimethyl phosphoramidocyanidate (77-81-6)

(3) O-Alkyl (H or ≤C_{10}, incl. cycloalkyl) S-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonothiolates and corresponding alkylated or protonated salts

e.g. VX: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate (50782-69-9)

(4) Sulfur mustards:

2-Chloroethylchloromethylsulfide (2625-76-5)
Mustard gas: Bis(2-chloroethyl)sulfide (505-60-2)
Bis(2-chloroethylthio)methane (63869-13-6)
Sesquimustard: 1,2-Bis(2-chloroethylthio)ethane (3563-36-8)
1,3-Bis(2-chloroethylthio)-n-propane (63905-10-2)
1,4-Bis(2-chloroethylthio)-n-butane (142868-93-7)
1,5-Bis(2-chloroethylthio)-n-pentane (142868-94-8)
Bis(2-chloroethylthiomethyl)ether (63918-90-1)
O-Mustard: Bis(2-chloroethylthioethyl)ether (63918-89-8)

51 Schedules of Chemicals

descriptions/formulas

(5) Lewisites:

Lewisite 1: 2-Chlorovinyldichloroarsine (541-25-3)
Lewisite 2: Bis(2-chlorovinyl)chloroarsine (40334-69-8)
Lewisite 3: Tris(2-chlorovinyl)arsine (40334-70-1)

(6) Nitrogen mustards:

HN1: Bis(2-chloroethyl)ethylamine (538-07-8)
HN2: Bis(2-chloroethyl)methylamine (51-75-2)
HN3: Tris(2-chloroethyl)amine (555-77-1)

(7) Saxitoxin (35523-89-8)

(8) Ricin (9009-86-3)

B. Precursors:

(9) [illegible], Et, n-Pr or i-Pr) phosphonyldifluorides

e.g. DF: Methylphosphonyldifluoride (676-99-3)

(10) O-Alkyl (H or ≤C_{10}, incl. cycloalkyl) O-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonites and corresponding alkylated or protonated salts

e.g. QL: O-Ethyl O-2-diisopropylaminoethyl methylphosphonite (57856-11-8)

(11) Chlorosarin: O-Isopropyl methylphosphonochloridate (1445-76-7)

(12) Chlorosoman: O-Pinacolyl methylphosphonochloridate (7040-57-5)

Chemical Abstracts Service (CAS) Registry Numbers

Schedule 2

A. Toxic chemicals:

(1) Amiton: O,O-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate and corresponding alkylated or protonated salts (78-53-5)

(2) PFIB: 1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene (382-21-8)

(3) BZ: 3-Quinuclidinyl benzilate (*) (6581-06-2)

B. Precursors:

(4) Chemicals, except for those listed in Schedule 1, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms,

e.g. Methylphosphonyl dichloride (676-97-1)
Dimethyl methylphosphonate (756-79-6)

Exemption: Fonofos: O-Ethyl S-phenyl ethylphosphonothiolothionate (944-22-9)

(5) N,N-Dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidic dihalides

(6) Dialkyl (Me, Et, n-Pr or i-Pr) N,N-dialkyl (Me, Et, n-Pr or i-Pr)-phosphoramidates

(7) Arsenic trichloride

(8) 2,2-Diphenyl-2-hydroxyacetic acid

(9) Quinuclidin-3-ol

(10) N,N-Dialkyl (Me, Et, n-Pr [illegible] and corresponding [illegible]

(11) N,N-D[illegible]

(111-48-8)

[illegible]outan-2-ol (464-07-3)

53 Schedules of Chemicals

Schedule 3

A. Toxic chemicals:

(1) Phosgene: Carbonyl dichloride (75-44-5)

(2) Cyanogen chloride (506-77-4)

(3) Hydrogen cyanide (74-90-8)

(4) Chloropicrin: Trichloronitromethane (76-06-2)

B. Precursors:

(5) Phosphorus oxychloride

(6) Phosphorus trichloride

(7) Phosphorus pentachloride

(8) Trimethyl pho[illegible]

(9) [illegible]

[illegible]-9)

(10545-99-0)

(7719-09-7)

(139-87-7)

[illegible]olamine (105-59-9)

Triethanolamine (102-71-6)

Schedules of Chemicals 54

Specific chemicals

53 specific chemicals are listed by chemical name, CAS number and/or uniquely defined chemical formula

(3 are exemptions to the Schedule they would otherwise fall under)

OPCW

Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1

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

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

(b) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(c) It has little or no use for purposes not prohibited under this Convention.

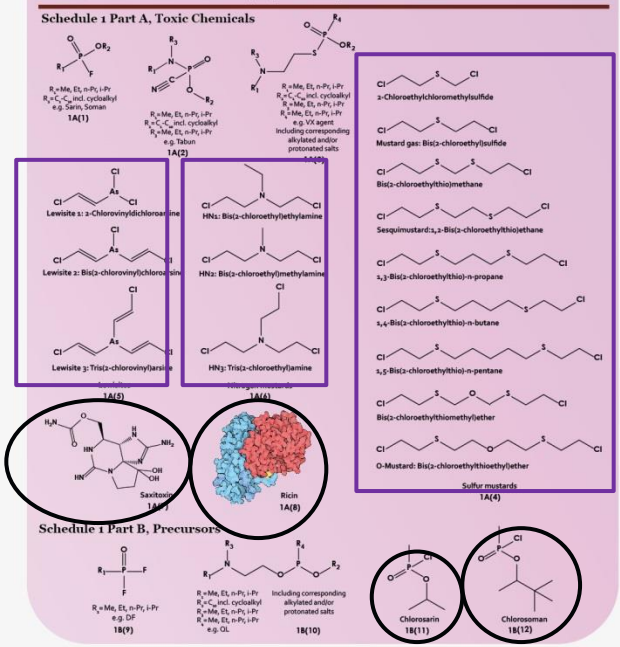
Convention because one or more of the following conditions are met:

(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1 and has or can be expected to have toxic properties similar to those chemicals;

(ii) It possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;

Schedule 1 Part A, Toxic Chemicals



Schedule 1 Part B, Precursors

Schedule 2

Guidelines for Schedule 2

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

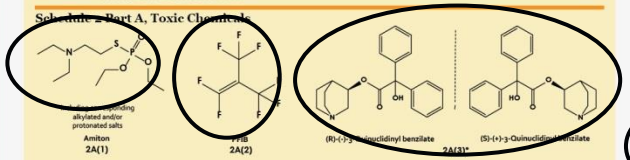
(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;

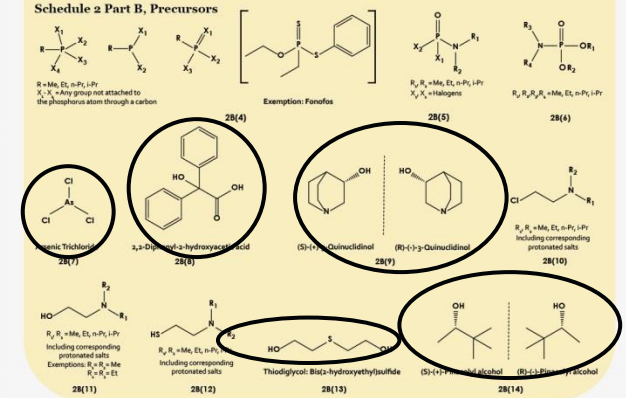
(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 2, part A;

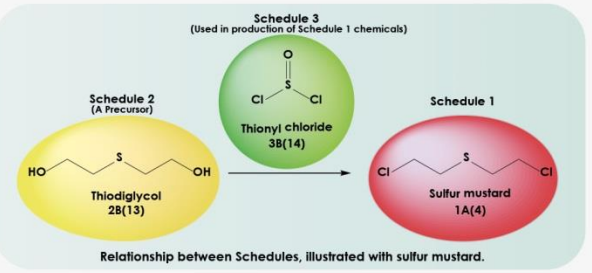
(d) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 2 Part A, Toxic Chemicals



Schedule 2 Part B, Precursors





Schedule 3

Guidelines for Schedule 3

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

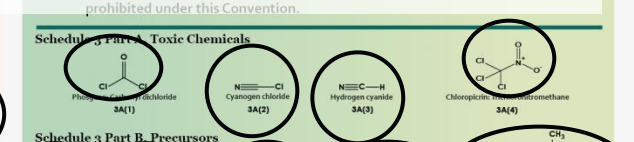
(a) It has been produced, stockpiled or used as a chemical weapon;

(b) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that might enable it to be used as a chemical weapon;

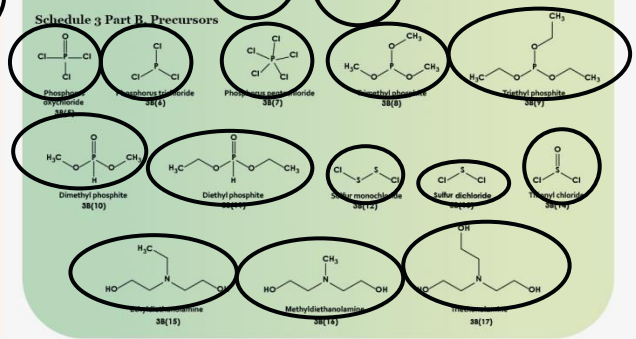
(c) It poses a risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2, part A;

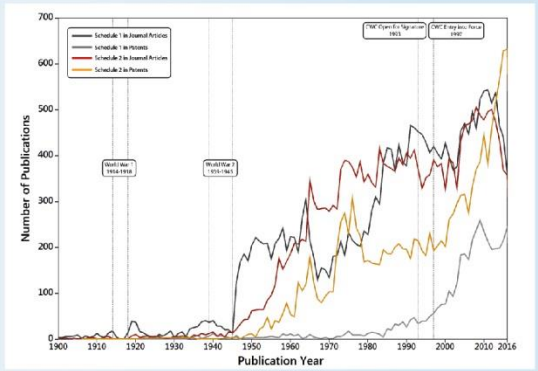
(d) It may be produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 3 Part A, Toxic Chemicals



Schedule 3 Part B, Precursors





Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

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

3 Groups of compounds (15 compounds in total)

26 Single chemical substances

3 Single chemical substances

Shown here as stereoisomers

Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1

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

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

(b) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(c) It has little or no use for purposes not prohibited under this Convention.

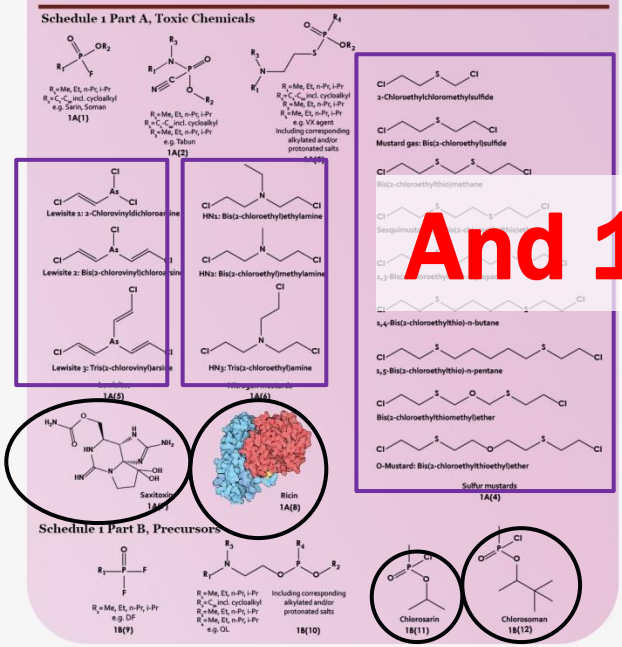
Convention because one or more of the following conditions are met:

(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1 and has or can be expected to have toxic properties similar to those chemicals;

(ii) It possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;

Schedule 1 Part A, Toxic Chemicals



Schedule 1 Part B, Precursors

Schedule 2

Guidelines for Schedule 2

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

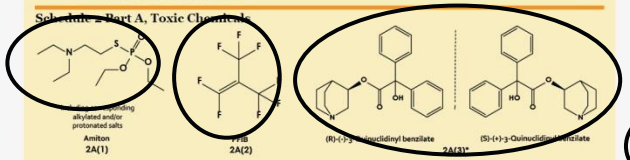
(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;

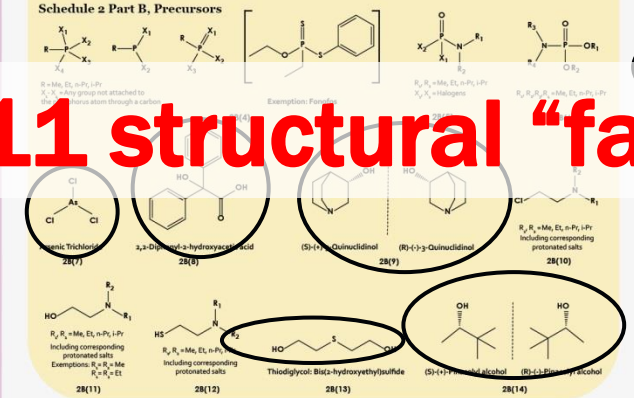
(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2, part A;

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

Schedule 2 Part A, Toxic Chemicals



Schedule 2 Part B, Precursors



Schedule 3

Guidelines for Schedule 3

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

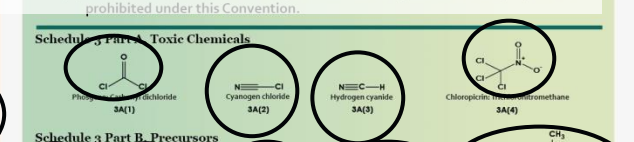
(a) It has been produced, stockpiled or used as a chemical weapon;

(b) It poses a significant risk to the object and purpose of this Convention because it might enable it to be used as a chemical weapon;

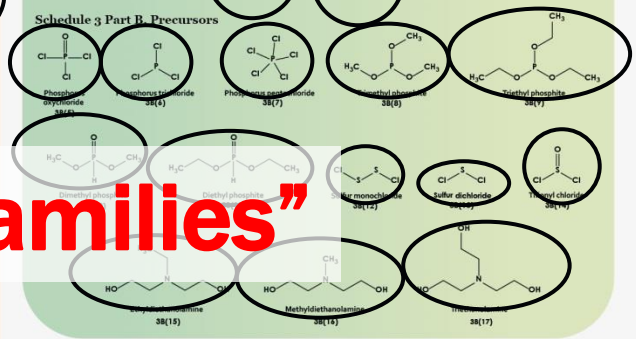
(c) It poses a risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2;

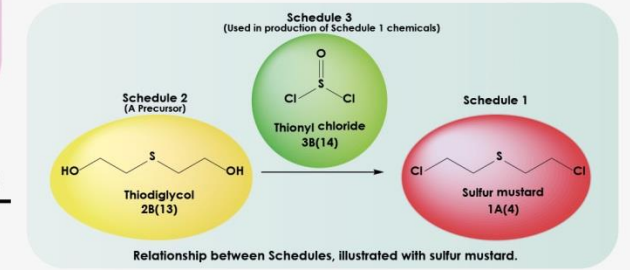
(d) It may be produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 3 Part A, Toxic Chemicals

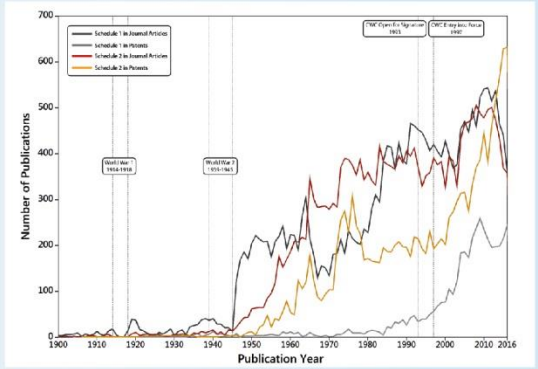


Schedule 3 Part B, Precursors





Relationship between Schedules, illustrated with sulfur mustard.



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3 Groups of compounds (15 compounds in total)

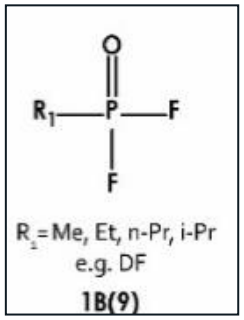
26 Single chemical substances

3 Single chemical substances

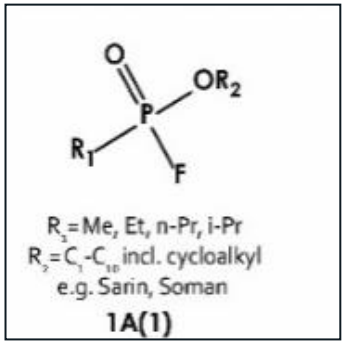
Shown here as stereoisomers

And 11 structural "families"

Families of Chemicals?



- **1B.09: Four members**



- **1A.01**
  - R_1 has four possible structures
  - *What about R_2?*

With one variable R group from C1 to C10 for 1A.01, 1A.02 and 1A.03: *> 1.3 million possible chemicals in these three Schedules*

$R_2 = C_1$ ($-CH_3$), 1 structure X 4 = 4 1A.01 chemicals

$R_2 = C_2$ ($-CH_2CH_3$), 1 structure X 4 = 4 1A.01 chemicals

$R_2 = C_3$ ($-CH_2CH_2CH_3$ or $-CH(CH_3)_2$ or △), 3 structures X 4 = 12 1A.01 chemicals

Includes sarin

.

.

