



# Biotoxin bootcamp: saxitoxin, ricin, and beyond

Science for  
Diplomats Series

OPCW

Organisation for the Prohibition of Chemical Weapons

Sarah Clapham, OSP  
Karina Vignati, OPCW Lab  
Héctor Romero Cantú, Intern

1

Introduction  
to biotoxins

2

TWG on  
analysis of  
biotoxins

3

Biotoxins at  
the ChemTech  
Centre

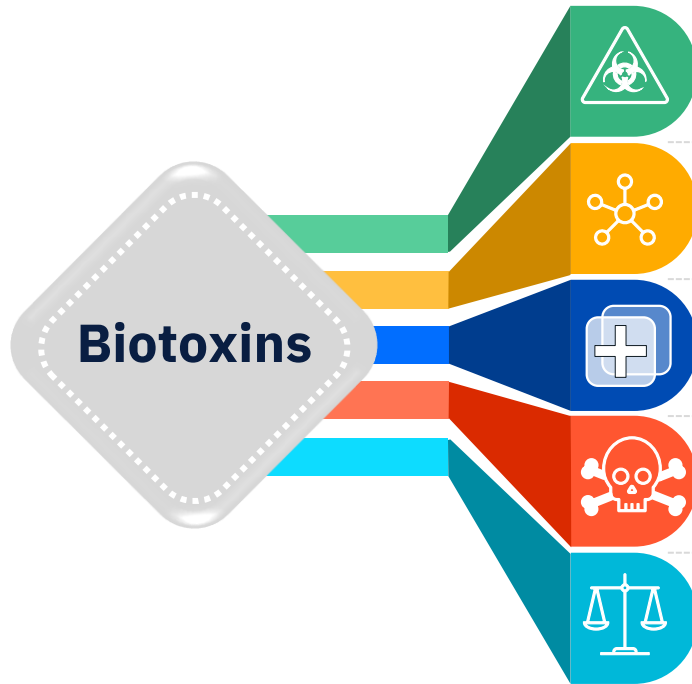
4

Lab time





# What are biotoxins?



**Toxic chemicals** usually obtained from biological source materials

May be a single biotoxin or a family of biotoxins

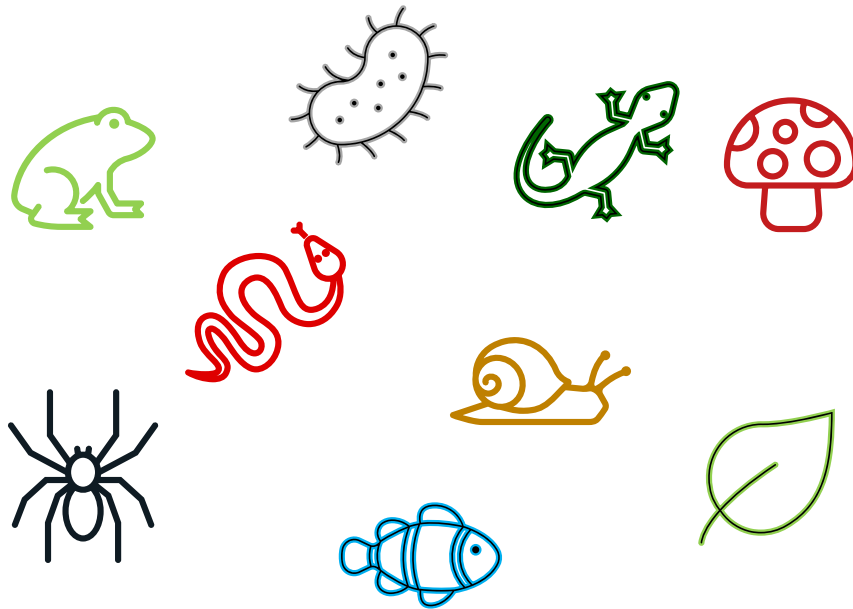
Not infectious and cannot self-replicate

