# Advances in science and technology: risks and opportunities

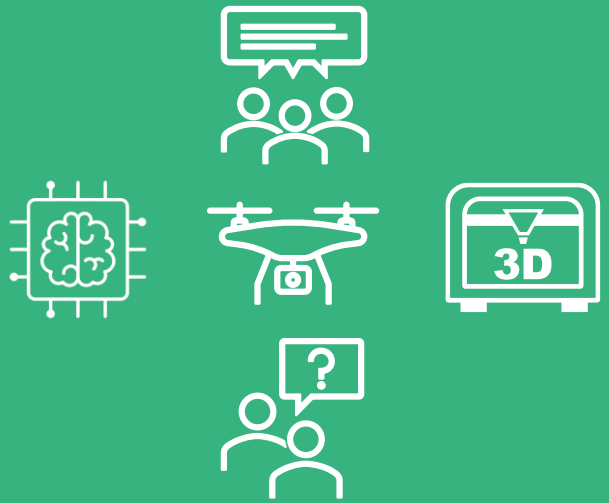
Science for Diplomats Series

Sarah Clapham OPCW
Robert Kristovich SAB
Richard Hartshorn IUPAC

OPCW
Organisation for the Prohibition of Chemical Weapons

IUPAC
INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

# Today's Science for Diplomats



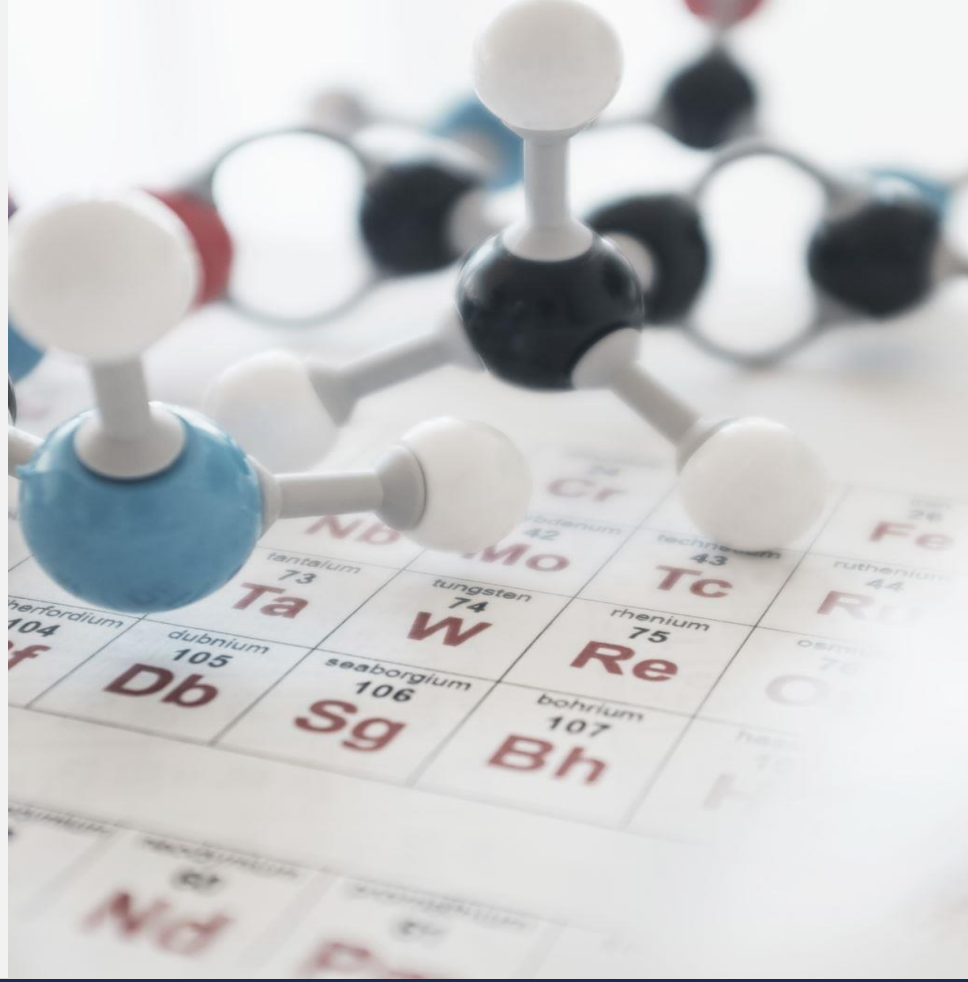

1. Scientific Advisory Board

2. Advances in science and technology (S&T)

3. Wrap-up and Q&A

# S&T underpins the CWC

- Science-based treaty
- Understanding S&T is critical
- Establishment of a Scientific Advisory Board (SAB) in the CWC