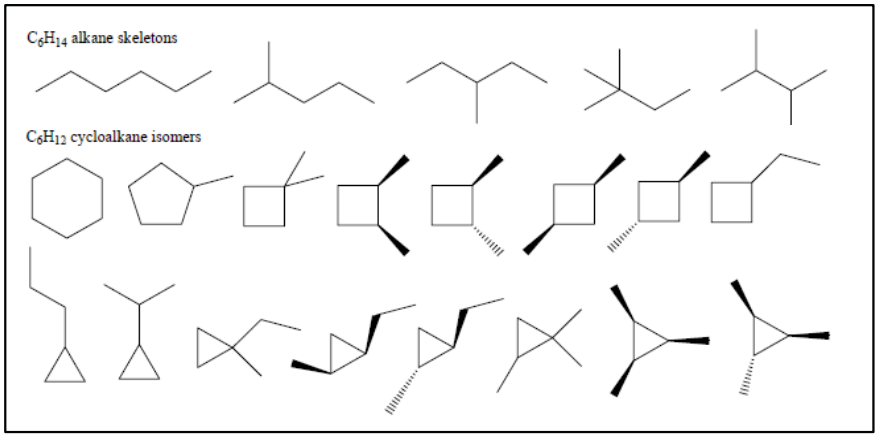
$R_2 = C_6$

21 structures

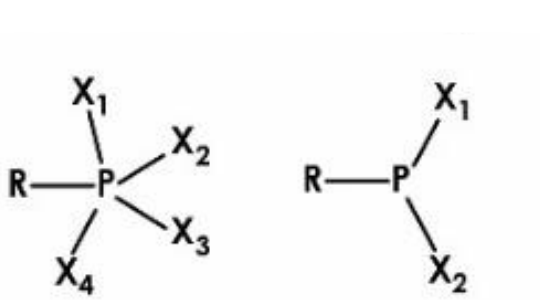
83 ways of attachment

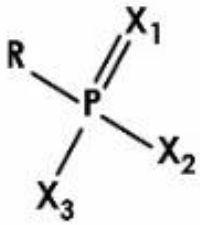
332 1A.01 chemicals

Includes soman, cyclosarin



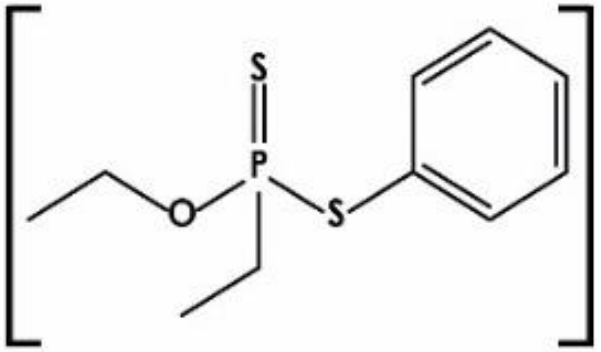
Families of Chemicals?





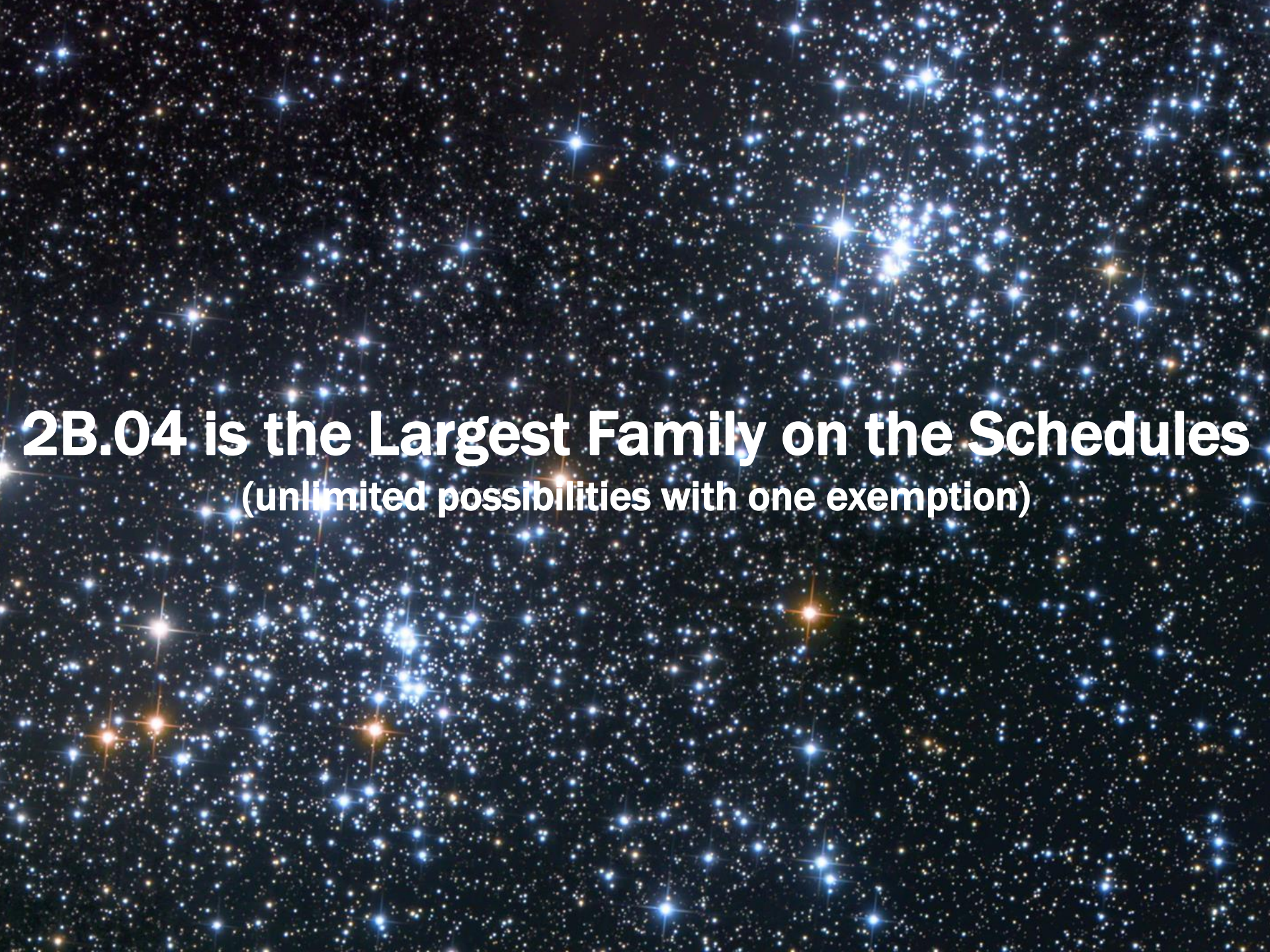
R = Me, Et, n-Pr, i-Pr

X_2 - X_4 = Any group not attached to the phosphorus atom through a carbon

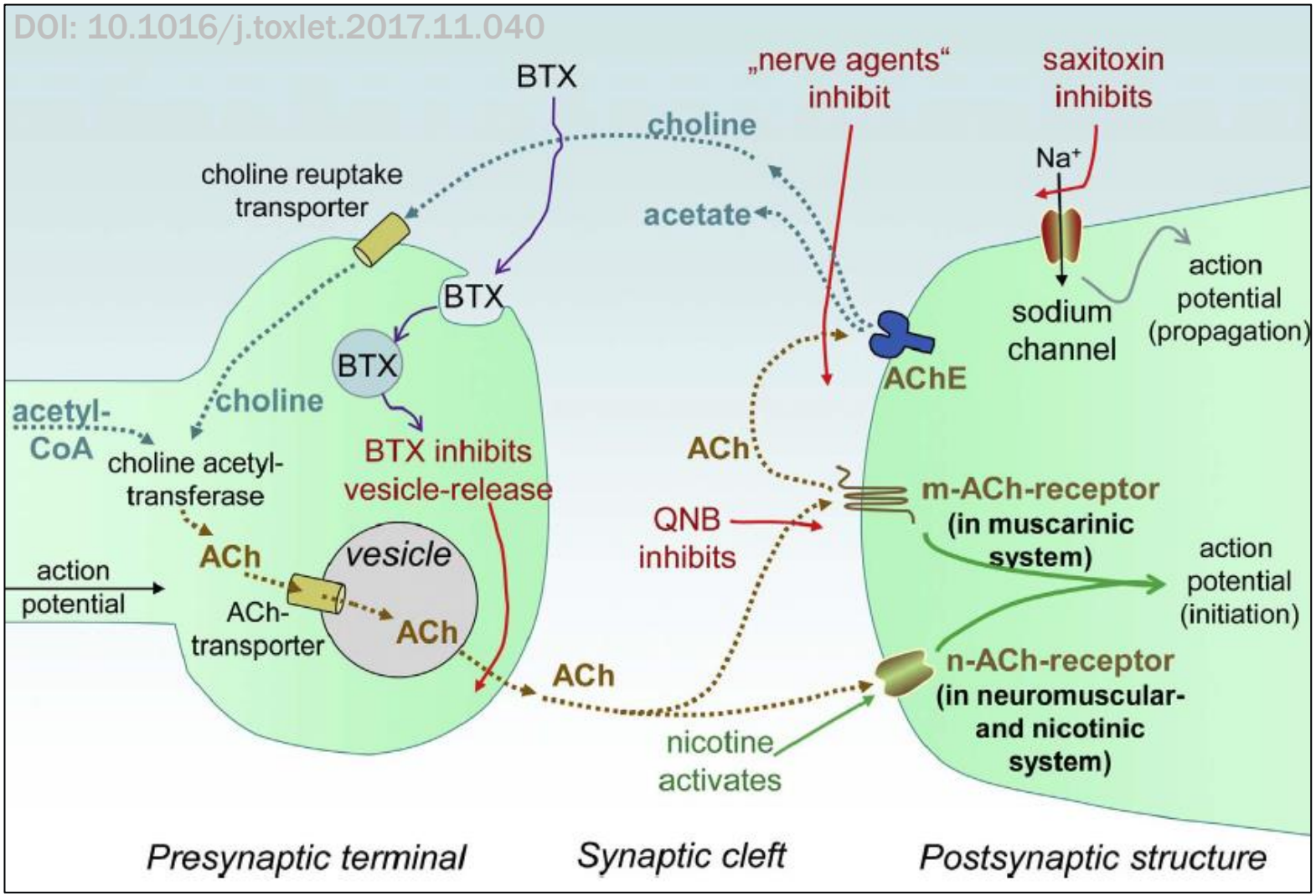


Exemption: Fonofos

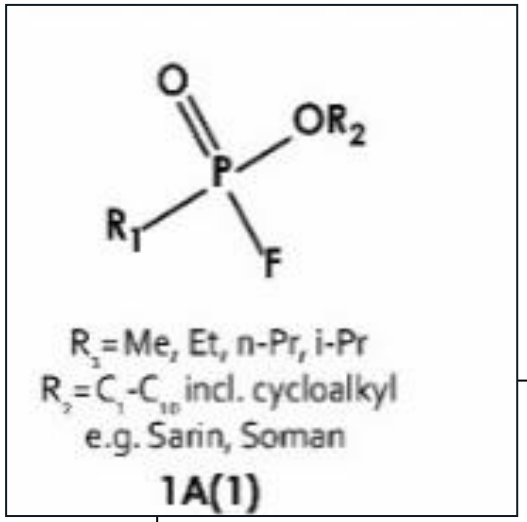
2B(4)


2B.04 is the Largest Family on the Schedules
(unlimited possibilities with one exemption)

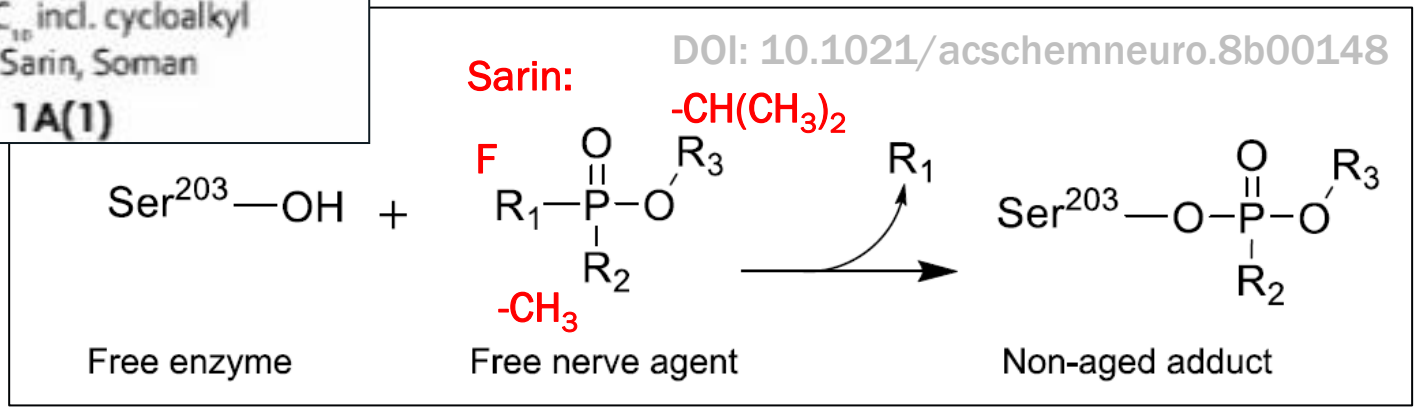
Is that all a bit too complicated?

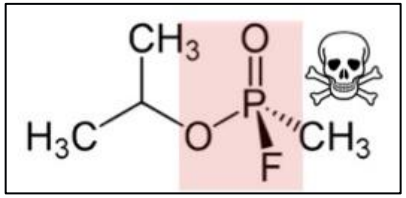


Is that all a bit too complicated?



Why stop at C_{10}?





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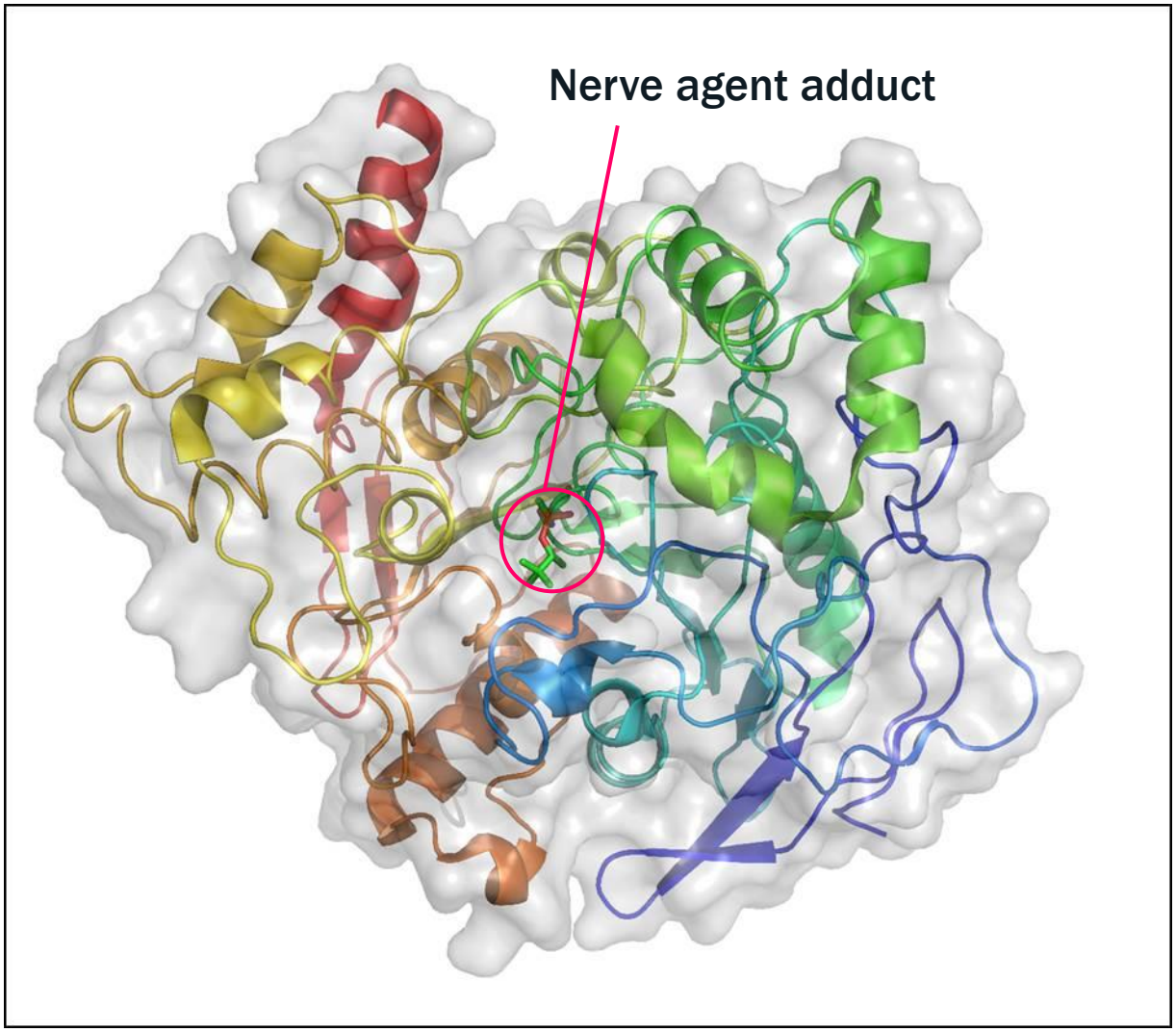
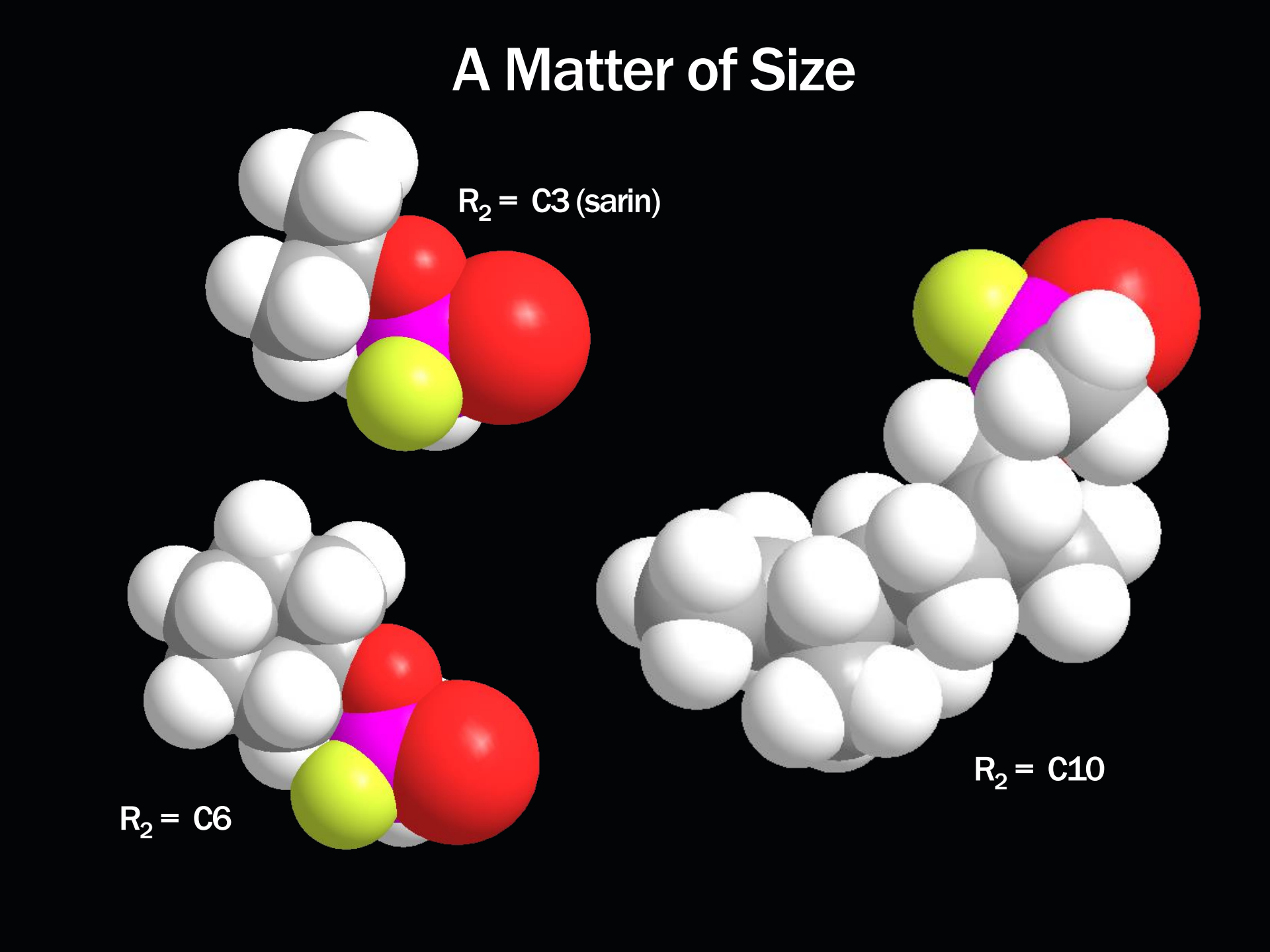
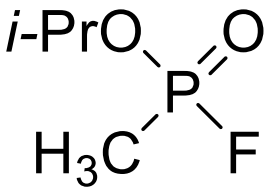