Toxicity may be similar to or exceed that of traditional nerve agents

May be grouped into low molecular weight and high molecular weight



# What are biotoxins?



# What are biotoxins?

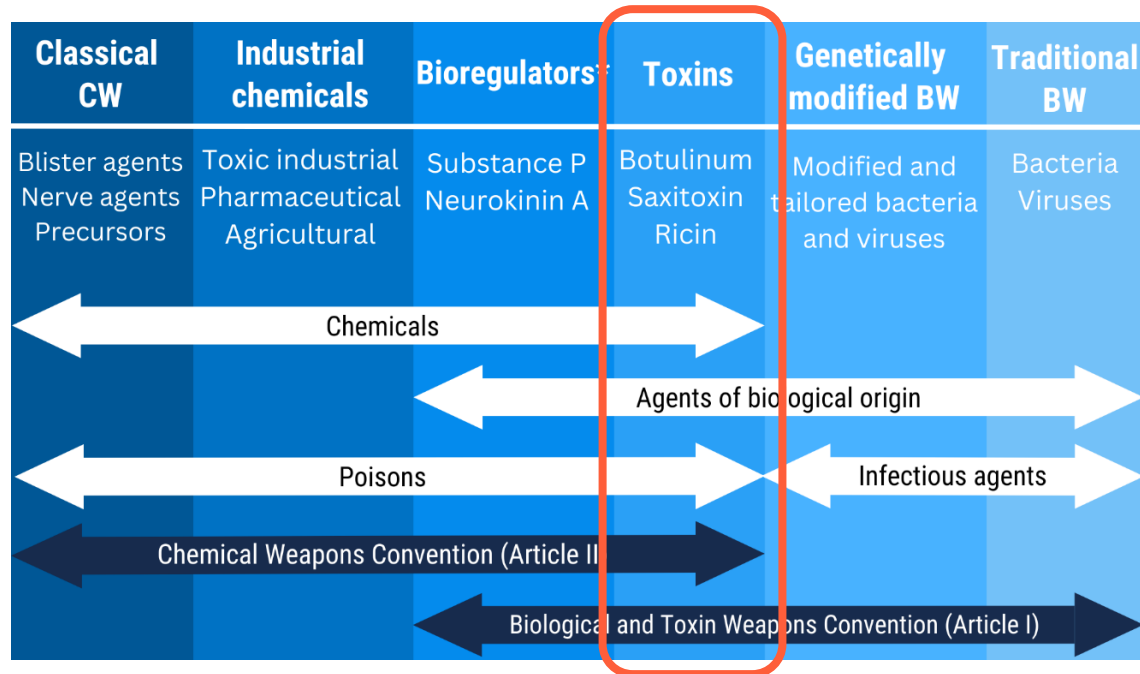


# Biotoxins and the Convention

2

Scheduled biotoxins:  
**ricin and saxitoxin**

Any use of the toxic properties of chemicals as a method of warfare is prohibited



\*Differing views exist regarding whether or not bioregulators are covered by the BTWC

