For Asia Centre for Health Security (ACHS) Webinar Series, Oct. 23, 2025

Governance of Dual-Use Risks of Synthetic Biology: Recent Efforts in China

Weiwen Zhang

Tianjin University Center for Biosafety Research and Strategy

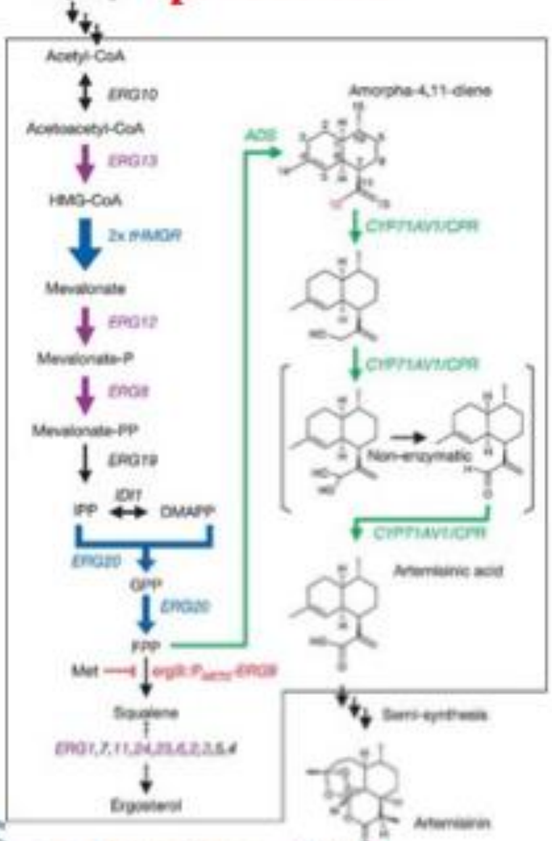
National Key Laboratory of Synthetic Biotechnology of China

School of Chemical Engineering & Technology

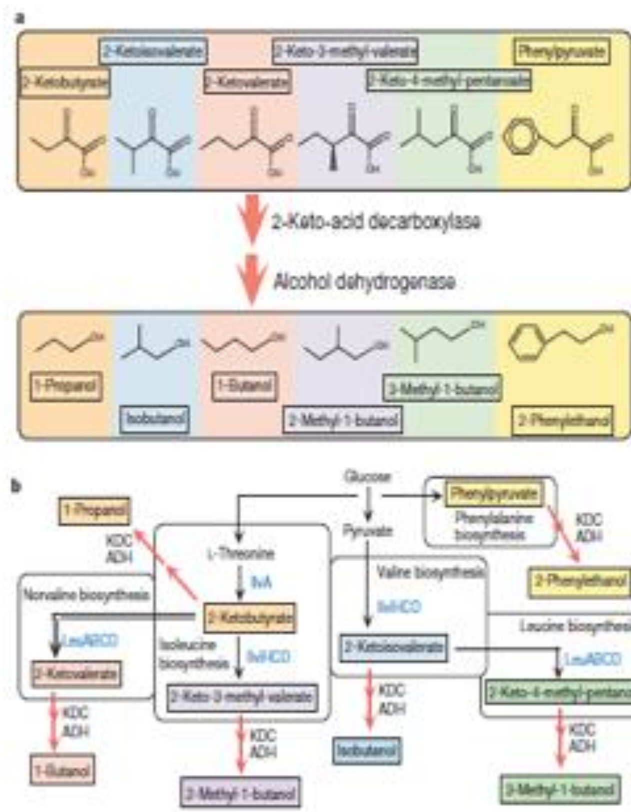
Tianjin University, Tianjin, China

Synthetic biology revolutionized traditional biotechnology industry

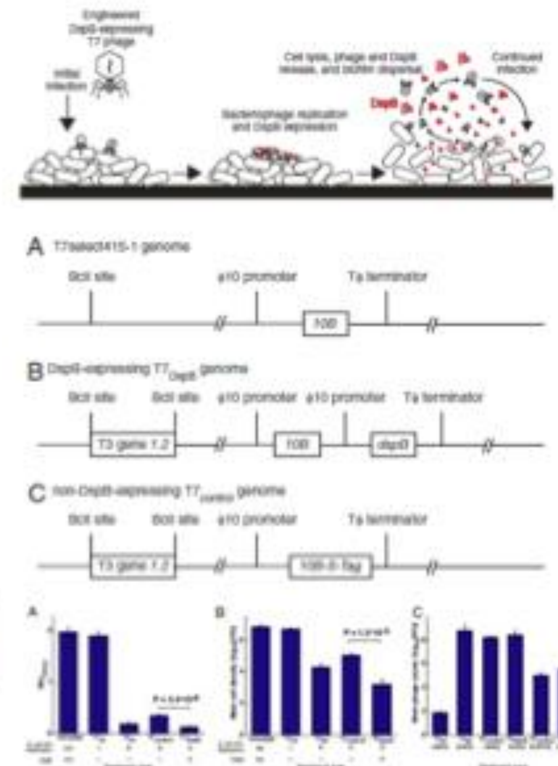
Biopharmaceuticals production



Sustainable chemicals



Gene Therapy



Atsumi, *et al.*, *Nature* 451.7174 (2008): 86.
Ro, *et al.*, *Nature* 440.7086 (2006): 940.
Lu, *et al.*, *PNAS* 104.27 (2007): 11197-11202.