A Matter of Size



Families also help to mitigate issues of “designer” compounds being exempt from monitoring and control

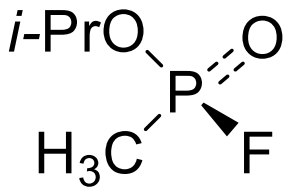
Are Individual Chemicals any Less Complicated?



Sarin

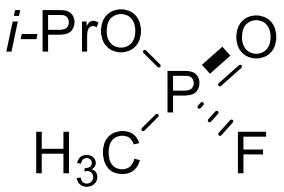
CAS 107-44-8

Schedule 1.A.01



(*R*)-(-)-Sarin

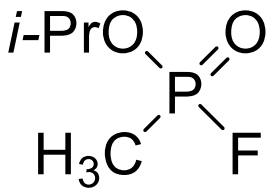
CAS 6171-94-4



(*S*)-(+)-Sarin

CAS 6171-93-3

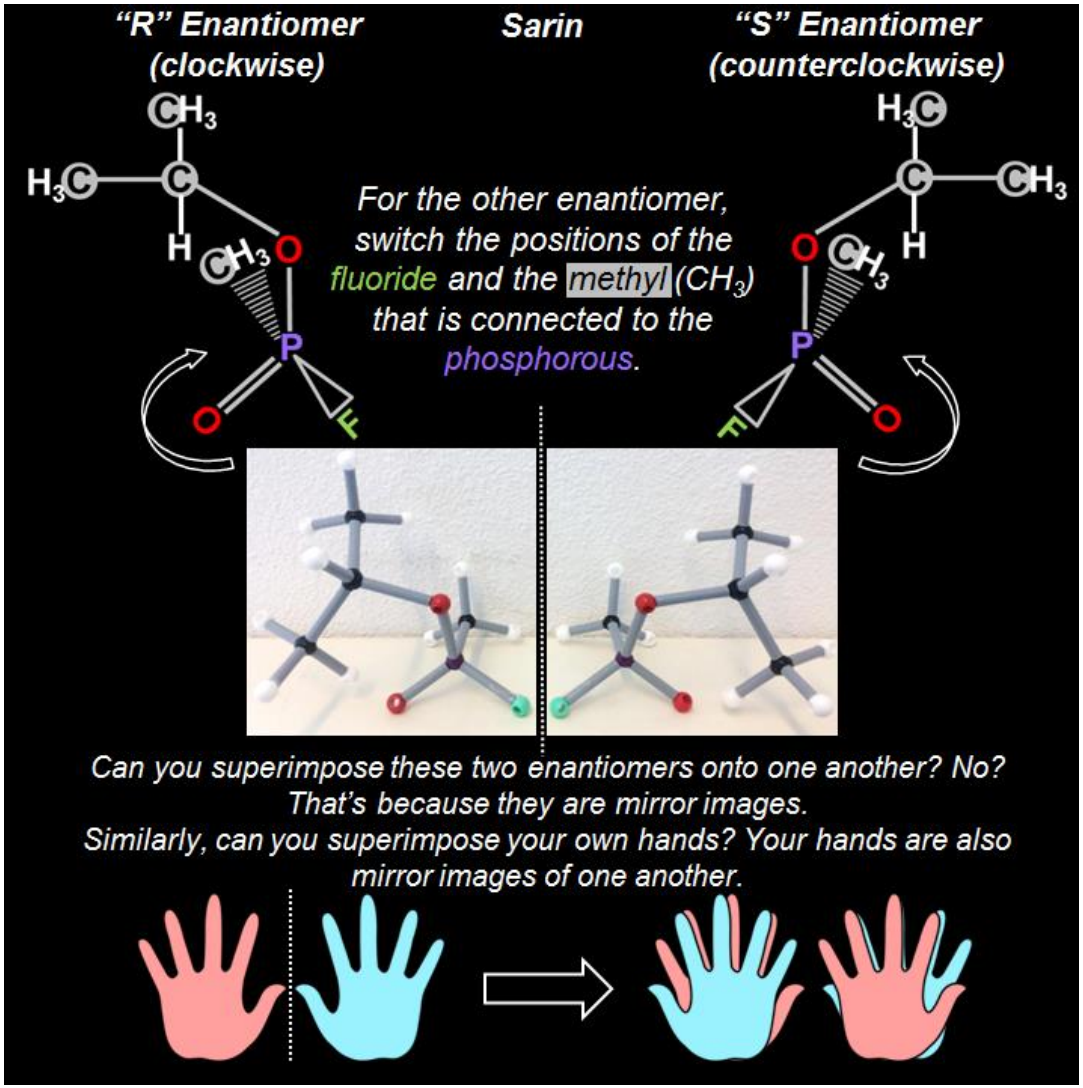
Are Individual Chemicals any Less Complicated?



Sarin

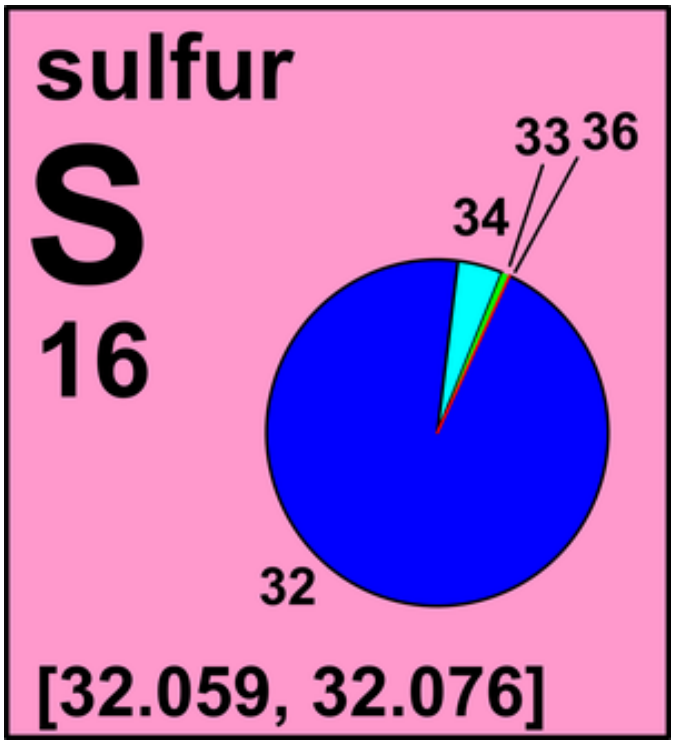
CAS 107-44-8

Schedule 1.A.01



Stereoisomers should still fall under the Schedule of the parent compound (SAB Recommendation)

ISOTOPES



16 protons

+

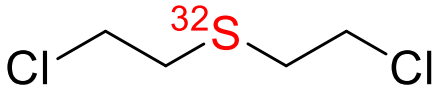
16, 17, 18 or 19 neutrons

=

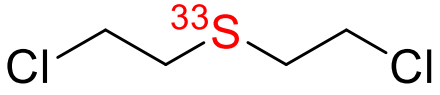
4 isotopes (^{32}S, ^{33}S, ^{34}S, ^{35}S)

ISOTOPES

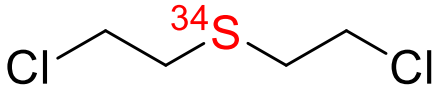
Isotopically labeled chemicals should still fall under the Schedule of the parent compound (SAB Recommendation)



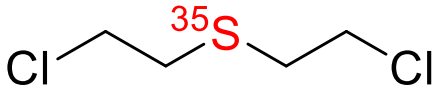
94.99 %



0.75 %

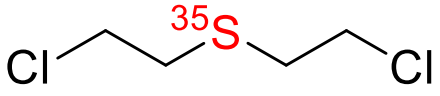


4.25 %



0.01 %

sulfur mustard: bis(2-chloroethyl)sulfide as listed within Schedule 1.A.04 under CAS 505-60-2

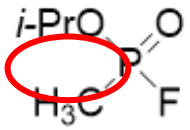


this isotopically labelled form has CAS 6755-76-6

ISOTOPES

Just to complicate things more:

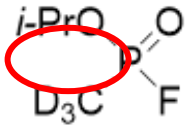
Hydrogen isotopes are written in chemical structures as: H (^{1}H), D (^{2}H) or T (^{3}H)



sarin

Schedule 1.A.01

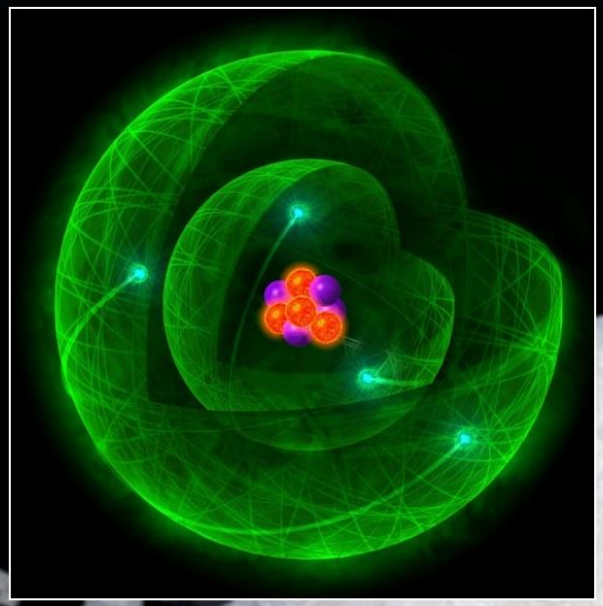
CAS 107-44-8

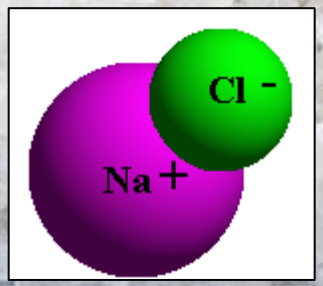


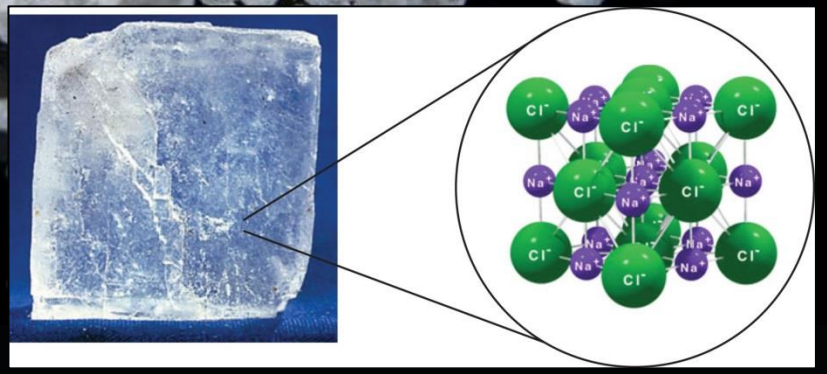
sarin-d_3

CAS 104801-08-3

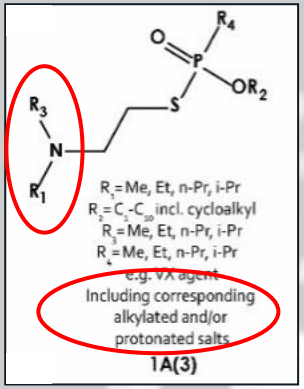
Salts?

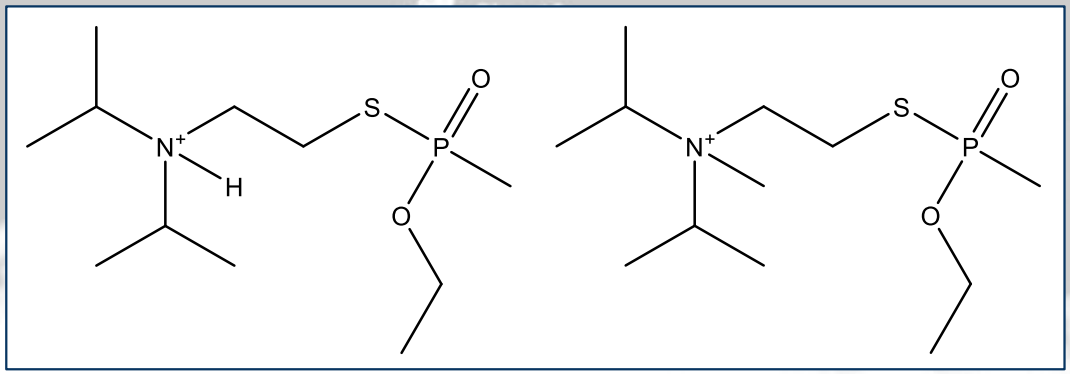


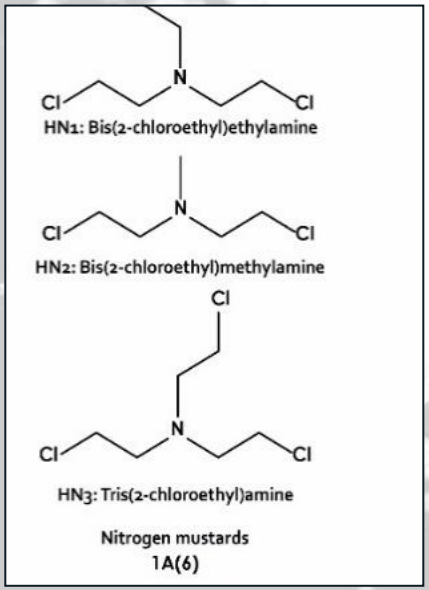


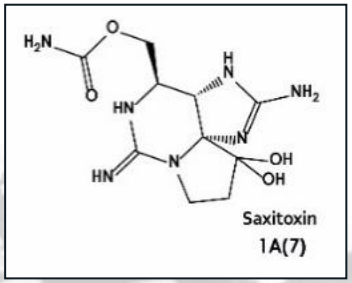


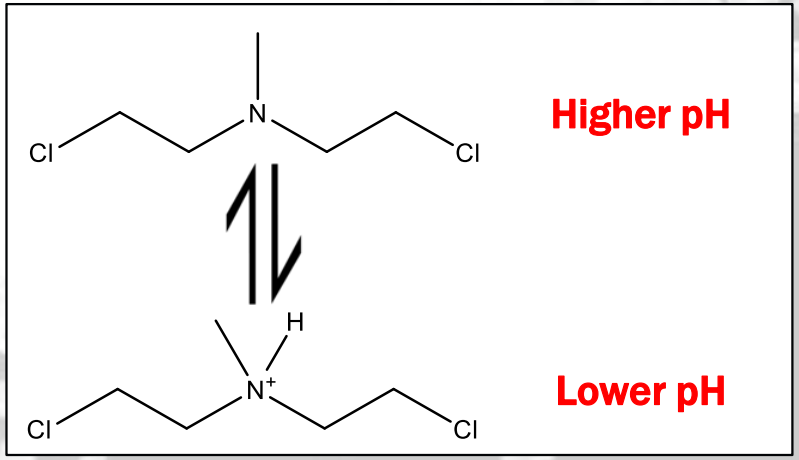
Why Does This Matter?