# Saxitoxin

Schedule  
1.A.7



# Saxitoxin

Low molecular weight



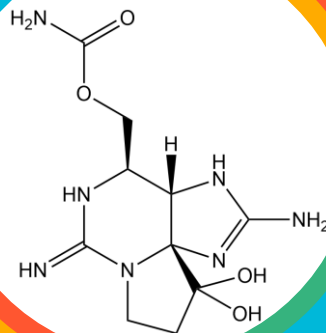
Paralytic shellfish poisoning



No antidote



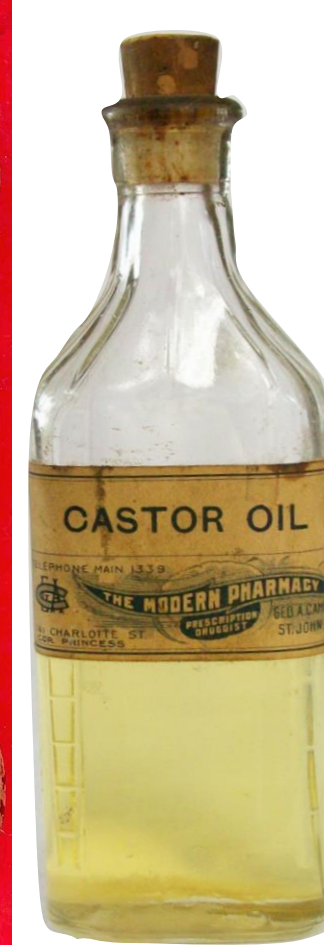
Death in hours





# Ricin

Schedule  
1.A.8



# Ricin

High molecular weight



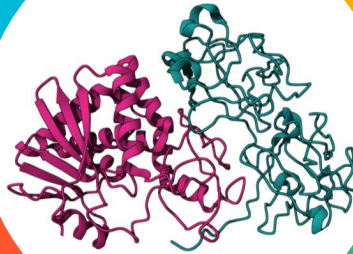
Stops protein synthesis



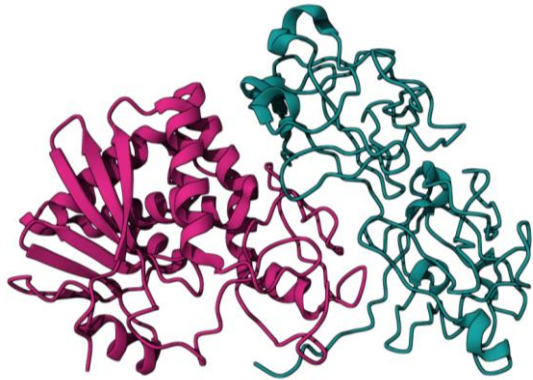
No antidote



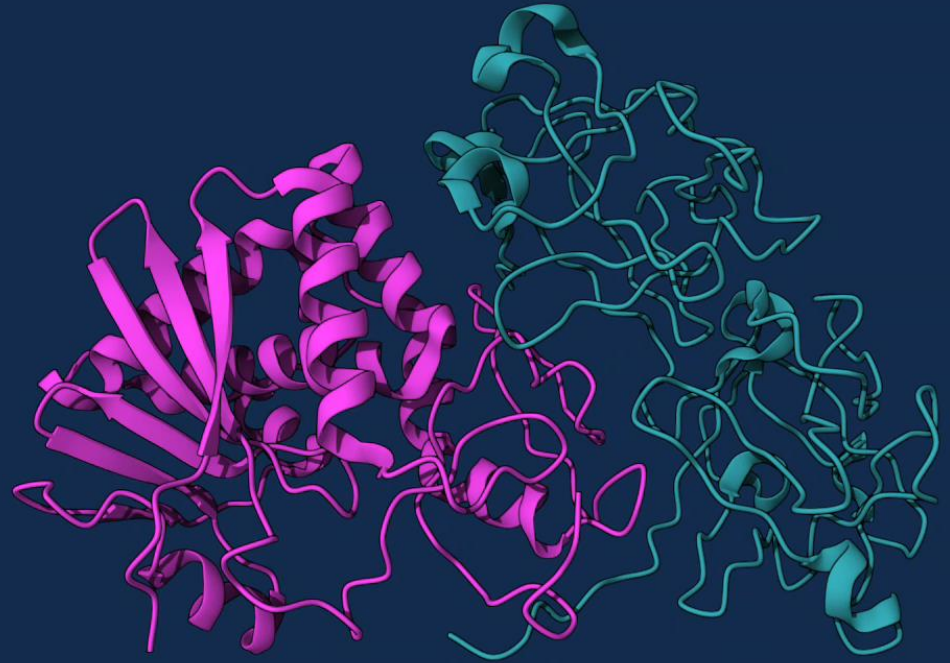
Death in days



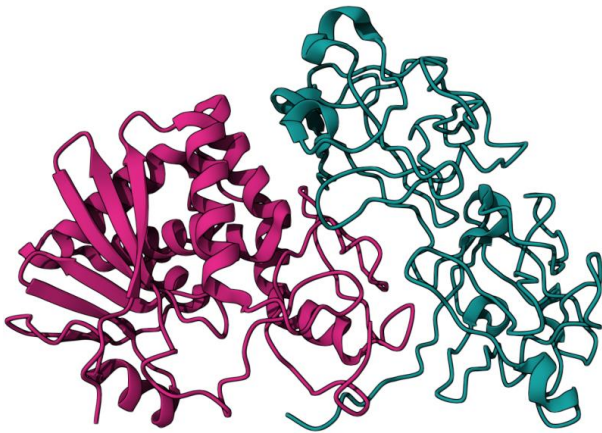
# Ricin



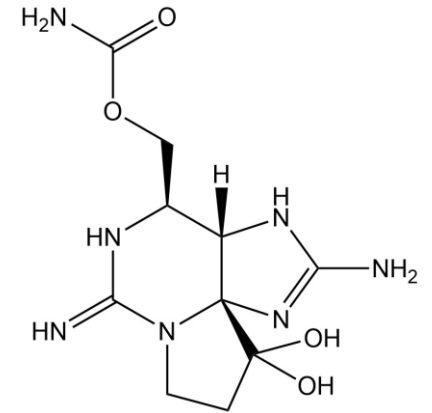
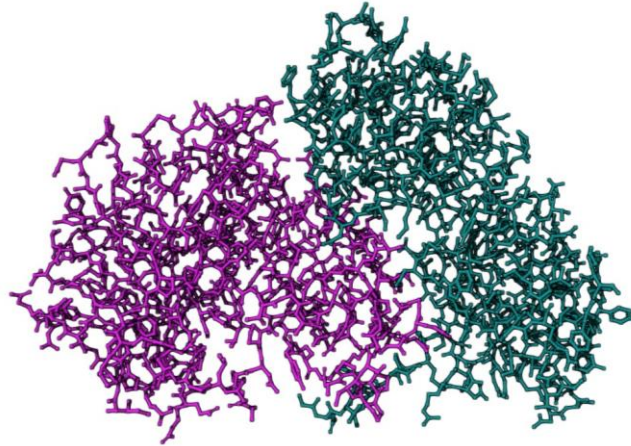
Ribbon diagram – 3D  
representation of a protein



# HMW *versus* LMW

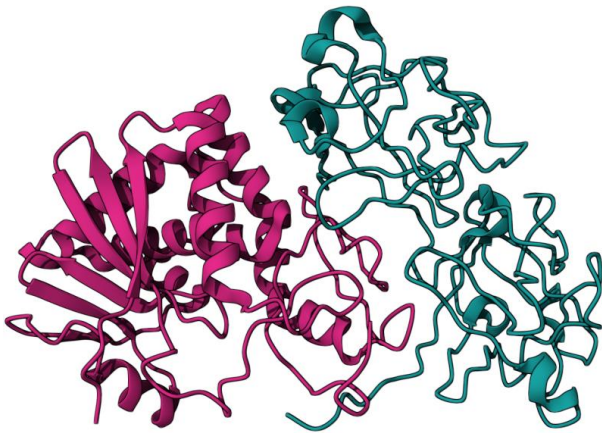


**Ricin – HMW**

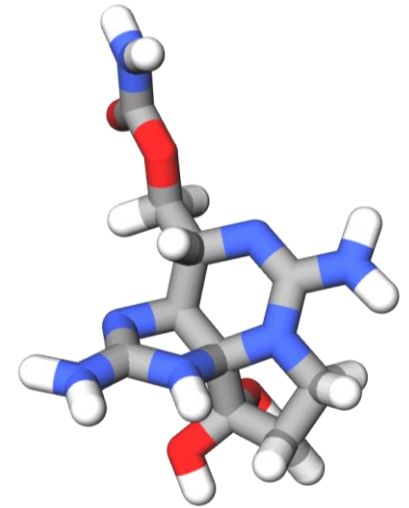
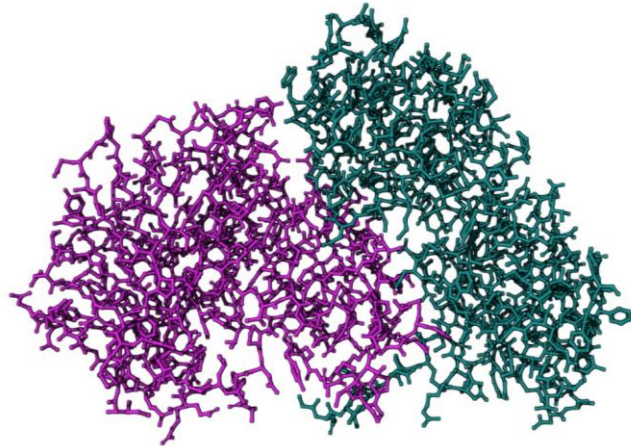