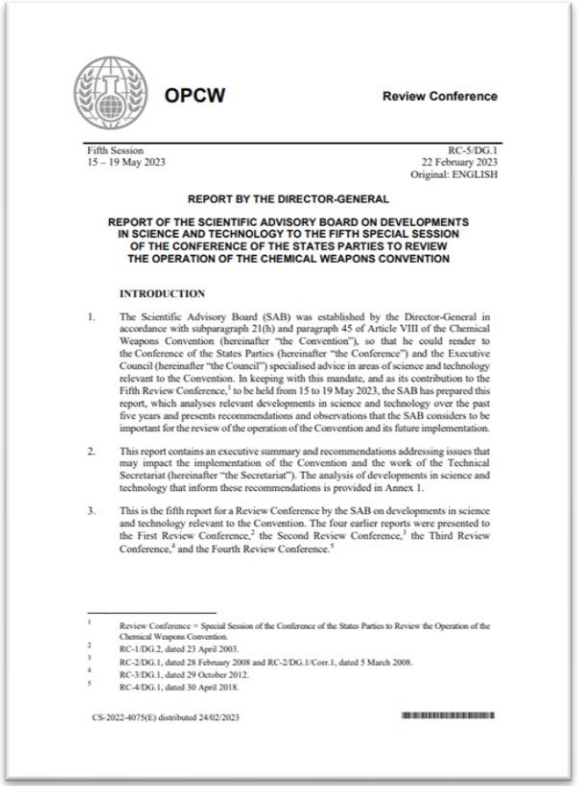


# S&T under review

- Independent advisory board
- 25 experts
- Regular meetings
- SAB report and DG’s response

# RC-5/DG.1: Report on developments in S&T to the Fifth Review Conference

https://bit.ly/SABRC5



OPCW — Review Conference

Fifth Session
15 – 19 May 2023

RC-5/DG.1
22 February 2023
Original: ENGLISH

**REPORT BY THE DIRECTOR-GENERAL**

**REPORT OF THE SCIENTIFIC ADVISORY BOARD ON DEVELOPMENTS IN SCIENCE AND TECHNOLOGY TO THE FIFTH SPECIAL SESSION OF THE CONFERENCE OF THE STATES PARTIES TO REVIEW THE OPERATION OF THE CHEMICAL WEAPONS CONVENTION**

**INTRODUCTION**

1. The Scientific Advisory Board (SAB) was established by the Director-General in accordance with subparagraph 21(h) and paragraph 45 of Article VIII of the Chemical Weapons Convention (hereinafter "the Convention"), so that he could render to the Conference of the States Parties (hereinafter "the Conference") and the Executive Council (hereinafter "the Council") specialised advice in areas of science and technology relevant to the Convention. In keeping with this mandate, and as its contribution to the Fifth Review Conference,[1] to be held from 15 to 19 May 2023, the SAB has prepared this report, which analyses relevant developments in science and technology over the past five years and presents recommendations and observations that the SAB considers to be important for the review of the operation of the Convention and its future implementation.

2. This report contains an executive summary and recommendations addressing issues that may impact the implementation of the Convention and the work of the Technical Secretariat (hereinafter "the Secretariat"). The analysis of developments in science and technology that inform these recommendations is provided in Annex 1.

3. This is the fifth report for a Review Conference by the SAB on developments in science and technology relevant to the Convention. The four earlier reports were presented to the First Review Conference,[2] the Second Review Conference,[3] the Third Review Conference,[4] and the Fourth Review Conference.[5]