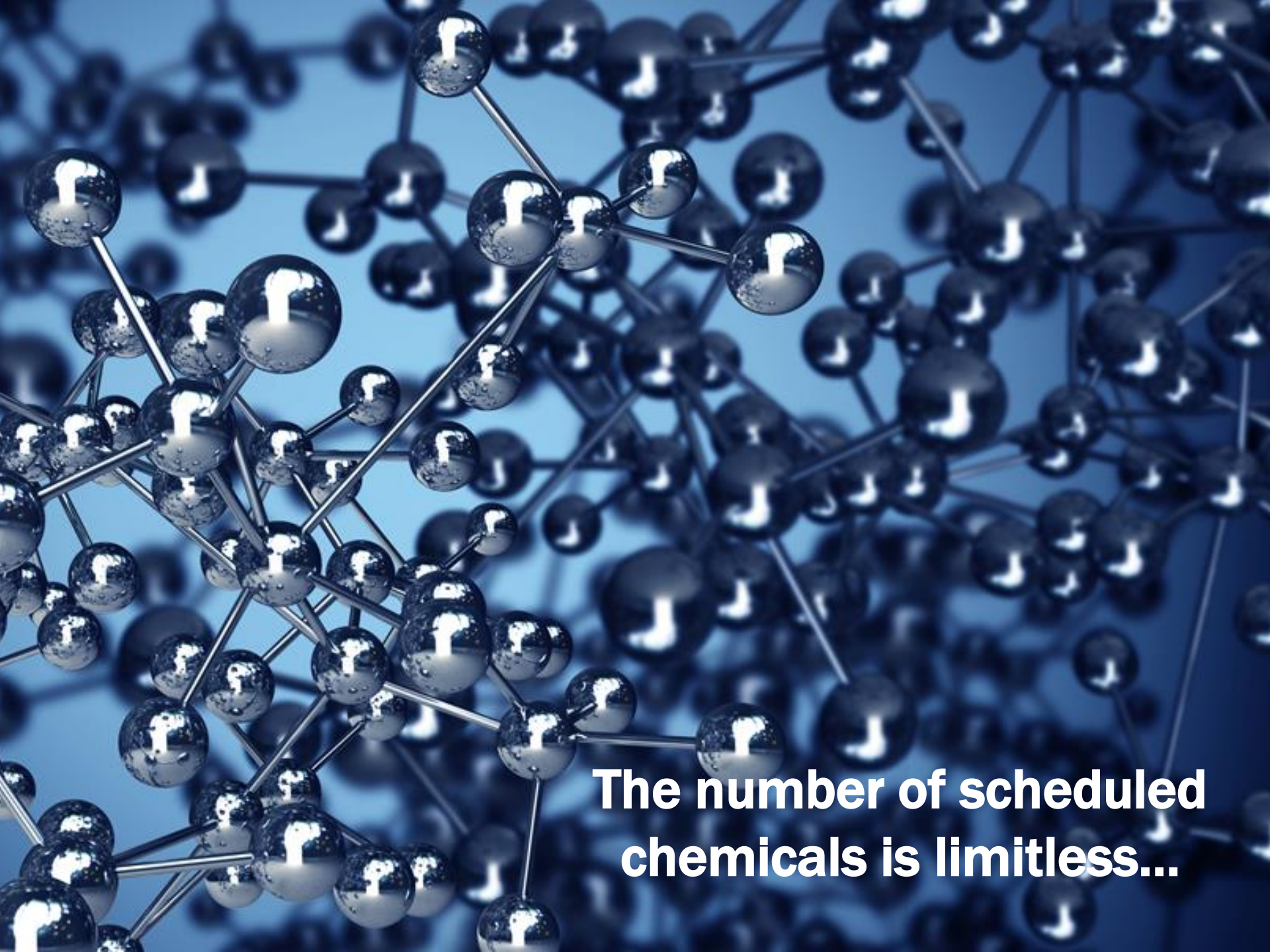


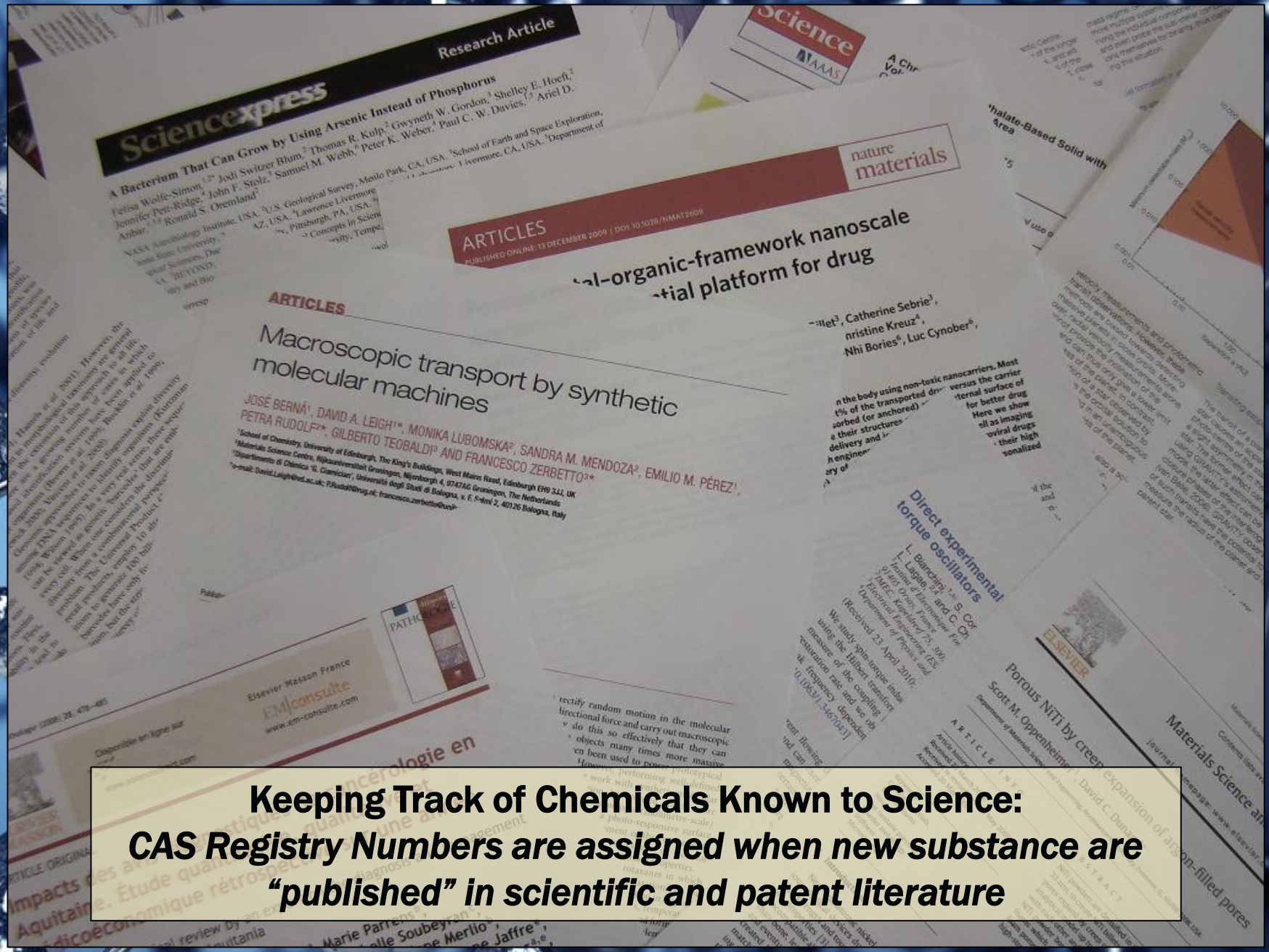




Are salts of 1A.04 and 1A.07 chemicals scheduled?

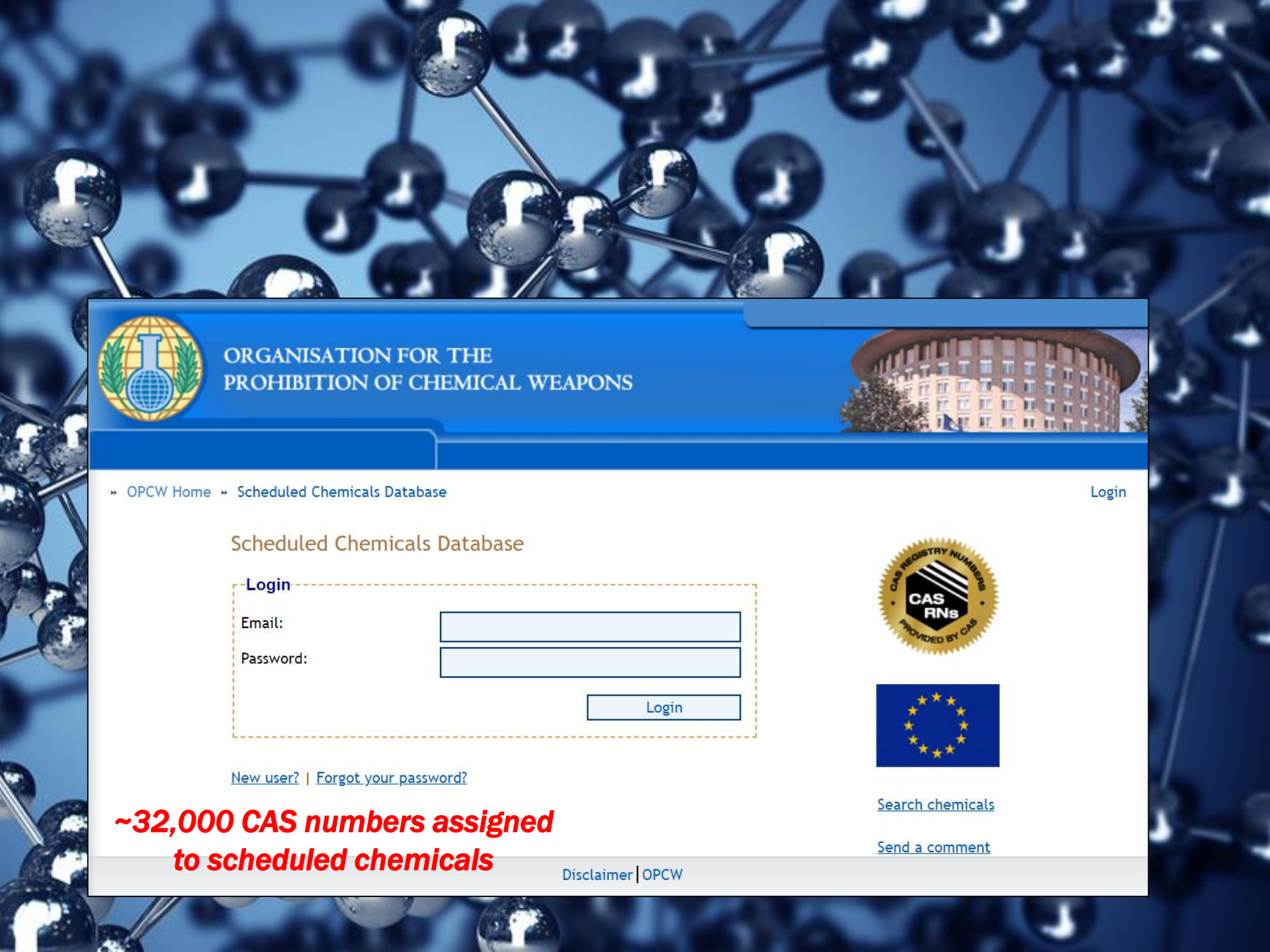
Should salts of scheduled chemicals not specified on the schedules be scheduled?


The number of scheduled chemicals is limitless...



Keeping Track of Chemicals Known to Science:

CAS Registry Numbers are assigned when new substance are "published" in scientific and patent literature


ORGANISATION FOR THE
PROHIBITION OF CHEMICAL WEAPONS
» OPCW Home » Scheduled Chemicals Database
Login
Scheduled Chemicals Database
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Email:
Password:
Login
New user? | Forgot your password?
CAS REGISTRY NUMBERS
CAS RNs
PROVIDED BY CAS
Search chemicals
Send a comment
Disclaimer | OPCW
~32,000 CAS numbers assigned
to scheduled chemicals

Chemicals

Ordered by Schedule and by CAS Registry Number or Key

Chemical name: 1-Isobutyl-3-methylbutyl isopropylphosphonofluoridate

Schedule: 1A01

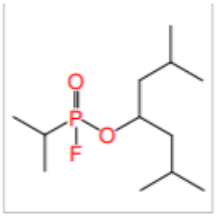
CAS RN: HS code: 2931.39

Key: (108-82-7)-I1A1

Molecular formula: C12H26FO2P

CAS Index Name: Phosphonofluoridic acid, 1-methylethyl-, 1-isobutyl-3-methylbutyl ester

IUPAC name: 1-Isobutyl-3-methylbutyl isopropylphosphonofluoridoate



Synonyms: Phosphonofluoridic acid, 1-methylethyl-, 2,6-dimethylhept-4-yl ester

O-1-Isobutyl-3-methylbutyl isopropylphosphonofluoridate

2,6-Dimethylheptan-4-yl 1-methylethylphosphonofluoridate

2,6-Dimethylhept-4-yl 1-methylethylphosphonofluoridate

Chemical name: 1-Isobutyl-3-methylbutyl propylphosphonofluoridate

Schedule: 1A01

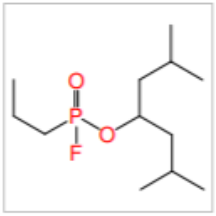
CAS RN: HS code: 2931.39

Key: (108-82-7)-P1A1

Molecular formula: C12H26FO2P

CAS Index Name: Phosphonofluoridic acid, propyl-, 1-isobutyl-3-methylbutyl ester

IUPAC name: 1-Isobutyl-3-methylbutyl propylphosphonofluoridoate



Synonyms: Phosphonofluoridic acid, propyl-, 2,6-dimethylhept-4-yl ester

O-1-Isobutyl-3-methylbutyl propylphosphonofluoridate

2,6-Dimethylheptan-4-yl propylphosphonofluoridate

2,6-Dimethylhept-4-yl propylphosphonofluoridate

Chemical name: Cyclohexyl methyl-d3-phosphonofluoridate

Schedule: 1A01

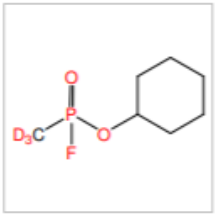
CAS RN: HS code: 2845.90

Key: (108-93-0)-M1A1(D3)

Molecular formula: C7H11D3FO2P

CAS Index Name: Phosphonofluoridic acid, methyl-d3-, cyclohexyl ester

IUPAC name: Cyclohexyl methyl-d3-phosphonofluoridoate



Synonyms: O-Cyclohexyl trideuteriomethylphosphonofluoridate

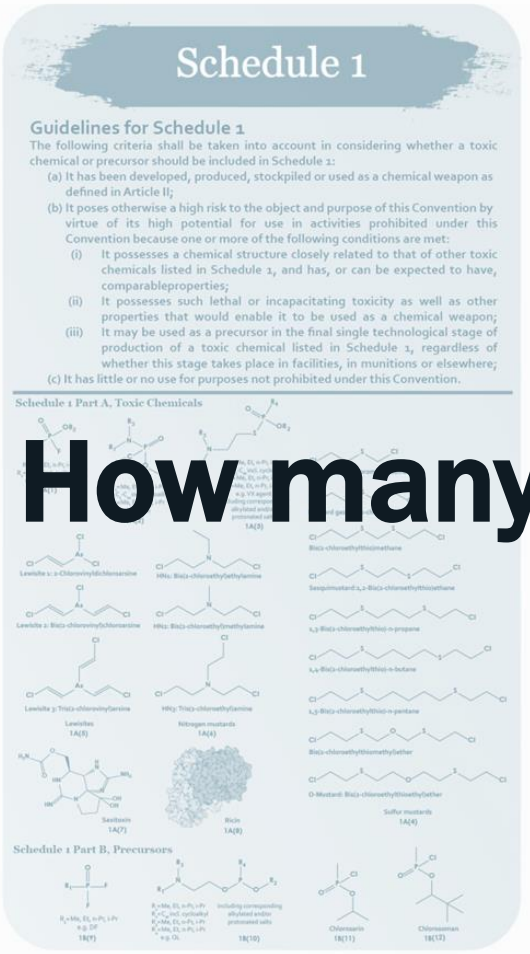
O-Cyclohexyl methyl-d3-phosphonofluoridate

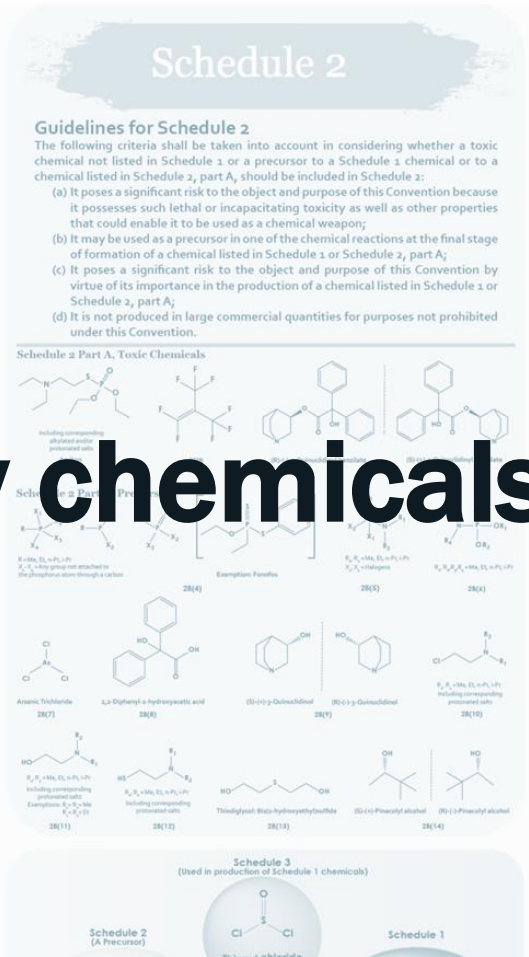
Handbook on Chemicals 2017 Revised version 1

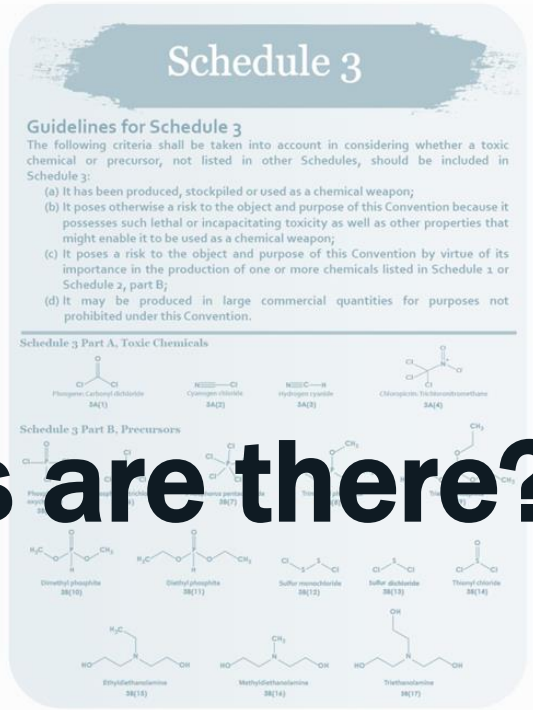
www.opcw.org/our-work/non-proliferation/declarations-adviser/handbook-on-chemicals/

Not all scheduled chemicals that have been declared have CAS numbers

What About Chemicals Not on Schedules?