**Saxitoxin – LMW**

# HMW *versus* LMW

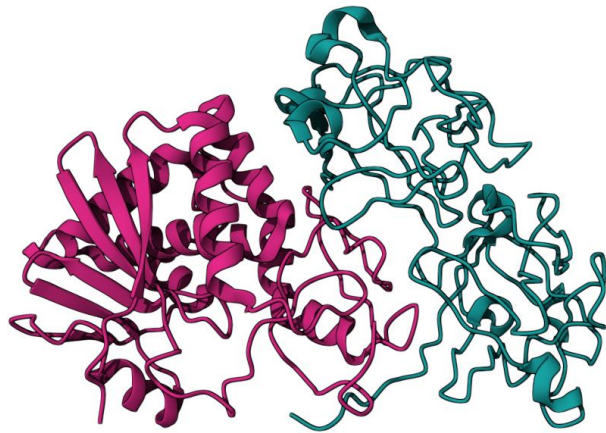


**Ricin – HMW**

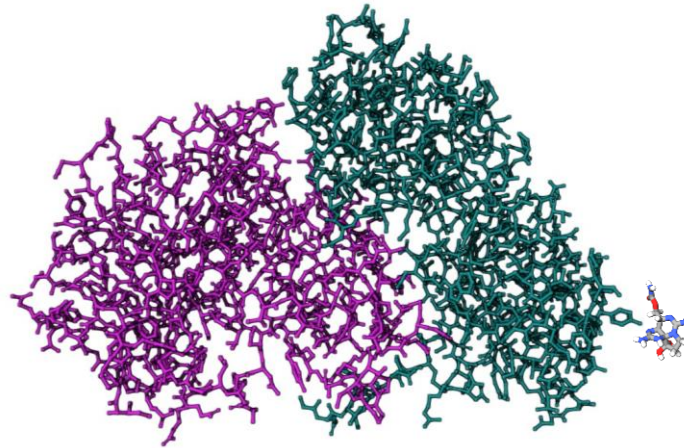


**Saxitoxin – LMW**

# HMW *versus* LMW



Ricin – HMW



7 nanometres

7 nanometres

Saxitoxin – LMW

---

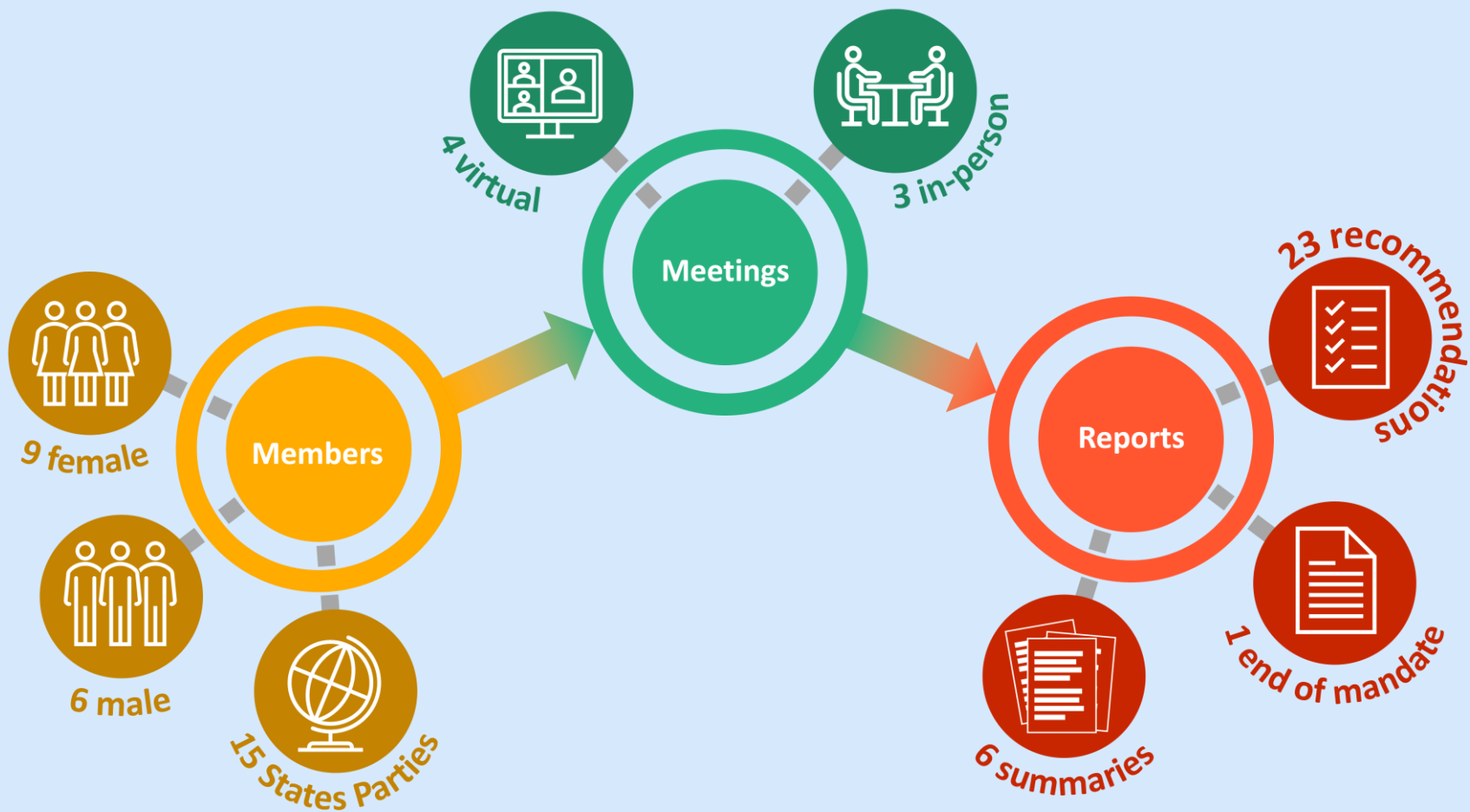
# TWG on analysis of biotoxins



Review the relevant science and technology and identify considerations to be taken into account in investigations of alleged use of biotoxins



**2021 – 2023**



# TWG on biotoxins by numbers



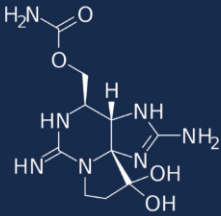
# End of mandate report

SAB/REP/1/23, April 2023

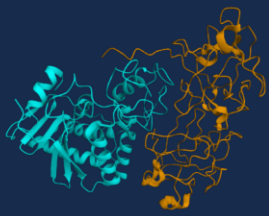


## Analysis of Biotoxins

Report of the Scientific Advisory Board's  
Temporary Working Group


NC(=O)O[C@@H]1[C@H](N)C(=O)N[C@@H]1C(=O)N

*Saxitoxin*

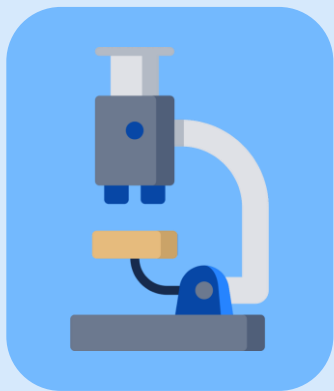


*Ricin*

SAB/REP/1/23  
April 2023



# Challenges



**Extremely diverse**  
in terms of size and  
chemical properties



**No universal  
detector** for wide-  