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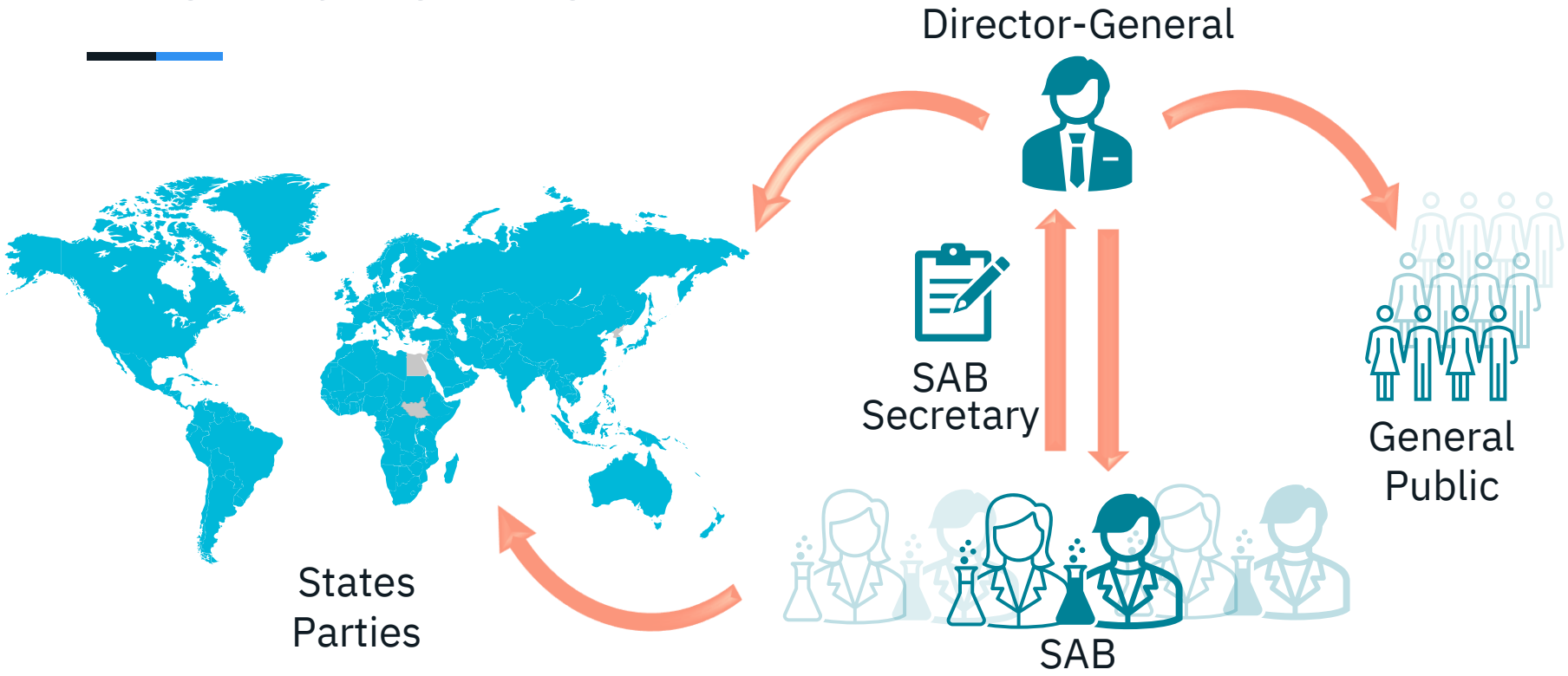
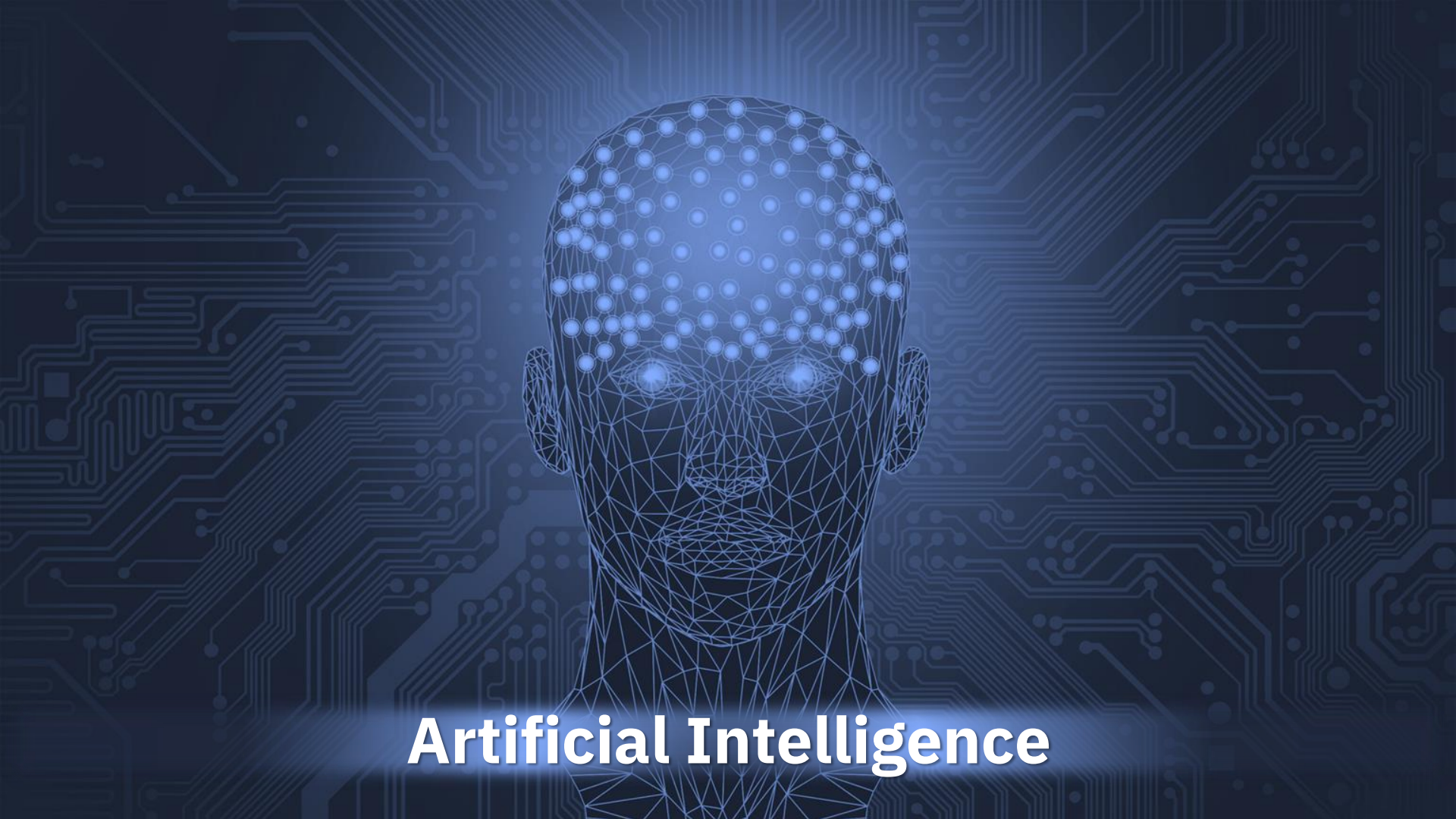
# Information flow