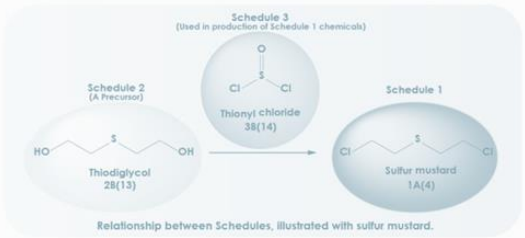




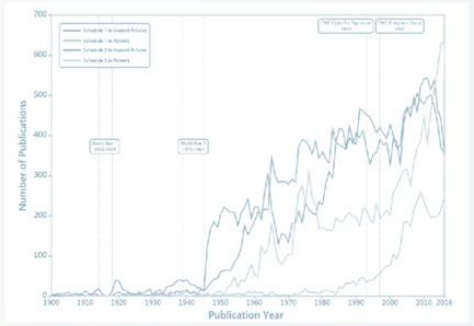


How many chemicals are there?

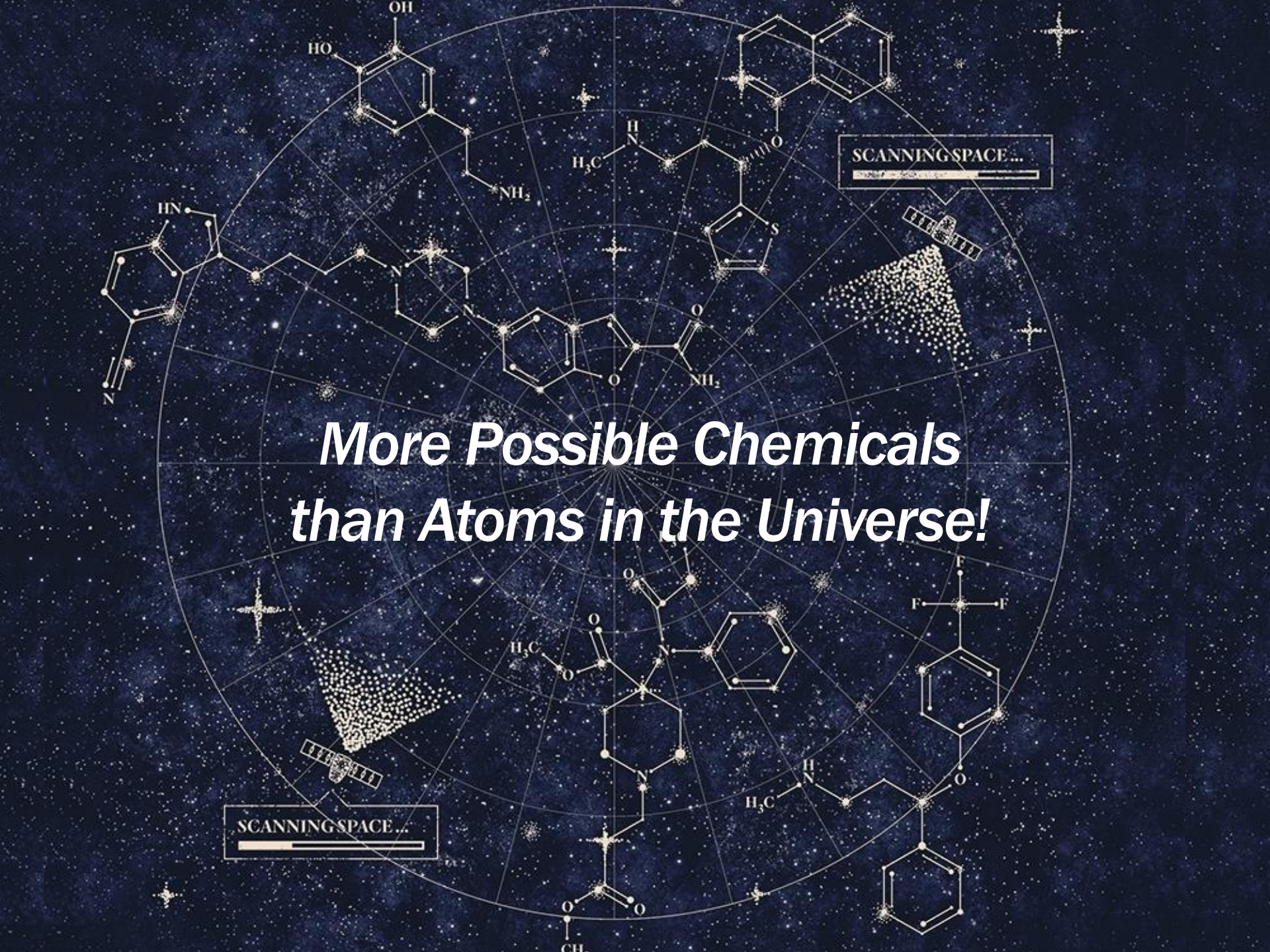
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS
Working Together for a World Free of Chemical Weapons



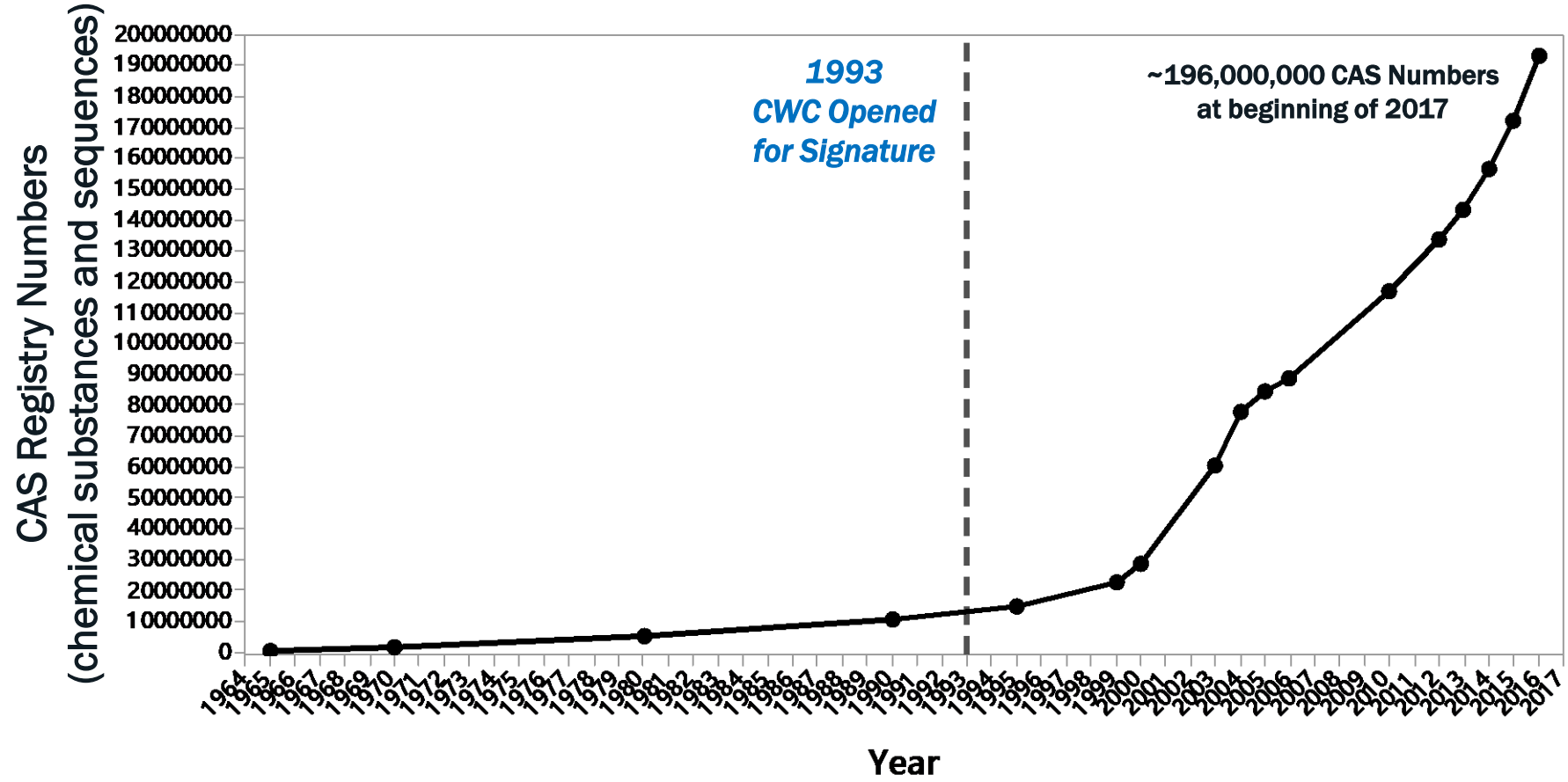
Relationship between Schedules, illustrated with sulfur mustard.



Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.



More Possible Chemicals than Atoms in the Universe!



> 209 million CAS Numbers as of July 2018...

> 142 million are organic/inorganic chemical substances

> 13 million new CAS numbers in past 18 months...

What About Chemicals Not on Schedules?

Which unscheduled chemicals matter?

Definition of a 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, Paragraph 2

Riot Control Agents

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

Riot control agents cannot be scheduled...

OPCW

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

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

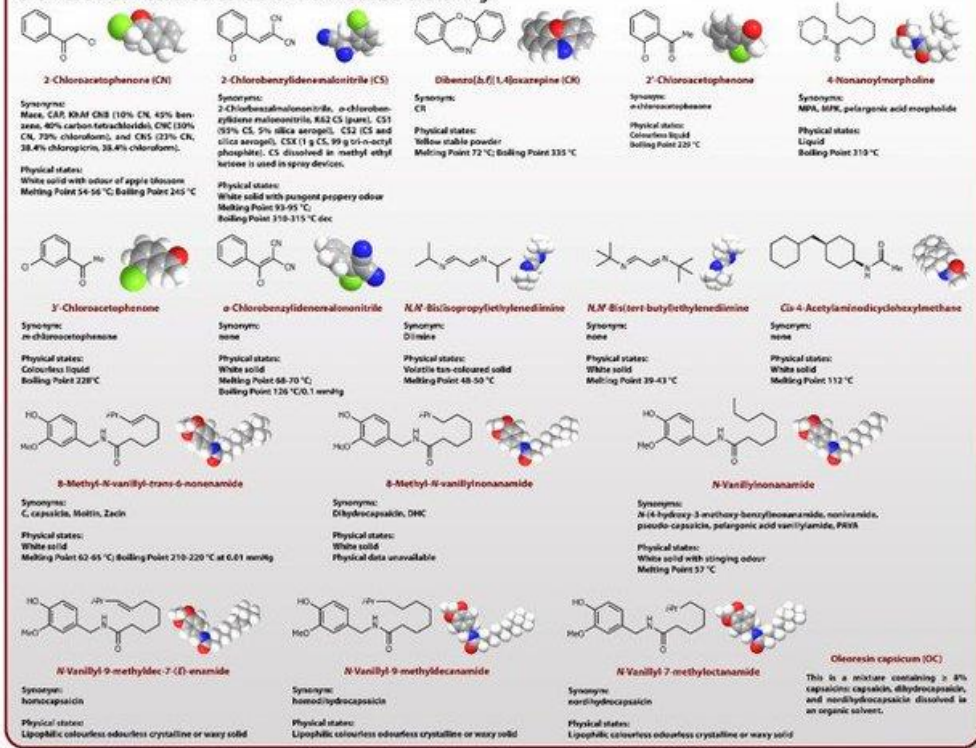
"Any chemical not listed in a Schedule, which can produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure."

How do Riot Control Agents work?

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

What are Riot Control Agents?

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



2-Chloroacetophenone (CN)

Synonyms:
Mace, CAP, Khat CNB (10% CN, 45% benzene, 40% carbon tetrachloride), CNC (30% CN, 70% chloroform), and CNS (23% CN, 38.4% chloropicrin, 38.4% chloroform).

Physical states:
White solid with odour of apple blossom
Melting Point 54-56 °C; Boiling Point 245 °C

2-Chlorobenzylidenemalononitrile (CS)

Synonyms:
2-Chlorobenzalmalononitrile, o-chlorobenzylidene malononitrile, K62 CS (pure), CS1 (95% CS, 5% silica aerogel), CS2 (CS and silica aerogel), CSX (1 g CS, 99 g tri-n-octyl phosphite). CS dissolved in methyl ethyl ketone is used in spray devices.

Physical states:
White solid with pungent peppery odour
Melting Point 93-95 °C;
Boiling Point 310-315 °C dec

Dibenzo[b,f][1,4]oxazepine (CR)

Synonym:
CR

Physical states:
Yellow stable powder
Melting Point 72 °C; Boiling Point 335 °C

2'-Chloroacetophenone

Synonym:
o-chloroacetophenone

Physical states:
Colourless liquid
Boiling Point 229 °C

4-Nonanoylmorpholine

Synonyms:
MPA, MPK, pelargonic acid morpholide

Physical states:
Liquid
Boiling Point 319 °C

3'-Chloroacetophenone

Synonym:
m-chloroacetophenone

Physical states:
Colourless liquid
Boiling Point 228°C

o-Chlorobenzylidenemalononitrile

Synonym:
none

Physical states:
White solid
Melting Point 68-70 °C;
Boiling Point 126 °C/0.1 mmHg

N,N'-Bis(isopropylidiethylenediimine

Synonym:
Diimine

Physical states:
Volatile tan-coloured solid
Melting Point 48-50 °C

N,N'-Bis(tert-butylidiethylenediimine

Synonym:
none

Physical states:
White solid
Melting Point 39-43 °C

Cis-4-Acetylaminodicyclohexylmethane

Synonym:
none

Physical states:
White solid
Melting Point 112 °C

8-Methyl-N-vanillyl-trans-6-nonenamide

Synonyms:
C. capsicikle, Moltin, Zacin

Physical states:
White solid
Melting Point 62-65 °C; Boiling Point 210-220 °C at 0.01 mmHg

8-Methyl-N-vanillylnonanamide

Synonyms:
Dihydrocapsaicin, DHC

Physical states:
White solid
Physical data unavailable

N-Vanillylnonanamide

Synonyms:
N-(4-hydroxy-3-methoxy-benzyl)nonanamide, nonivamide, pseudo-capsaicin, pelargonic acid vanillylamide, PAVA

Physical states:
White solid with stinging odour
Melting Point 57 °C

N-Vanillyl-9-methyldec-7-(E)-enamide

Synonym:
homocapsaicin

Physical states:
Lipophilic colourless odourless crystalline or waxy solid

N-Vanillyl-9-methyldecanamide

Synonym:
homodihydrocapsaicin

Physical states:
Lipophilic colourless odourless crystalline or waxy solid

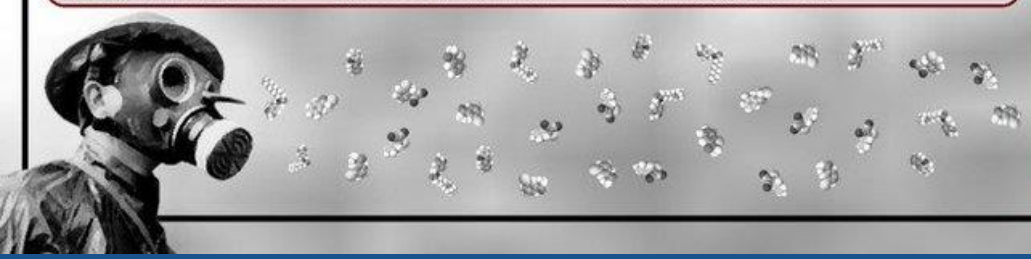
N-Vanillyl-7-methyloctanamide

Synonym:
nordihydrocapsaicin

Physical states:
Lipophilic colourless odourless crystalline or waxy solid

Oleoresin capsicum (OC)

This is a mixture containing ≥ 8% capsaicins: capsaicin, dihydrocapsaicin, and nordihydrocapsaicin dissolved in an organic solvent.