area monitoring



**No single analytical  
technique** which  
can be applied



# Most relevant biotoxins

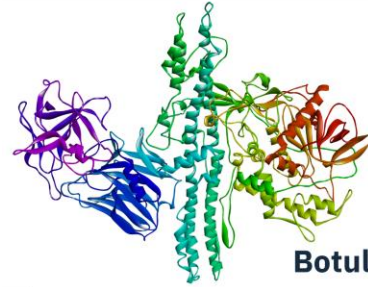
- 9 biotoxins or biotoxin families
- HMW and LMW



**Abrin**



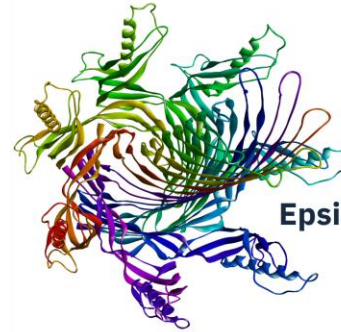
**Ricin**



**Botulinum A**



**Staphylococcal enterotoxin B**



**Epsilon A**



**Aflatoxin B1**



**Saxitoxin**



**T-2 toxin**

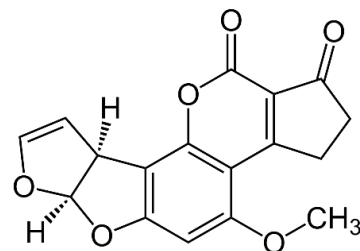


**Tetrodotoxin**

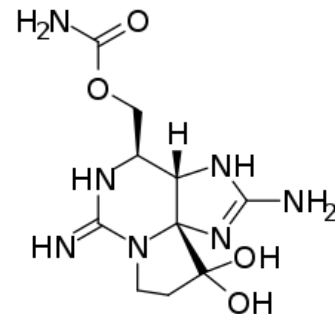


# Most relevant biotoxins

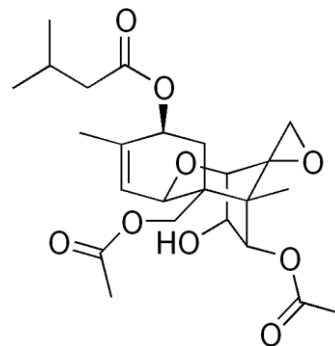
- 9 biotoxins or biotoxin families
- HMW and LMW



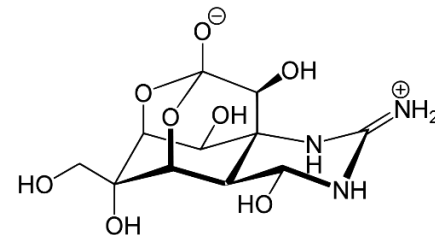
Aflatoxin B1



Saxitoxin



T-2 toxin



Tetrodotoxin



The OPCW should consider a proficiency test regime for biotoxin analysis that enables a laboratory to seek separate designation for the analysis of ricin or of saxitoxin



---

The OPCW should adopt a comprehensive forensic approach to every investigation of alleged use of biotoxins ...