Artificial Intelligence

# Artificial intelligence…

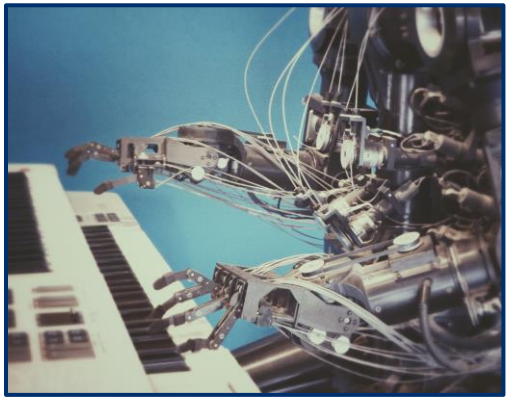
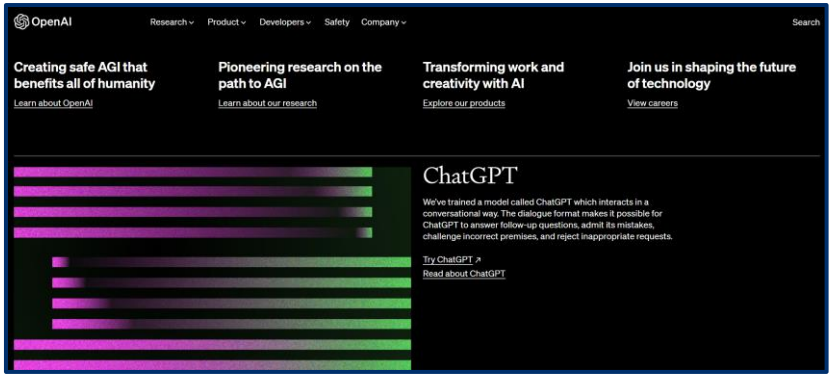


