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DNA Synthesis Screening & the International Common Mechanism

G7 Global Partnership Conference on Current Biosecurity Challenges
Overview

I. Technology advances & emerging biorisks
II. DNA synthesis & screening
III. The Common Mechanism
IV. Benchtop synthesis
V. An international home for the Common Mechanism
VI. Discussion
Technology Advances & Emerging Biorisks
Technology advances offer tremendous opportunities …

• Easier to read, write, edit DNA & RNA - Blueprint for all living organisms

• AI & robotics enable automation & experimentation at scale

• Cloud labs

• Emerging protein engineering capabilities
Technology Advances & Emerging Bio-Risks

... but these advances also create potential risks

• Easier to generate pathogens from scratch or modify existing pathogens to make them more dangerous.

• Some researchers are using new tools to synthesize and modify pathogens.
Deliberate & Accidental Release Risks

Democratized access enables a wider range of actors to engineer pathogens

- Increased risk of non-state actor attack
- Increased risk of accidental release of engineered pathogen
- Might shape state bioweapons risks

Aum Shinrikyo

2001 Anthrax Attacks

Sverdlovsk Accidental Anthrax Release

Shipment of insufficiently inactivated anthrax spores to 194 labs.
DNA Synthesis & Screening
DNA Synthesis is a Key Enabling Technology

- DNA synthesis is getting faster, cheaper, and more accessible

- DNA synthesis screening is voluntary
  - An estimated 80% of global market share is screened
  - International Gene Synthesis Consortium of providers that screen orders
  - Not legally required in any country

- Commercial availability of benchtop synthesis
  - Likely to expand in next 2-5 years
  - Biosecurity safeguards for devices?
Our work in this area: The Technical Consortium

- NTI-WEF Working Group report, Jan 2020
  - Establish a Technical Consortium to develop a DNA screening tool
  - Establish a normative entity to strengthen global norms and guidelines

- Launch of Technical Consortium, May 2020
  - Industry and international representation
  - IGSC collaboration and representation

- Ongoing Technical Consortium Activities
  - Development of Common Mechanism
  - Customer Screening Framework
  - Ensuring Integration with Benchtop Devices
The International Common Mechanism for DNA Synthesis Screening
The Common Mechanism

Overview

Customer creates an account with the company

Is the customer safe to work with?

Customer places order

Are shipping and payment conditions appropriate?

Order proceeds to sequence screening

Is the DNA safe to work with?

If order is flagged, company performs follow-up screening

What is the use case? Has it been approved?

If not flagged, order can proceed

Cleared orders are shipped to customers

Screening failures are logged
The Common Mechanism

- Databases used for screening:
  - biorisk database
  - benign database
  - species database
  - regulated pathogens

- Software to perform screening

- Decision support system

Status:
- Complete
- In progress
- Under consideration
Overarching approach
Biorisk screen

• **FLAG genes that pose an intrinsic threat**

• Criteria for identifying a “biorisk”
  • Genes that are regulated (e.g. toxins)
  • Genes that contribute to causing disease in regulated pathogens

• Build “sequence profiles” for each biorisk from publicly available sequences
  • Integrating many examples of the same sequence allows us to identify sequences designed to evade screening

*NTI approach: compare to a sequence profile*

*Current approach: compare to individual sequences*
Regulated pathogen screen

• **FLAG DNA/proteins from a regulated pathogen**

• Criteria for identifying sequences from regulated pathogens
  • Compare orders to publicly available DNA and proteins tagged with organism of origin
  • Cross-check organisms against recognized pathogen control lists

• Flag orders more similar to a regulated pathogen than any other organism
Benign sequence exceptions

• **PASS regulated pathogen sequences if they have a known harmless function**

• Some regulated pathogen DNA can be supplied safely to a range of customers

• We pass pathogen genes if they are common to many living organisms – essential functions for life
Key considerations

• Which biorisks should fall under screening guidelines?

• Can screening tools be tested against an agreed-upon performance standard?

• What should companies do for pathogen DNA of unknown or poorly documented function?
Guidance from Government

- The only guidance on DNA synthesis screening is from the US.
- Will other countries also provide guidance?
- Work toward globally agreed standards?
IV

Benchtop Devices: Safeguarding Distributed DNA Synthesis
Benchtop Devices

• Enables distributed DNA printing

• Commercial availability likely to expand over next 2-5 years

• NTI conducted interviews with >30 experts

• Three Key Questions:
  • What are current and anticipated benchtop device capabilities?
  • What are the biosecurity implications?
  • What governance approaches can most effectively safeguard this technology?
Benchtop Devices: NTI Report

Findings

• **Near-future capabilities**: Devices will be easier to use and able to automatically synthesize DNA fragments up to 5,000–7,000 base pairs

• **Biosecurity implications**:
  • May increase the potential for misuse of synthetic DNA, including risks associated with pathogen engineering
  • Significant hurdles to pathogen engineering would remain

• **Governance**:
  • Many potential oversight mechanisms depend on device manufacturers to conduct customer and sequence screening
  • A range of incentives, including from governments, will be needed
Benchtop Devices: NTI Report

Recommendations

• Device manufacturers should:
  • Ensure rigorous customer screening
  • Ensure sequence screening directly by manufacturer, where feasible

• Governments should:
  • Provide guidance, incentives, and resources to support screening
  • Implement regulations requiring biosecurity practices for most devices

• Civil society, funders, and others should:
  • Develop resources, tools, and funding requirements to support screening
  • Explore other types of incentives, such as insurance and liability
V

An international home for the Common Mechanism
A NEW INTERNATIONAL INITIATIVE

IBBIS

International Biosecurity and Biosafety Initiative for Science
MISSION & VISION

MISSION

▪ IBBIS works collaboratively with global partners to strengthen biosecurity norms and develop innovative tools to uphold them.
▪ We undertake this work to safeguard science and reduce the risk of catastrophic events that could result from deliberate abuse or accidental misuse of bioscience and biotechnology.

VISION

▪ A world in which bioscience and biotechnology can flourish, safely and responsibly
VI

Discussion
Discussion Questions

I. What should governments do to safeguard DNA synthesis technology?

II. Should the international community work toward globally agreed upon standards for DNA synthesis screening?

III. How can governments, industry and civil society work together to strengthen biosecurity for DNA synthesis and other emerging biotechnologies?
Thank you!