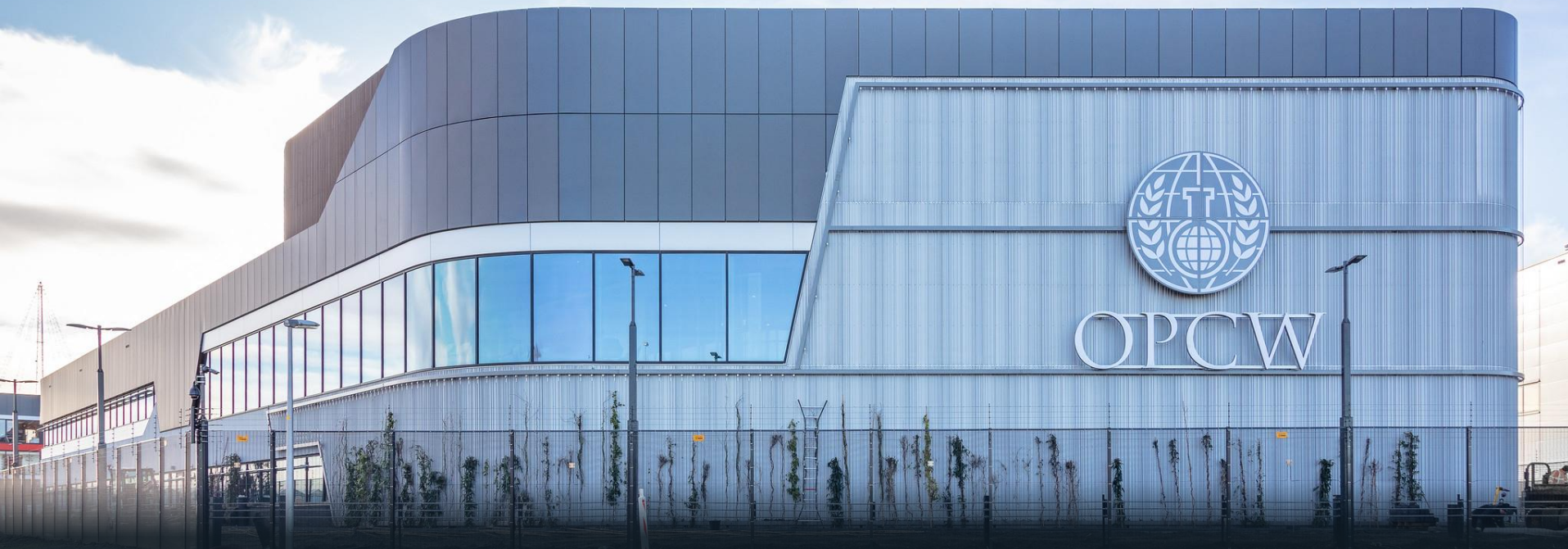
---



The OPCW should work closely with the UN...along with any other interested organisations and laboratories... to establish an informal network for biotoxin analysis to facilitate building international capabilities for forensic analysis of biotoxins



# Biotoxins at the ChemTech Centre



Developing the OPCW's capabilities to enable it to better respond to incidents of alleged biotoxin use



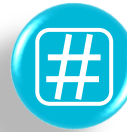




# Analysis of biotoxins exercises

Agreed with Designated Laboratories:

- No exercise in 2023
- Mock proficiency test planned for 2024



7



November 2022



23 participants (21 reports)



Saxitoxins (85% identified)



Non-scheduled biotoxin



Global Partnership Working  
Group/UK Ministry of  
Defence



3 years



Develop:

- analytical techniques
- methods
- a validated ricin detection test kit



---

## Analysis of biotoxins project

Enhance the Secretariat's ability  
to respond to the threat of use of  
biotoxins



---

# Biotoxins and the UNSGM

Strengthening the relationship  
between the OPCW and the  
UNSGM



## Wilton Park

**June 2023**

Supporting the effective operationalisation  
and maintenance of the UNSGM



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

**September 2023**

8<sup>th</sup> Swiss UNSGM Designated Laboratories  
Workshop and post-workshop meeting with  
key stakeholders





**Lab time**

# Scenario summary

---

- During a **carnival**, several partygoers fall ill reporting **various symptoms**, including fatigue, fever, and vomiting.
- The widespread use of **coloured powders** during the event had previously raised some **security concerns**.
- The local authorities want your help in testing samples for the presence of **ricin**.