*Image: China Daily*

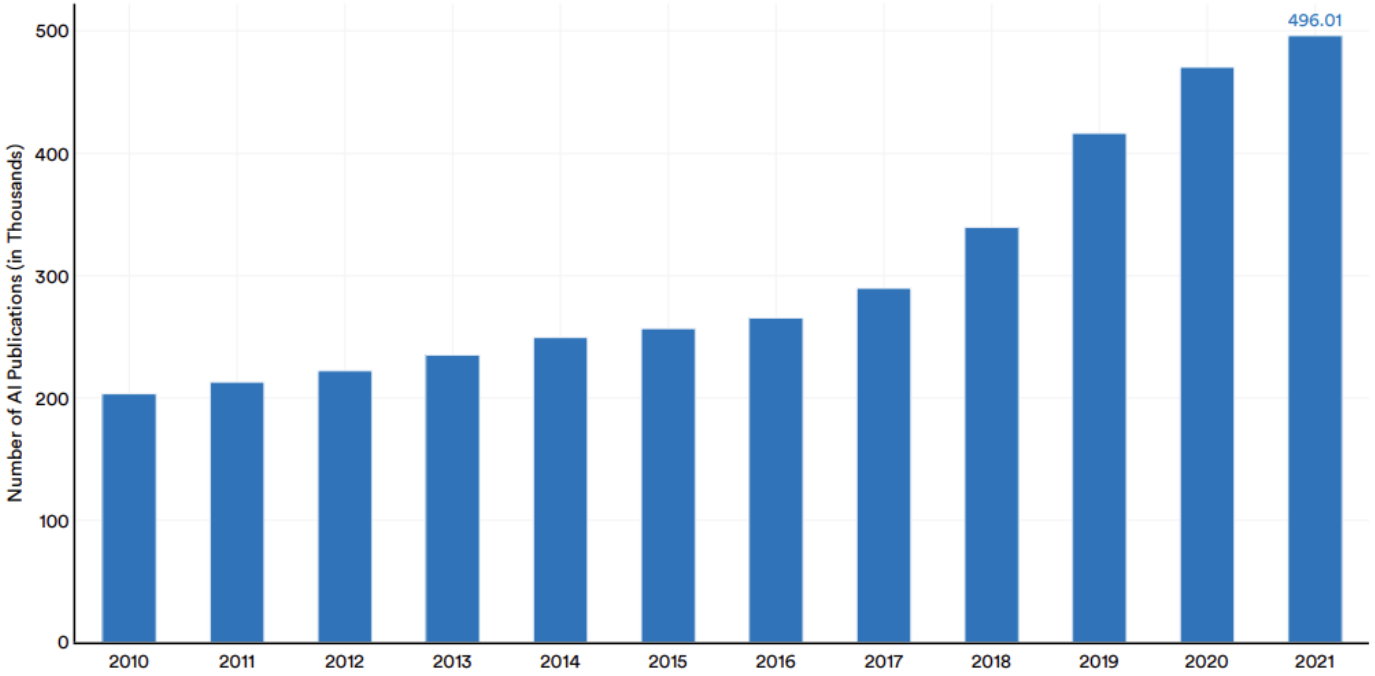


# ...is everywhere




Julian van Dieken, *A Girl With Glowing Earrings*

# Global AI publications 2010 – 2021

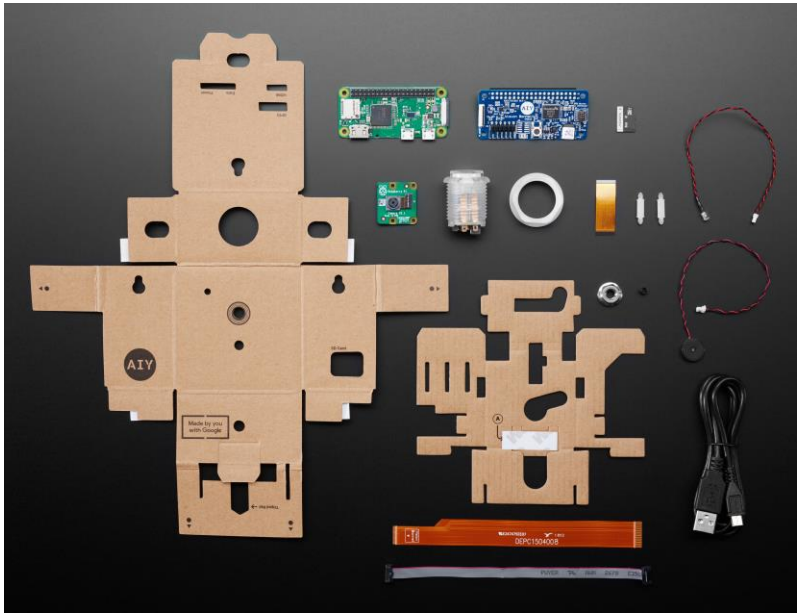



Source: Center for Security and Emerging Technology, 2022

Chart: 2023 AI Index Report

# AI demonstration

AIY Vision Kit



# AI and the CWC

What is the potential impact?


- Design toxic chemicals
- Identify novel syntheses
- Automate synthesis
- Spread disinformation

- Predict data
- Automate systems
- Predict maintenance
- Design new MedCMs
- Streamline processes
- Replace TICs

# Artificial intelligence

> The OPCW should closely monitor the rapid development in AI-assisted chemistry and machine learning and consider not just the potential risks that it poses, but also the opportunities it presents

*SAB recommendation*


Credit: University of Liverpool


Drones

# Drones and the CWC

What is the potential impact?