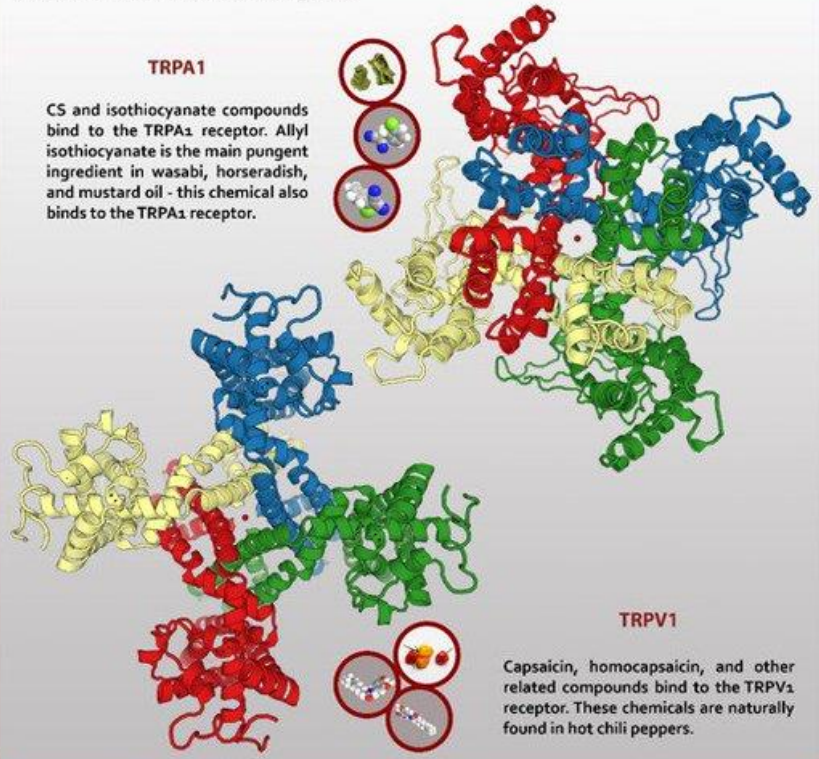
What are TRP Receptors?

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

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

TRPA1

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



TRPV1

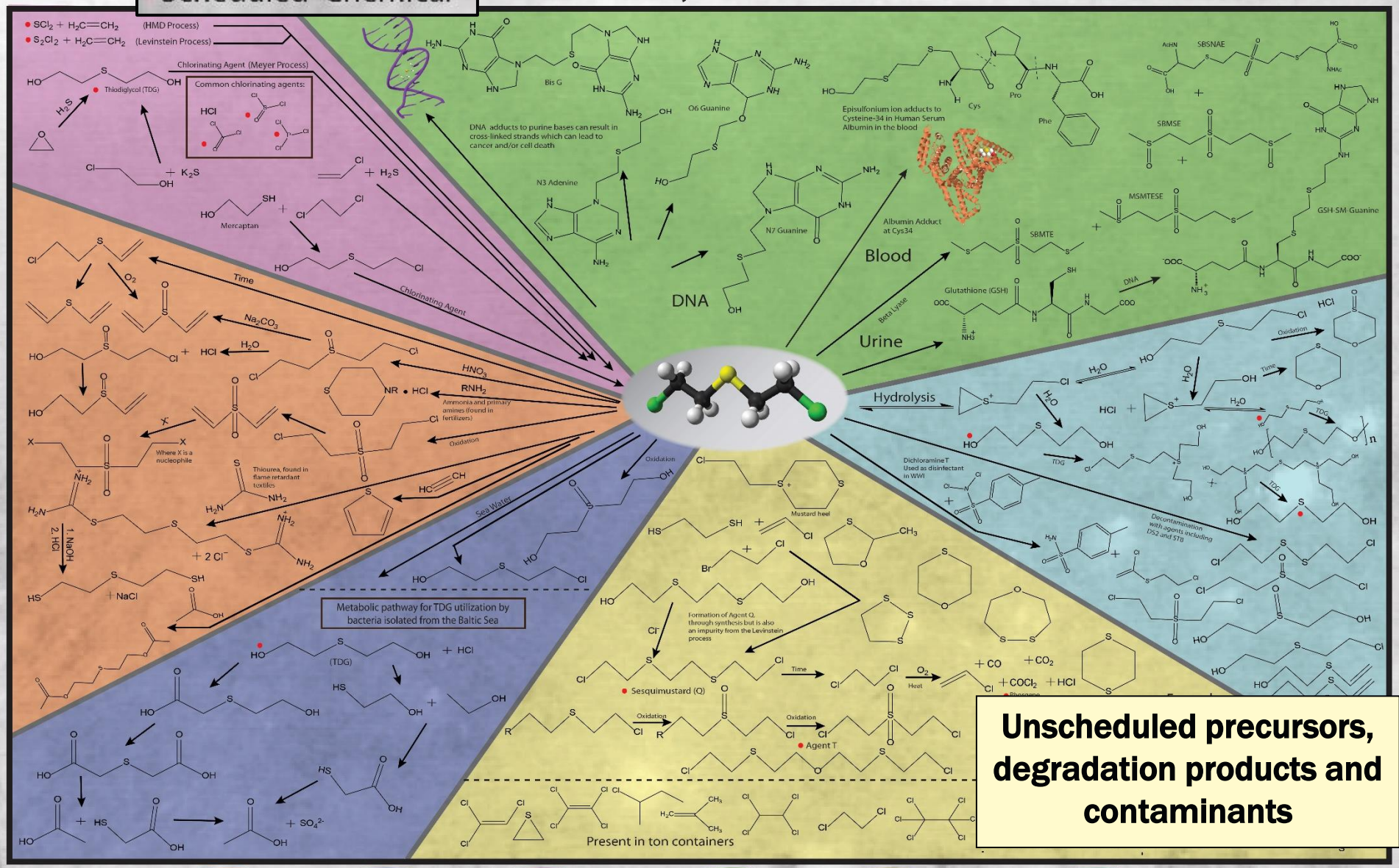
Capsaicin, homocapsaicin, and other related compounds bind to the TRPV1 receptor. These chemicals are naturally found in hot chili peppers.

Degradation and Environmental Fate of Sulfur Mustard

•Scheduled Chemical

Darcy van Eerten

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



Unscheduled precursors, degradation products and contaminants

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

Toxic Industrial Chemicals

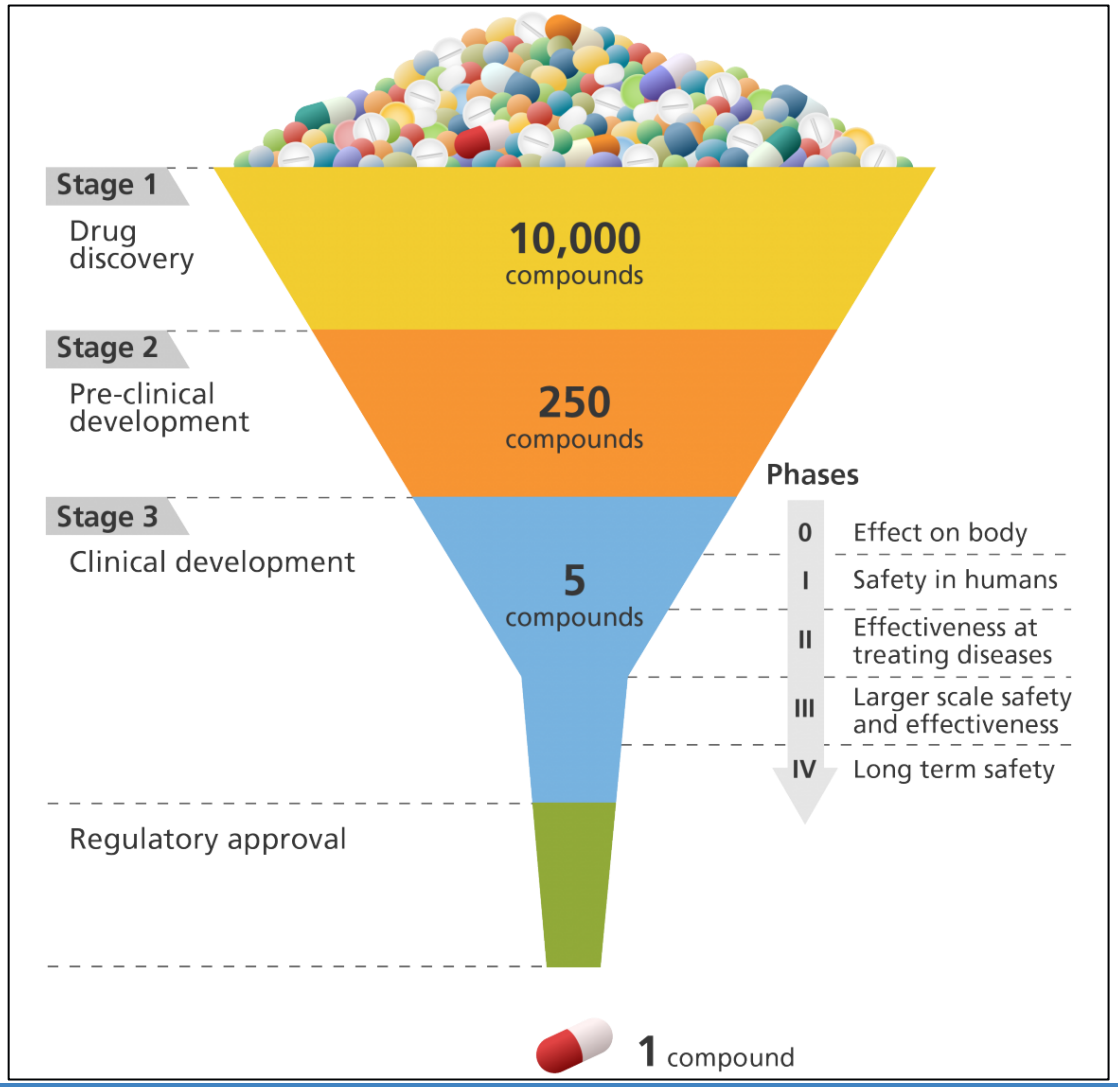
TICs listed by hazard index

High	Medium	Low
Ammonia (CAS# 7664-41-7)	**Acetone cyanohydrin** (CAS# 75-86-5)	**Allyl isothiocyanate** (CAS# 57-06-7)
Arsine (CAS# 7784-42-1)	**Acrolein** (CAS# 107-02-8)	**Arsenic trichloride** (CAS# 7784-34-1)
Boron trichloride (CAS#10294-34-5)	**Acrylonitrile** (CAS# 107-13-l)	**Bromine** (CAS# 7726-95-6)
Boron trifluoride (CAS#7637-07-2)	**Allyl alcohol** (CAS# 107-18-6)	**Bromine chloride** (CAS# 13863-41-7)
Carbon disulfide (CAS# 75-15-0)	**Allylamine** (CAS# 107-11-9)	**Bromine pentafluoride** (CAS# 7789-30-2)
Chlorine (CAS# 7782-50-5)	**Allyl chlorocarbonate** (CAS# 2937-50-0)	**Bromine trifluoride** (CAS# 7787-71-5)
Diborane (CAS# 19287-45-7)	**Boron tribromide** (CAS# 10294-33-4)	**Carbonyl fluoride** (CAS# 353-50-4)
Ethylene oxide (CAS# 75-21-8)	**Carbon monoxide** (CAS# 630-08-0)	**Chlorine pentafluoride** (CAS# 13637-63-3)
Fluorine (CAS# 7782-41-4)	**Carbonyl sulfide** (CAS# 463-58-1)	**Chlorine trifluoride** (CAS# 7790-91-2)
Formaldehyde (CAS# 50-00-0)	**Chloroacetone** (CAS# 78-95-5)	**Chloroacetaldehyde** (CAS# 107-20-0)
Hydrogen bromide (CAS# 10035-10-6)	**Chloroacetonitrile** (CAS# 7790-94-5)	**Chloroacetyl chloride** (CAS# 79-04-9)
Hydrogen chloride (CAS# 7647-01-0)	**Chlorosulfonic acid** (CAS# 7790-94-5)	**Crotonaldehyde** (CAS# 123-73-9)
Hydrogen cyanide (CAS#74-90-8)	**Diketene** (CAS# 674-82-8)	**Cyanogen chloride** (CAS# 506-77-4)
Hydrogen fluoride (CAS# 7664-39-3)	**1,2-Dimethylhydrazine** (CAS# 540-73-8)	**Dimethyl sulfate** (CAS# 77-78-1)
Hydrogen sulfide (CAS# 7783-0604)	**Ethylene dibromide** (CAS# 106-93-4)	**Diphenylmethane-4.4'-diisocyanate** (CAS# 101-68-8)
Nitric acid, fuming (CAS# 7697-37-2)	**Hydrogen selenide** (CAS# 7783-07-5)	**Ethyl chlroroformate** (CAS# 541-41-3)
Phosgene (CAS# 75-44-5)	**Methanesulfonyl chloride** (CAS# 124-63-0)	**Ethyl chlorothioformate** (CAS# 2941-64-2)
	n-Octyl mercaptan (CAS# 111-88-6)	**Tetraethyl lead** (CAS# 78-00-2)
	Titanium tetrachloride (CAS# 7550-45-0)	**Tetraethyl pyroposphate** (CAS# 107-49-3)
	Tricholoroacetyl chloride (CAS# 76-02-8)	**Tetramethyl lead** (CAS# 75-74-1)
	Trifluoroacetyl chloride (CAS# 354-32-5)	**Toluene 2.4-diisocyanate** (CAS# 584-84-9)
		Toluene 2.6-diisocyanate (CAS# 91-08-7)

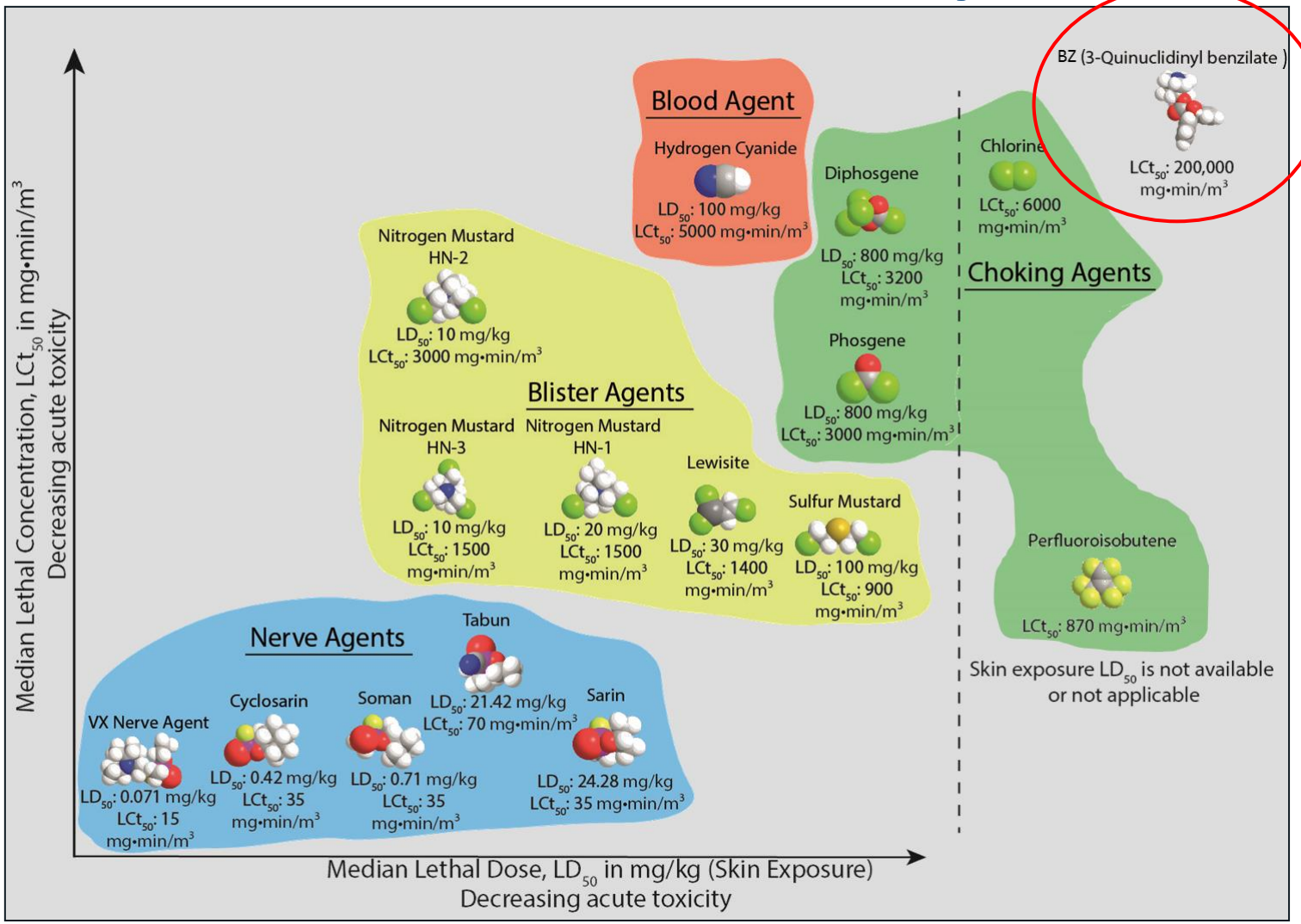
Some are scheduled

https://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html

Central Nervous System-Acting Chemicals

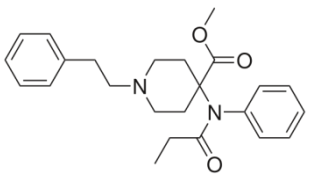


Relative Toxicity?