# Equipment



Buffer solution



Test vial



Swab



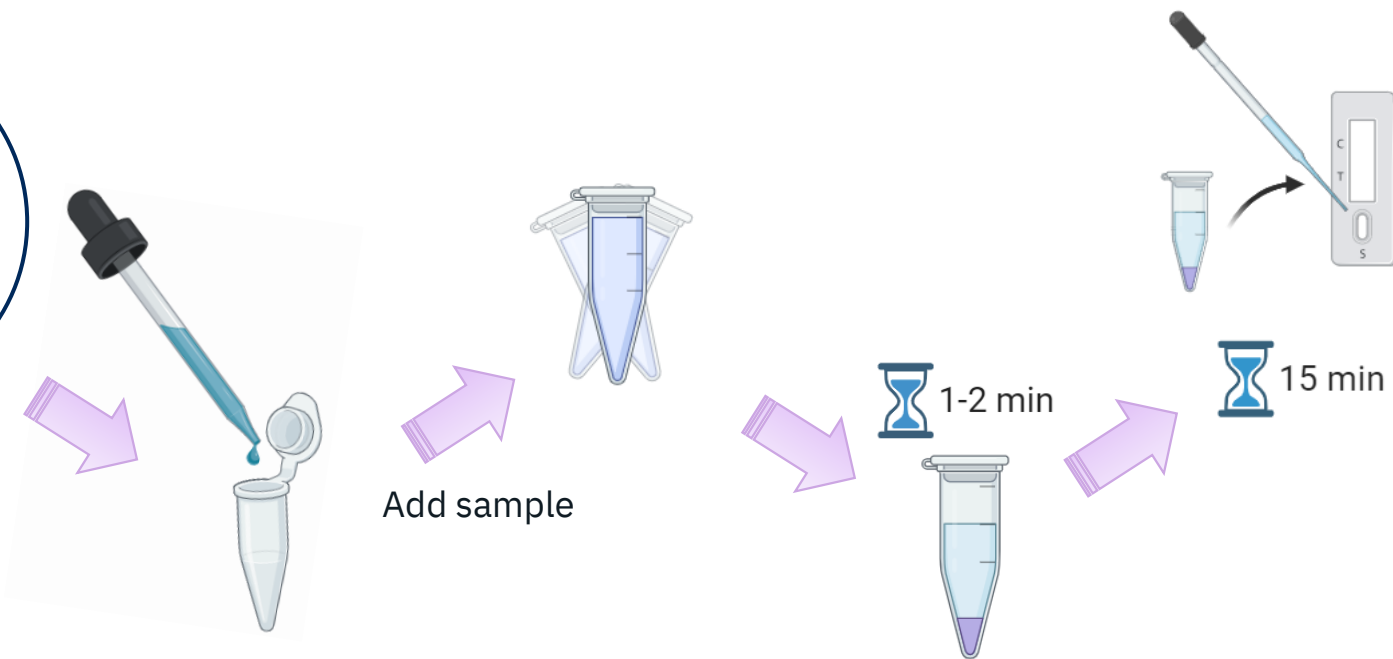
Tweezers



Pipette



# Instructions



# How does it work?

---



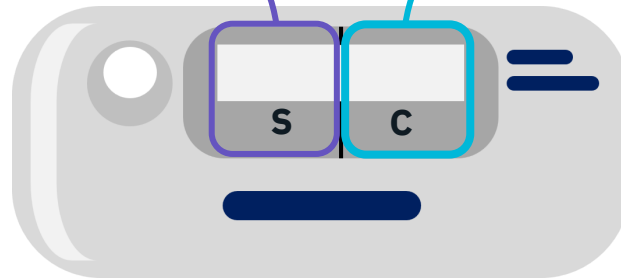


# Test results



Sample (S) window

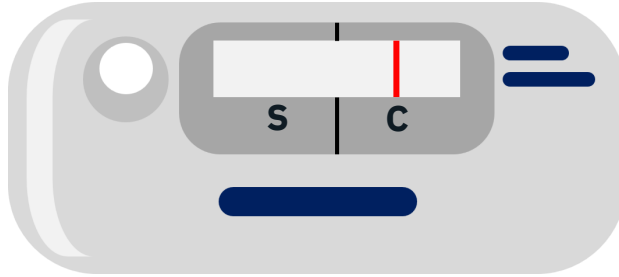
Control (C) window



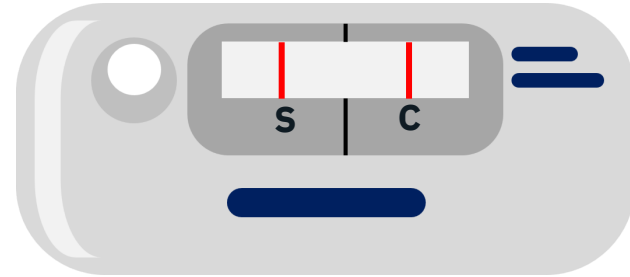
# Test results



**Negative**

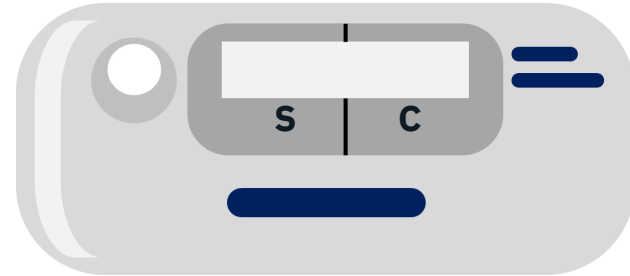
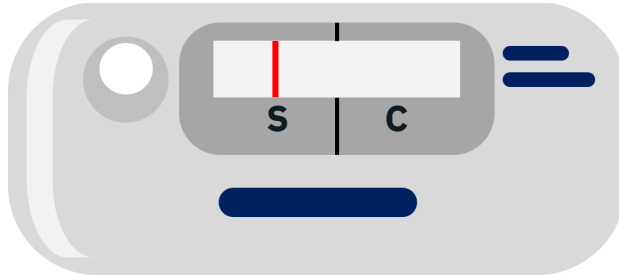