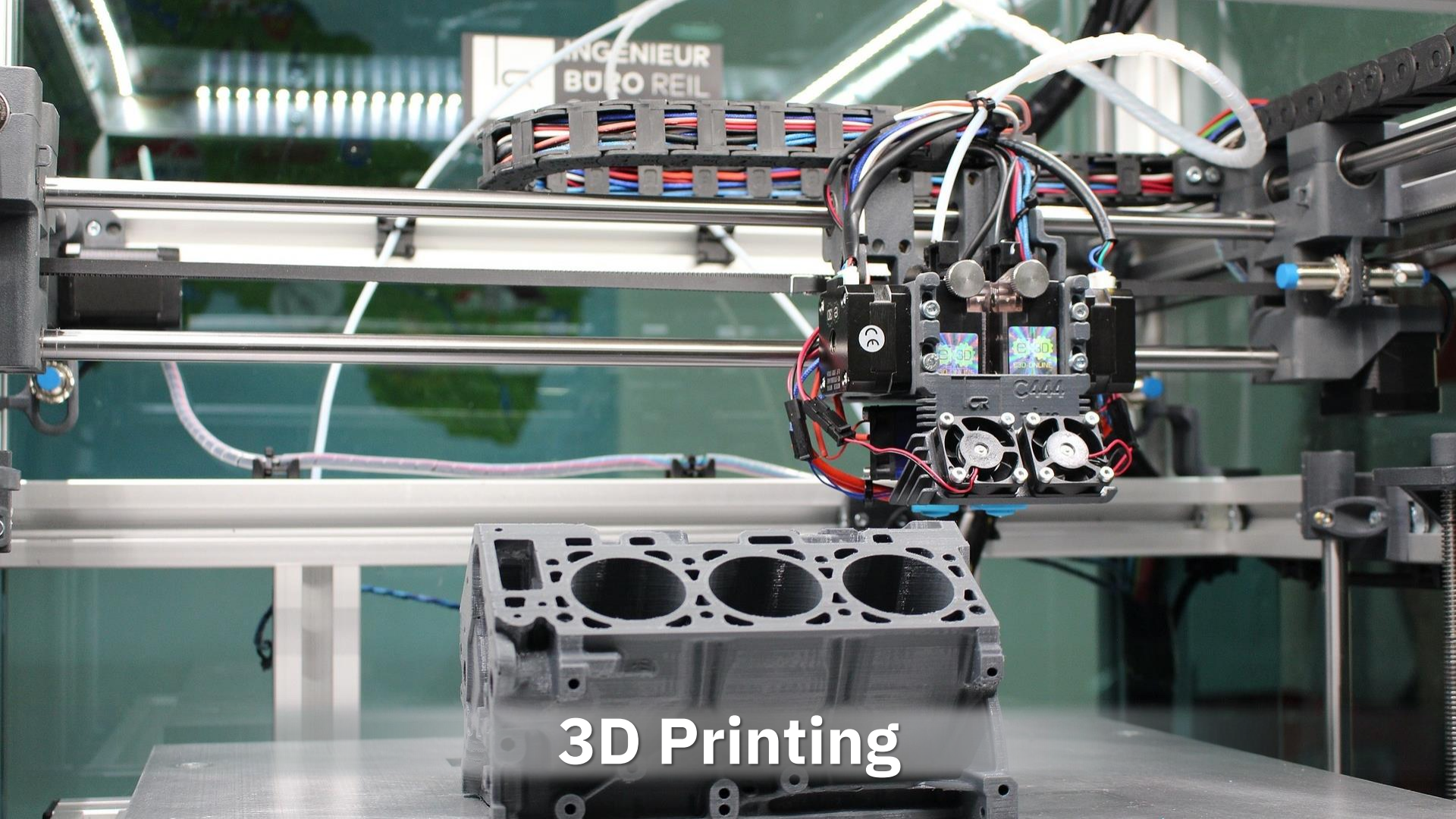

- Widely available
- Increased payload
- Components 3D printed
- Sprayer availability

- Remote capability
- Operator safety
- Sensor integration
- Real-time detection
- Sampling

# Drones

> The continued development of unmanned platforms to deliver payloads for permitted purposes …should be monitored to assess the risk of development for chemical weapons-delivery purposes

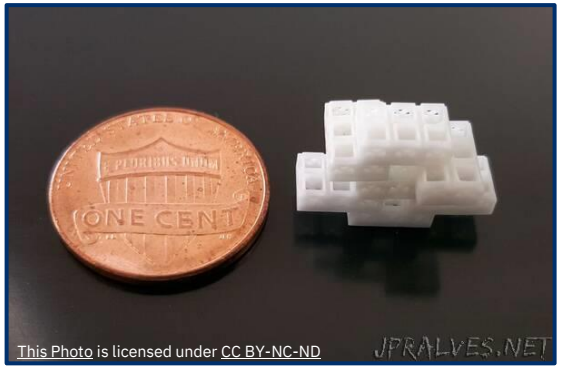
*SAB recommendation*



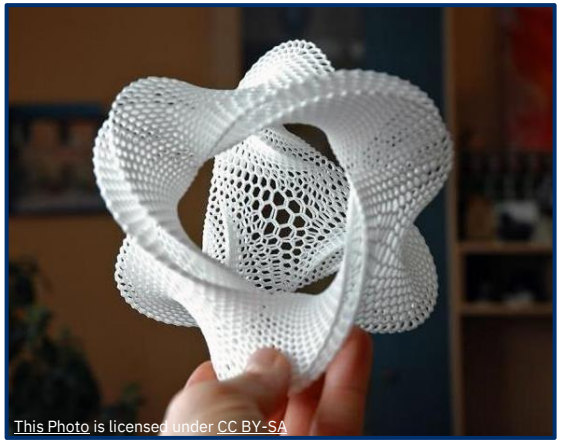

# 3D Printing

# 3D Printing










Capabilities

# 3D Printing and the CWC

What is the potential impact?

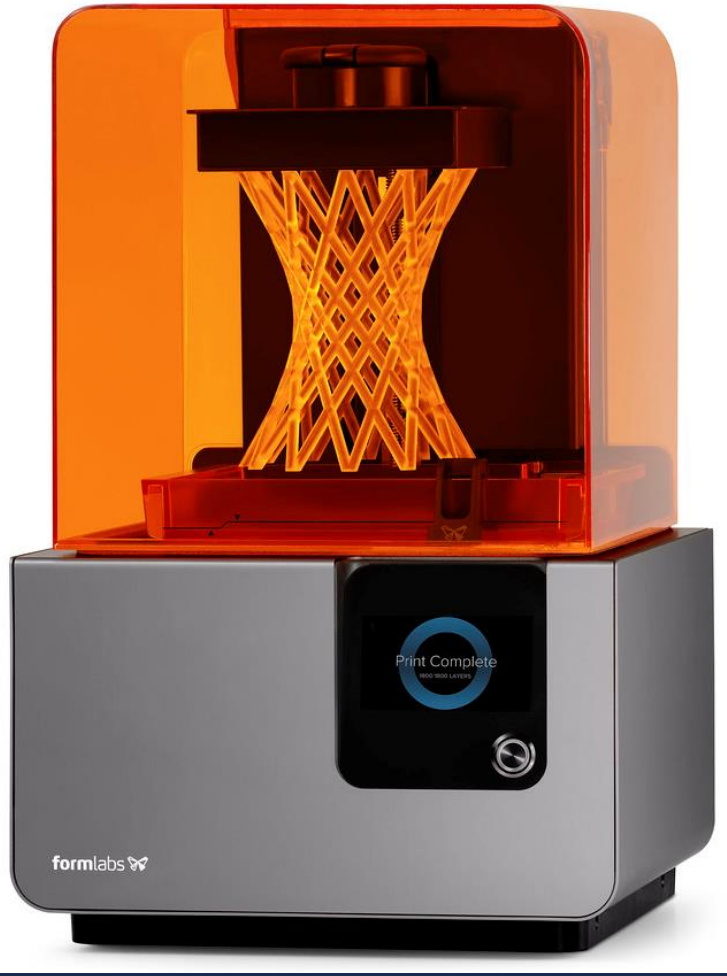

- Print reactors
- Print devices
- Wide range of materials
- Evade export controls