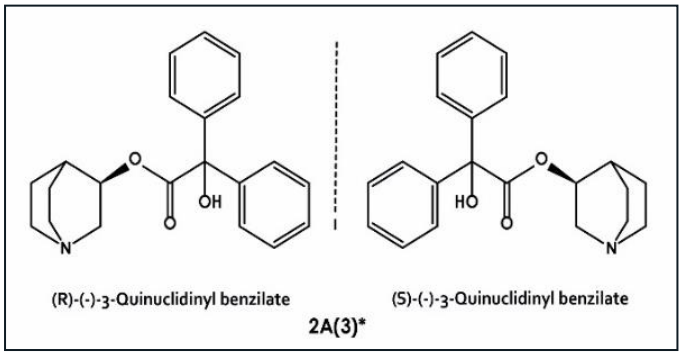
Can be lower than other CW

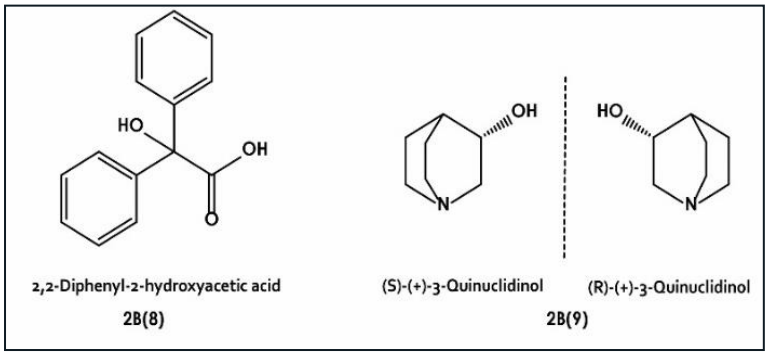
Can also be very high!



e.g. Carfentanil

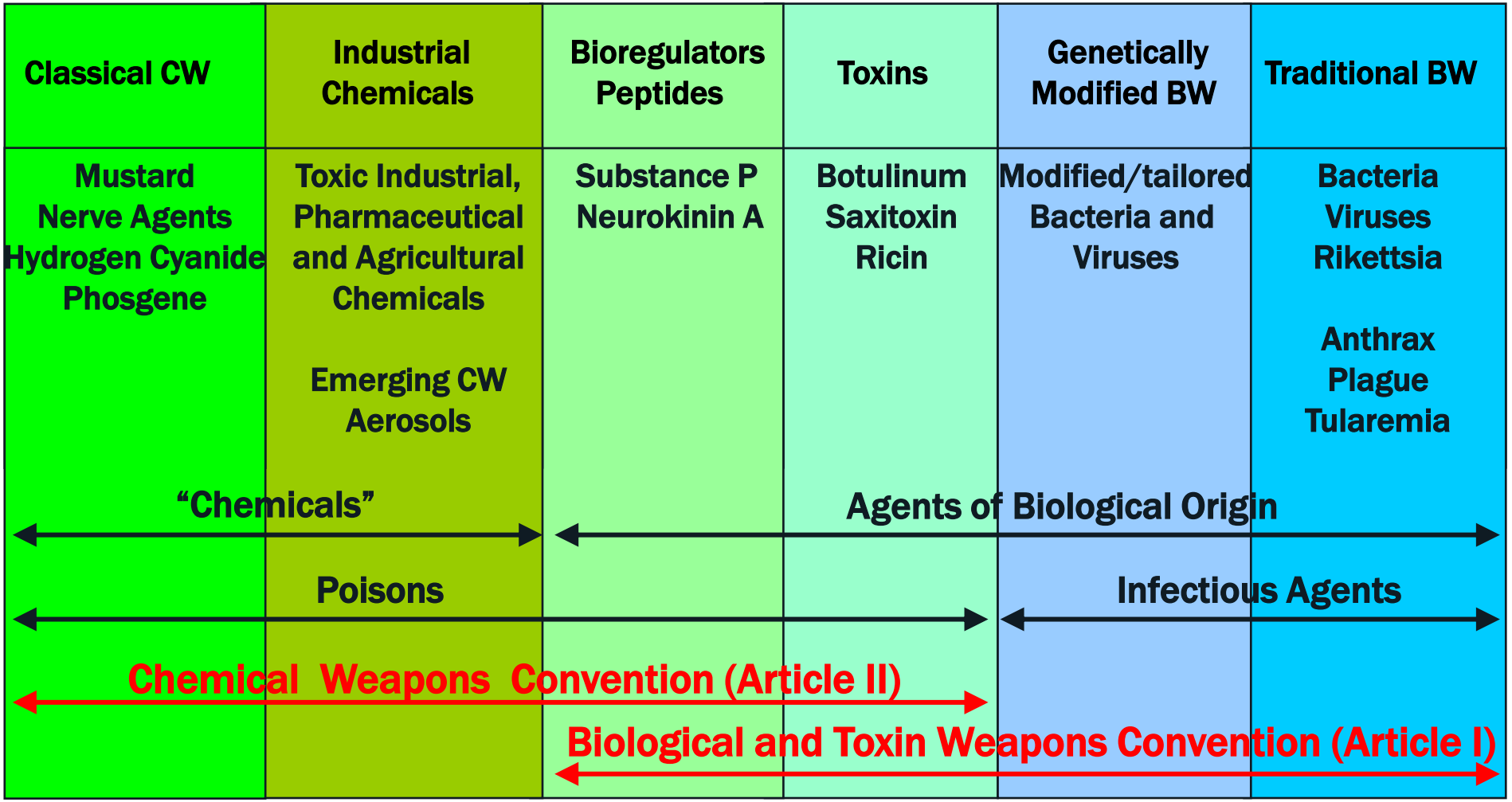
A scheduled CNS-acting chemical and its precursors





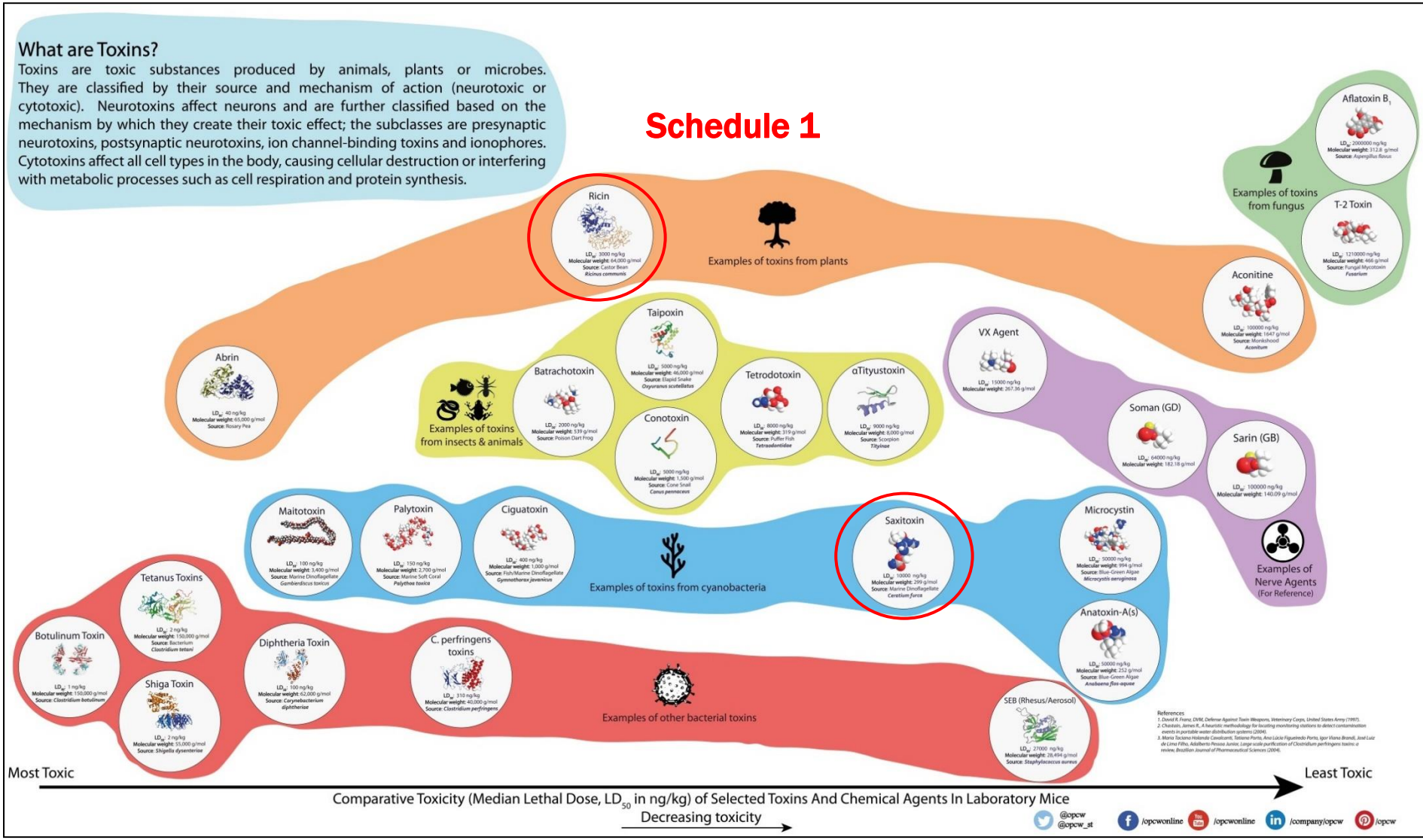
These precursors are not as widely used for pharmaceuticals as in the past
thanks to new and improved chemistry!

Chemical – Biological Threat Spectrum

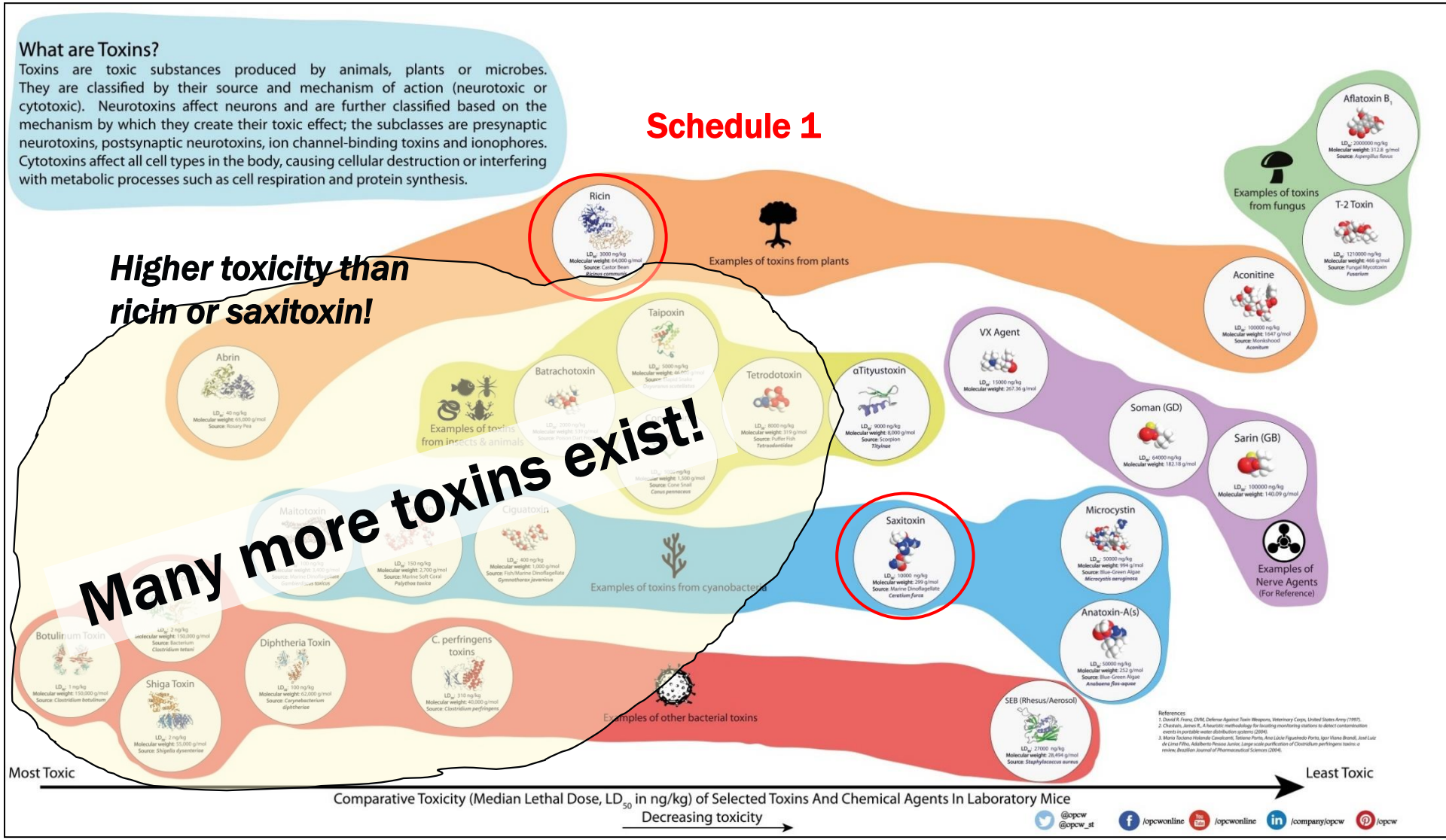


Adopted from Graham S Pearson, ASA Newsletter, 90-1, February 1990 and Robert Mathews at TWG on Convergence.1st Meeting 2011

Toxins


What are Toxins?
Toxins are toxic substances produced by animals, plants or microbes. They are classified by their source and mechanism of action (neurotoxic or cytotoxic). Neurotoxins affect neurons and are further classified based on the mechanism by which they create their toxic effect; the subclasses are presynaptic neurotoxins, postsynaptic neurotoxins, ion channel-binding toxins and ionophores. Cytotoxins affect all cell types in the body, causing cellular destruction or interfering with metabolic processes such as cell respiration and protein synthesis.
Schedule 1
Ricin
Examples of toxins from plants
Abrin
Aflatoxin B1
Examples of toxins from fungus
T-2 Toxin
Aconitine
Taipoxin
Batrachotoxin
Tetrodotoxin
αTityustoxin
Conotoxin
Examples of toxins from insects & animals
VX Agent
Soman (GD)
Sarin (GB)
Examples of Nerve Agents (For Reference)
Maitotoxin
Palytoxin
Ciguatoxin
Examples of toxins from cyanobacteria
Saxitoxin
Microcystin
Anatoxin-A(s)
Tetanus Toxins
Botulinum Toxin
Shiga Toxin
Diphtheria Toxin
C. perfringens toxins
Examples of other bacterial toxins
SEB (Rhesus/Aerosol)
References
Most Toxic
Least Toxic
Comparative Toxicity (Median Lethal Dose, LD50 in ng/kg) of Selected Toxins And Chemical Agents In Laboratory Mice
Decreasing toxicity
@opcw
@opcw_st
/opcwonline
/opcwonline
/company/opcw
/opcw

Toxins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Schedule 1
Higher toxicity than ricin or saxitoxin!
Many more toxins exist!
Ricin
Examples of toxins from plants
Aflatoxin B1
Examples of toxins from fungus
T-2 Toxin
Aconitine
Abrin
Taipoxin
Batrachotoxin
Tetrodotoxin
αTityustoxin
Examples of toxins from insects & animals
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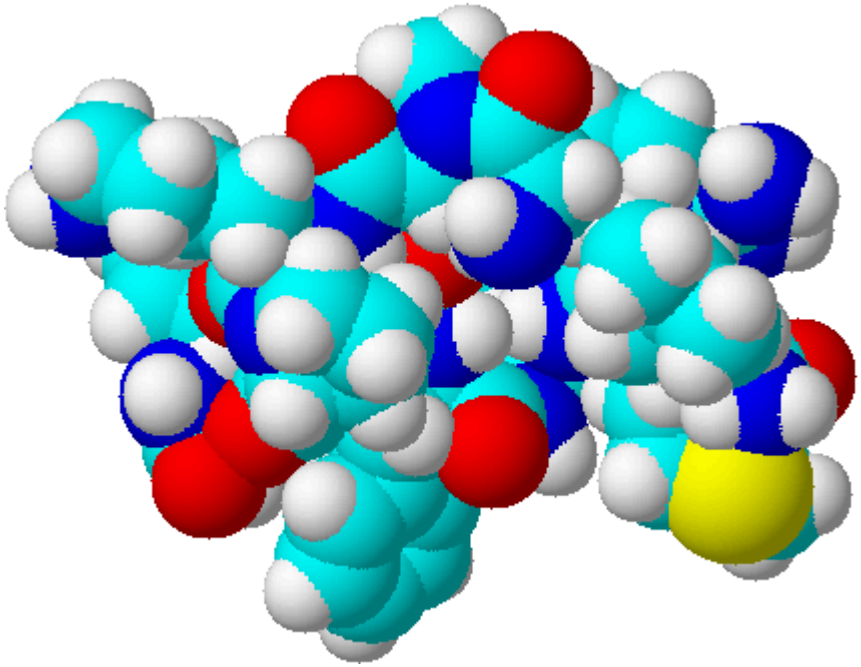
Decreasing toxicity
@opcw
@opcw_st
/opcwonline
/opcwonline
/company/opcw
/opcw