**Positive**

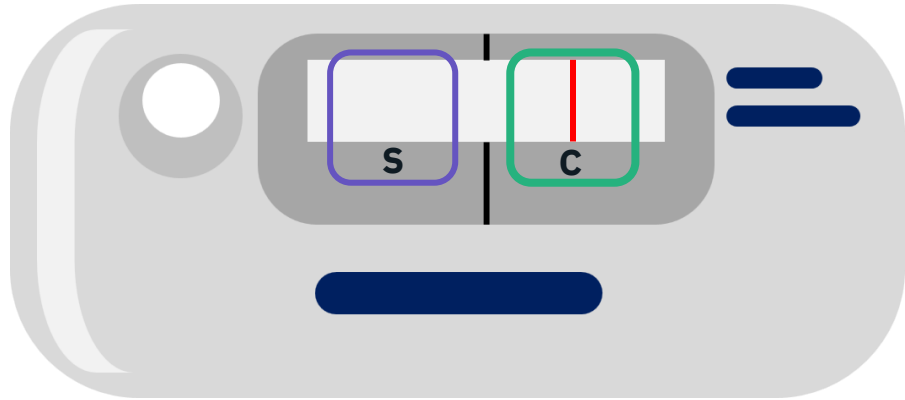


---

**Inconclusive**



# Test results – negative



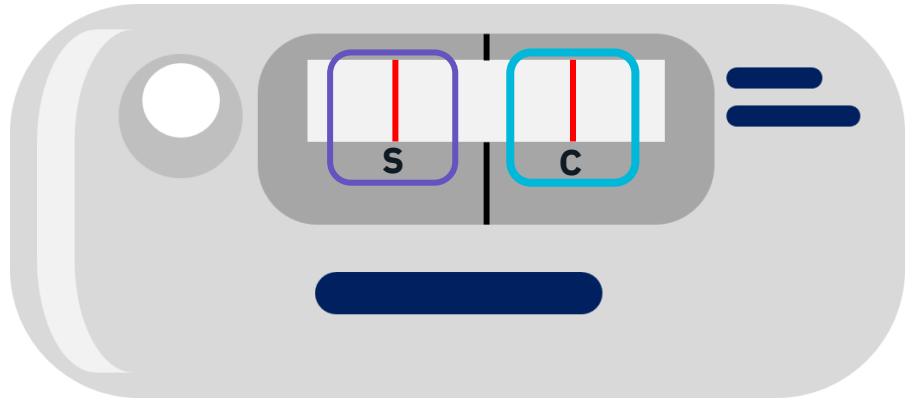
**High sensitivity:** low number of false negatives

**Low biotoxin concentrations:** below detectable concentration of the test strip



**Negative** results may be confirmed if required by context (symptoms, interferants, etc)

# Test results – **positive**



**Low specificity:** many false positives

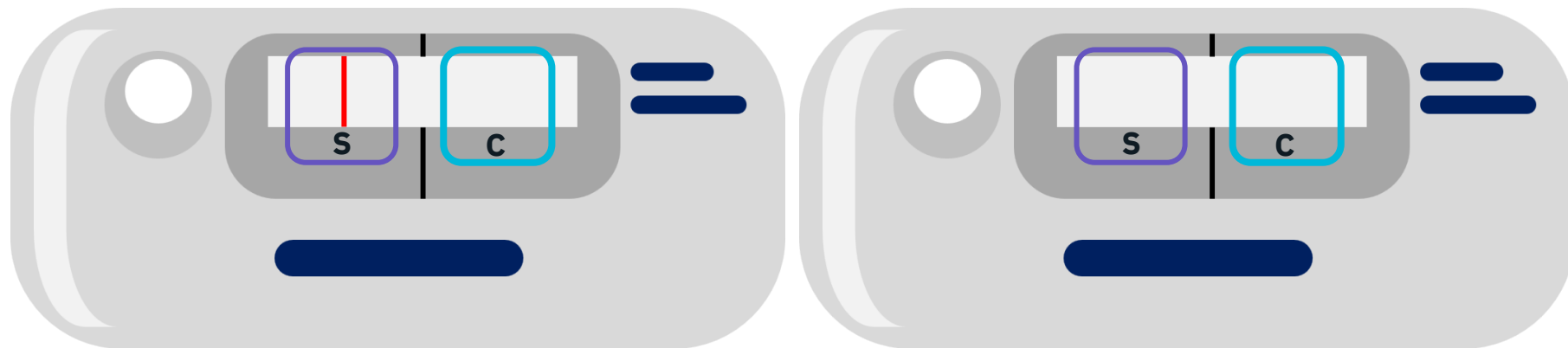


**Interferants:** may cross-react giving false positives



**Positive** results must be confirmed by specific lab-based techniques

# Test results – inconclusive



**Inconclusive** test will be repeated in the field



# Key takeaways

01

**Biotoxins are toxic chemicals** whose great diversity presents challenges to detection and identification

02

The TWG's in-depth review of the analysis of biotoxins highlights key areas for OPCW capability development to **ensure we are best prepared to address cases of use**

03

**TWG recommendations are already being implemented at the ChemTech Centre** to augment our capabilities



# Questions