- Accelerate research
- Faster and cheaper
- Use in the field
- Drug delivery
- Print sensors

# 3D Printing

> The SAB recommends that the Secretariat continue to seek information from experts and liaise with other international bodies…to stay apprised of the risks…

*SAB recommendation*

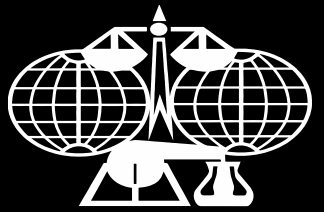


I U P A C

# IUPAC Vision

IUPAC is an indispensable resource for chemistry.

I U P A C



# Mission and Membership

## Mission:

The International Union of Pure and Applied Chemistry is the global organization that provides objective scientific expertise and develops the essential tools for the application and communication of chemical knowledge for the benefit of humankind and the world.

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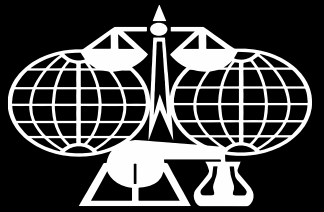

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## Membership:

About 2300 Volunteers, 800 Affiliate Members,

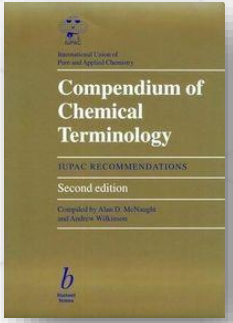
53 Member Organizations,

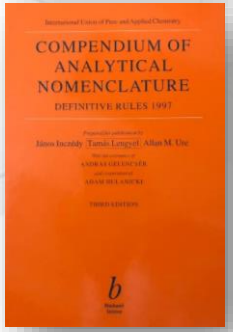
31 Associated Organizations, about 32 Company Associates.

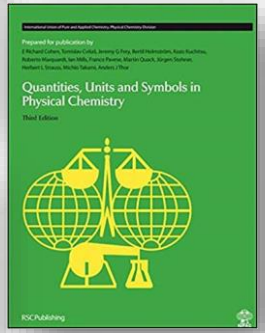
# Principal IUPAC Activities

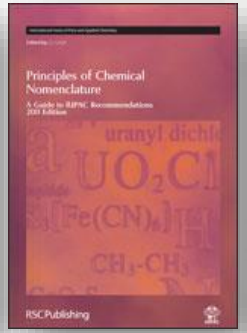
- Curation of the Periodic Table
- Colour books, Recommendations, and Technical Reports

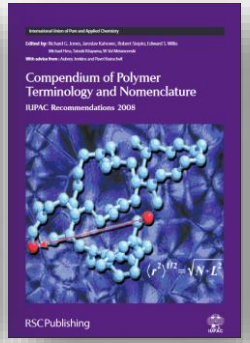
# IUPAC Colour Books

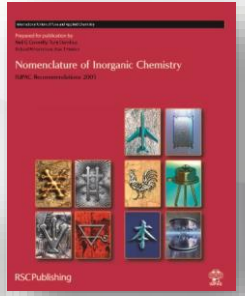


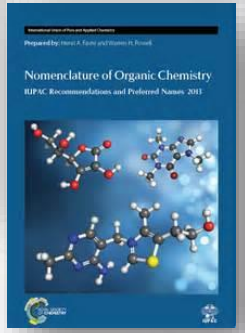



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- Education and Training; Diversity and Younger Chemists

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- Collaborations: UNESCO, ISC, BIPM, OPCW, CODATA, IUPAP, etc.

# IUPAC Issues for Today and the Future: FAIR Data and Cheminformatics

Data Should Be:

- Findable
- Accessible
- Interoperable
- Reusable

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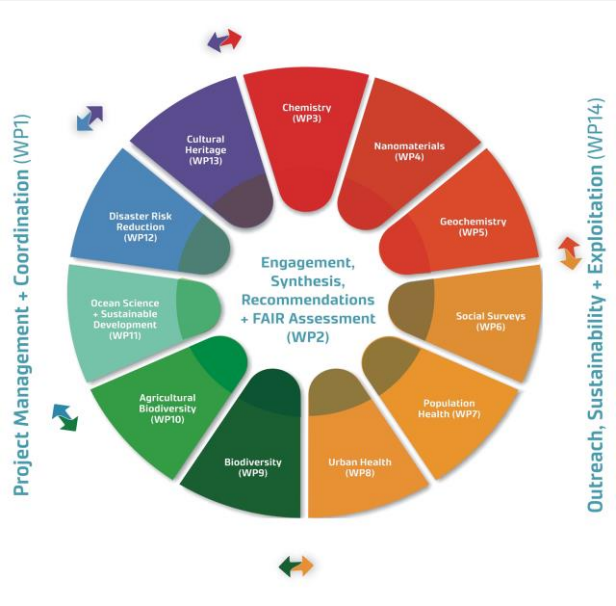