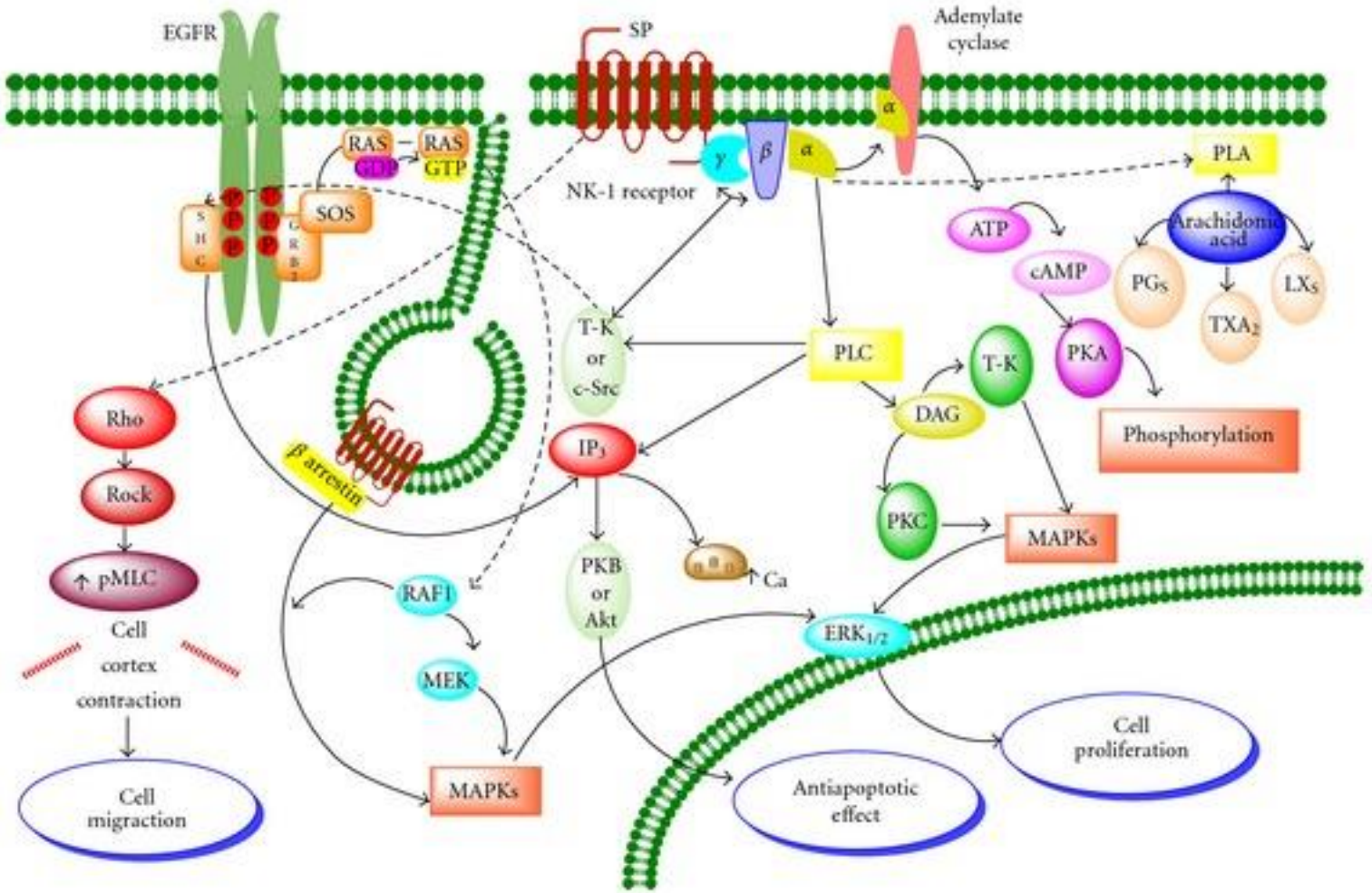
Bioregulators

- **Endogenous molecules that regulate life processes…**



Substance P (pain modulation)

Bioregulators



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SAB does not view advances in research on bioregulators as posing a risk at present

Unscheduled Chemicals that Pose a Risk to the Convention?

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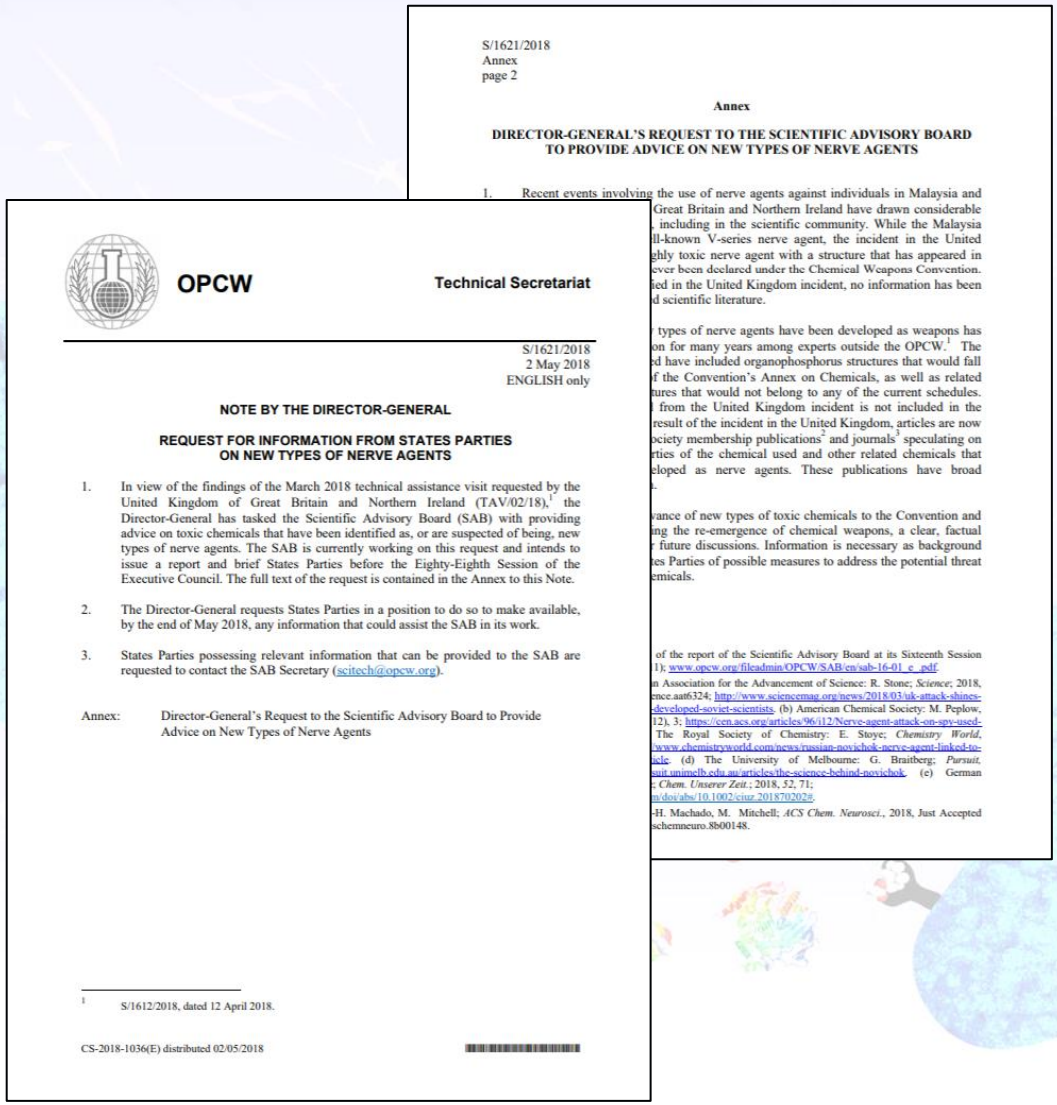
Recent Advice from the Scientific Advisory Board



S/1621/2018
Annex
page 2

Annex

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

1. Recent events involving the use of nerve agents against individuals in Malaysia and Great Britain and Northern Ireland have drawn considerable , including in the scientific community. While the Malaysia ll-known V-series nerve agent, the incident in the United ghly toxic nerve agent with a structure that has appeared in ever been declared under the Chemical Weapons Convention. ied in the United Kingdom incident, no information has been d scientific literature.

types of nerve agents have been developed as weapons has on for many years among experts outside the OPCW.[1] The d have included organophosphorus structures that would fall f the Convention's Annex on Chemicals, as well as related tures that would not belong to any of the current schedules. from the United Kingdom incident is not included in the result of the incident in the United Kingdom, articles are now ociety membership publications[2] and journals[3] speculating on rties of the chemical used and other related chemicals that eloped as nerve agents. These publications have broad

vance of new types of toxic chemicals to the Convention and ing the re-emergence of chemical weapons, a clear, factual future discussions. Information is necessary as background tes Parties of possible measures to address the potential threat emicals.

of the report of the Scientific Advisory Board at its Sixteenth Session 1); www.opcw.org/fileadmin/OPCW/SAB/en/sab-16-01_e_.pdf.

n Association for the Advancement of Science: R. Stone; *Science*; 2018, ence.aat6324; http://www.sciencemag.org/news/2018/03/uk-attack-shines- developed-soviet-scientists. (b) American Chemical Society: M. Peplow, 12), 3; https://cen.acs.org/articles/96/i12/Nerve-agent-attack-on-spy-used- The Royal Society of Chemistry: E. Stoye; *Chemistry World*, www.chemistryworld.com/news/russian-novichok-nerve-agent-linked-to- icle. (d) The University of Melbourne: G. Braitberg; *Pursuit*, uit.unimelb.edu.au/articles/the-science-behind-novichok. (e) German ; *Chem. Unserer Zeit.*; 2018, *52*, 71; n/doi/abs/10.1002/ciuz.201870202#.

-H. Machado, M. Mitchell; *ACS Chem. Neurosci.*, 2018, Just Accepted schemneuro.8b00148.

OPCW **Technical Secretariat**

S/1621/2018
2 May 2018
ENGLISH only

NOTE BY THE DIRECTOR-GENERAL

REQUEST FOR INFORMATION FROM STATES PARTIES ON NEW TYPES OF NERVE AGENTS

1. In view of the findings of the March 2018 technical assistance visit requested by the United Kingdom of Great Britain and Northern Ireland (TAV/02/18),[1] the Director-General has tasked the Scientific Advisory Board (SAB) with providing advice on toxic chemicals that have been identified as, or are suspected of being, new types of nerve agents. The SAB is currently working on this request and intends to issue a report and brief States Parties before the Eighty-Eighth Session of the Executive Council. The full text of the request is contained in the Annex to this Note.

2. The Director-General requests States Parties in a position to do so to make available, by the end of May 2018, any information that could assist the SAB in its work.

3. States Parties possessing relevant information that can be provided to the SAB are requested to contact the SAB Secretary (scitech@opcw.org).

Annex: Director-General's Request to the Scientific Advisory Board to Provide Advice on New Types of Nerve Agents

[1] S/1612/2018, dated 12 April 2018.

CS-2018-1036(E) distributed 02/05/2018

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Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1

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

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

(b) It poses otherwise a high risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention because one or more of the following conditions are met:

(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparableproperties;

(ii) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;

(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;

(c) It has little or no use for purposes not prohibited under this Convention.

Schedule 1 Part A, Toxic Chemicals

Schedule 1 Part B, Precursors

Schedule 2

Guidelines for Schedule 2

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

(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;

(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 2, part A;

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

Schedule 2 Part A, Toxic Chemicals

Schedule 3

Guidelines for Schedule 3

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

(a) It has been produced as a chemical weapon;

(b) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;

(c) It poses a high risk to the object and purpose of this Convention by virtue of its importance in the production of one or more chemicals listed in Schedule 1 or Schedule 2, part B;

(d) It can be produced in large commercial quantities for purposes not prohibited under this Convention.

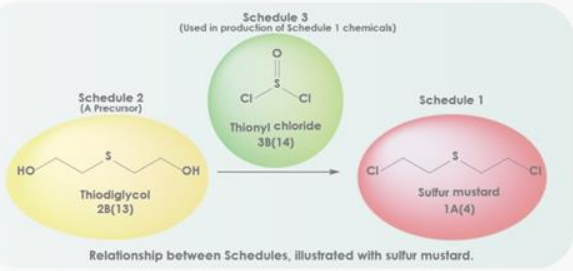
Schedule 3 Part A, Toxic Chemicals

Schedule 3 Part B, Precursors

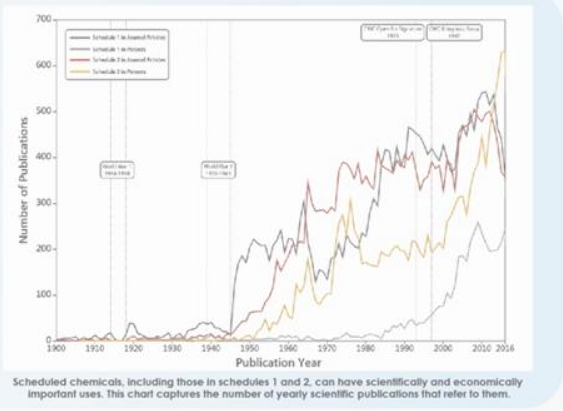
SAB Recommendations on Unscheduled Chemicals: Detection! OCAD!

Proposals to Change Schedules?

Must Come From States Parties (Article XV)



Relationship between Schedules, illustrated with sulfur mustard.

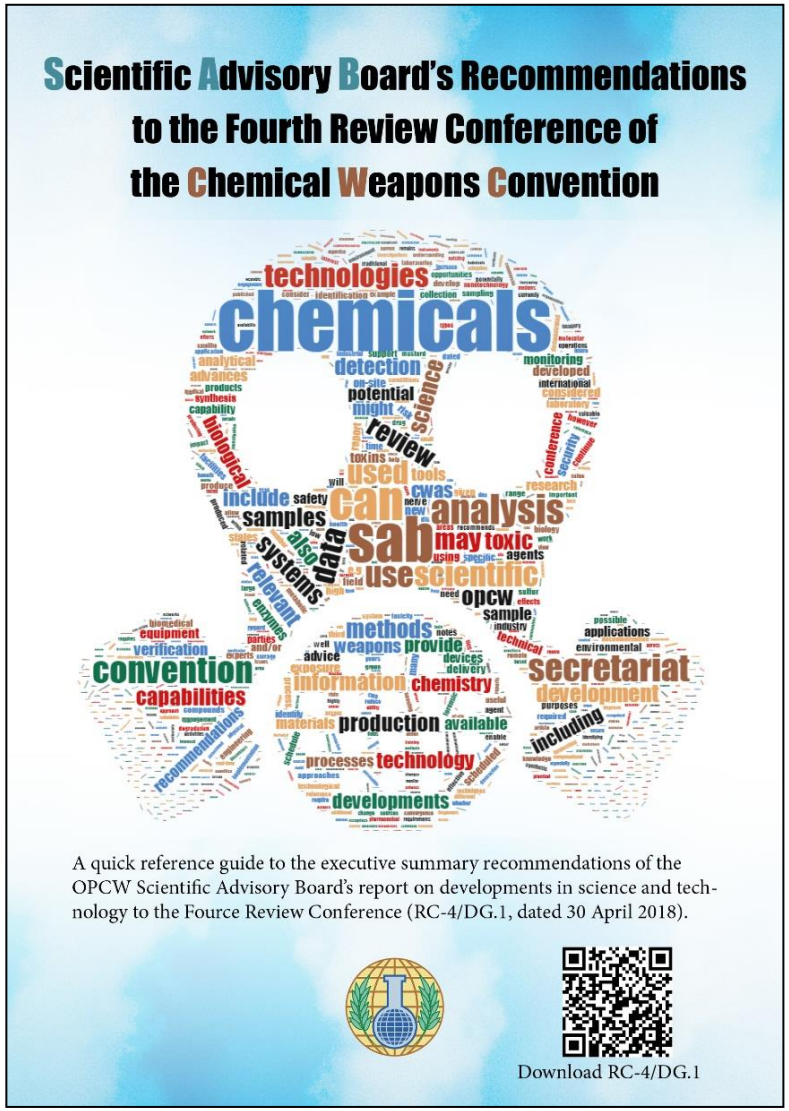


Scheduled chemicals, including those in schedules 1 and 2, can have scientifically and economically important uses. This chart captures the number of yearly scientific publications that refer to them.

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Working Together for a World Free of Chemical Weapons

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



"Given the substantial changes in chemistry and chemical industry since the schedules were finalised a quarter century ago, a review of the schedules should be considered to assess whether: (a) the chemicals currently listed are in the appropriate Schedule, and (b) any toxic chemicals or specific precursors should be added to or removed from the Schedules."

Scientific Advisory Board from January to July 2018

OPCW

Organisation for the Prohibition of Chemical Weapons

Summary of the First Meeting of the Scientific Advisory Board's Temporary Working Group on Investigative Science and Technology
(SAB-27/WP.1, dated 26 February 2018)

Report of the Scientific Advisory Board at its Twenty-Seventh Session
(SAB-27/1, dated 23 March 2018)

Director-General's Response to the Report of the Twenty-Seventh Session of the Scientific Advisory Board
(EC-88/DG.5, dated 9 May 2018)

Report of the Scientific Advisory Board on Developments in Science and Technology for the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention
(RC-4/DG.1, dated 30 April 2018)

Response by the Director-General to the report of the Scientific Advisory Board on Developments in Science and Technology for the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention
(RC-4/DG.2, dated 1 June 2018)

Response To The Director-General's Request To The Scientific Advisory Board To Provide Advice On New Types Of Nerve Agents
(SAB-28/1, dated 3 July 2018)

OPCW

منظمة حظر الأسلحة الكيميائية

禁止化学武器组织

Organisation for the Prohibition of Chemical Weapons

Organisation pour l'Interdiction des Armes Chimiques

Организация по запрещению химического оружия

Organización para la Prohibición de las Armas Químicas