CODATA and WorldFAIR

Tools (File/Data Standards) & Repositories (certification/accreditation)

# IUPAC Issues for Today and the Future: FAIR Data and Cheminformatics

- Data Management Plans – coming to organisations near you
- Electronic Lab Notebooks – will be used routinely
- Fully linked spectra and characterisation data
- Extended through into publication – being FAIR, digital standards and validation suites

# IUPAC Issues for Today:
# International Chemical Identifier (InChI) Standards

- Taking InChI Beyond Publications/Databases
- Inorganic/Coordination/Organometallic Compounds
- Mixtures
- Reactions
- QR Code Standard

# IUPAC Issues for Today: IUPAC Standards

| Heading to FAIR… | In some electronic form… | Analog equivalent… |
|---|---|---|
| • InChI (and family)<br>• HELM<br>• ThermoML<br>• SMILES+<br>• Adsorption Information File (AIF)<br>• FAIRSpec | • Gold Book (+Orange +Silver +White)<br>• Periodic Table (CIAAW tables)<br>• Atmospheric kinetics<br>• Polymerization kinetics<br>• NPU: properties & units for clinical chemistry<br>• Dissociation constants<br>• Stability constants<br>• JCAMP-DX | • Solubility Data Series*<br>• Green Book*<br>• Blue Book<br>• Red Book<br>• Purple Book<br>• Graphical representation |

## IUPAC Top Ten Technologies:

# Nanozymes (2022)

- Nanoparticles with enzyme-like chemical reactivity
- Much higher activity than conventional materials
- Not as reactive or selective as enzymes

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- Much higher activity than conventional materials
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- Much more robust
- Easier to modify and manipulate

## IUPAC Top Ten Technologies:

# Nanozymes (2022)

- Oxidation chemistry clearly demonstrated
- Potential in destruction/detoxification of chemical weapons?

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- Lanthanide framework compounds embedded in cross-linked films
- Fluorescence changes when analytes enter the framework

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- Lanthanide framework compounds embedded in cross-linked films
- Fluorescence changes when analytes enter the framework

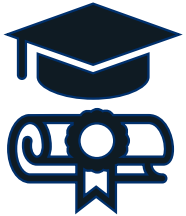
- Both removal and detection

## IUPAC Top Ten Technologies:

# Blockchain Technology (2021)

- Shared database
- Data blocks linked by cryptography
- Decentralised with collective (and not individual) control
- Immutable data

# What did you learn?



1. The SAB serves as a **critical source of impartial scientific advice** for the Director-General and, by extension, for States Parties.
2. S&T continues to develop at an astonishing pace and **the risk of misuse of these developments remains real**. Those areas of concern highlighted by the SAB should continue to be monitored and reviewed.
3. Whilst the risk posed by the misuse of developments in S&T is often the focus of our attention, we must not lose sight of **the increasing opportunities these same developments may afford**. They may be harnessed to better prepare the Organisation to provide assistance to States Parties and to address the threats of today and the future.

# Learn more

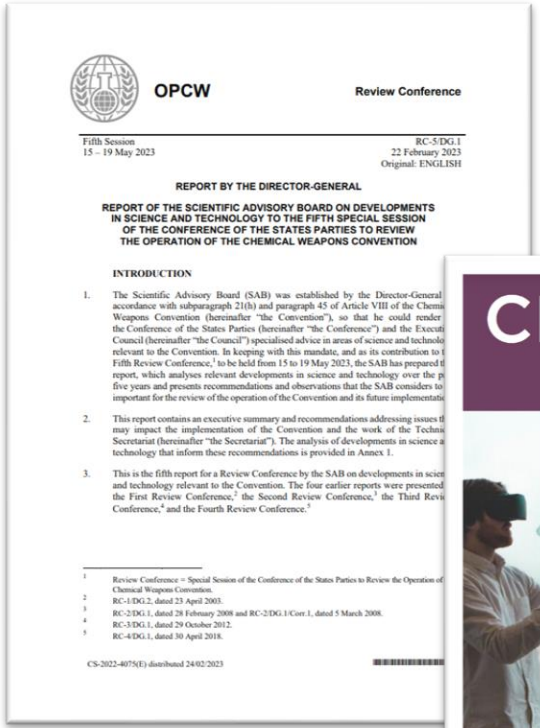
SAB report

DG response

IUPAC

RC-5/DG.1: https://bit.ly/SABRC5
RC-5/DG.2: https://bit.ly/DGSABRC5

https://iupac.org/iupac-2022-top-ten/



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IUPAC Top Ten Emerging Technologies in Chemistry

Implementing Data Sharing Policies ▶

Making Global Green Connections ▶

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# Questions?