- **National Basic Research Program ("973" Program) (2011-2015)**

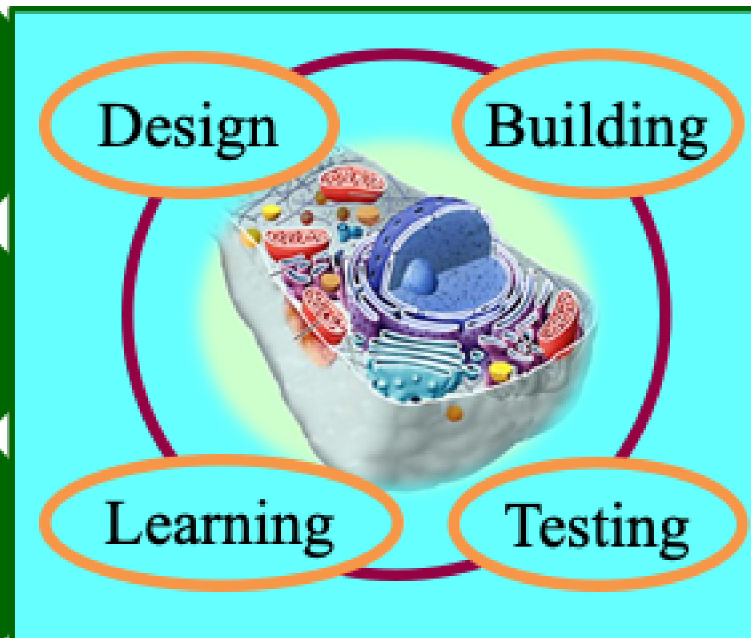
10 Projects awarded; each around 20-30 million RMB (3-4 million US dollars)

- **Synthetic Biology Roadmap of China（2017）**

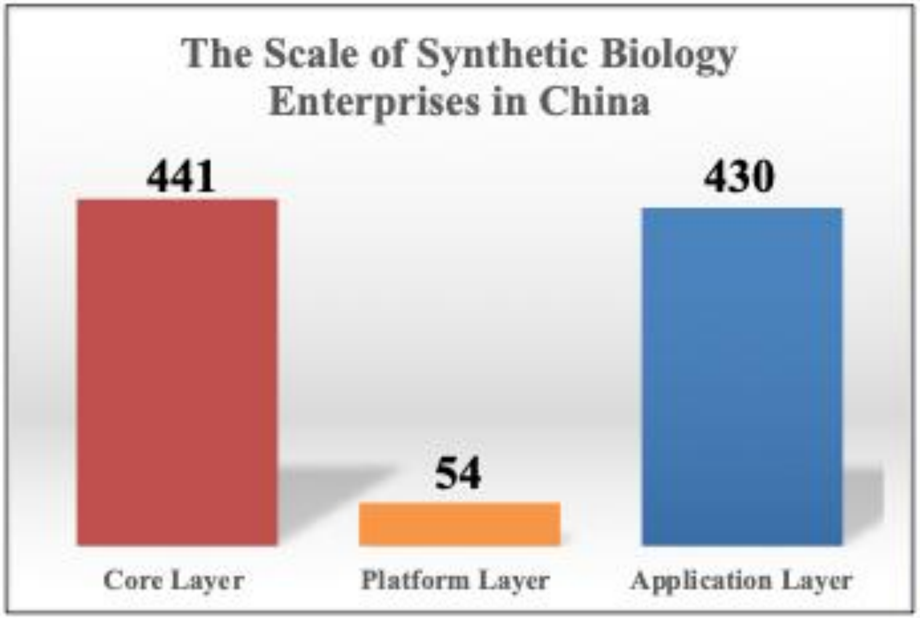
- **The National Key R&D Program: Synthetic Biology**

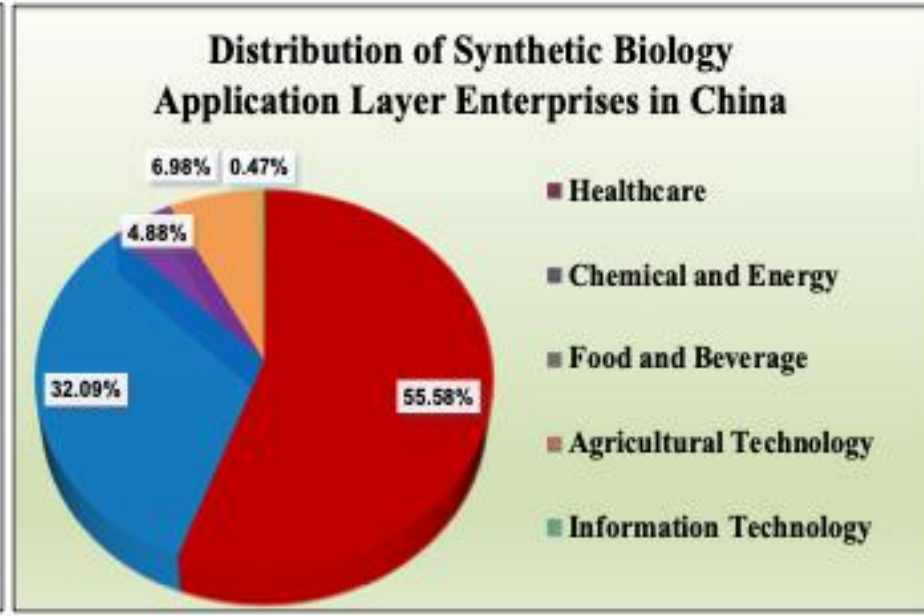
  1ST 5 years (2018-2022); Budget: ~2.3 billion RMB （300 million US dollar)
  2ND 5 years (2023- 2028); Budget: > 4.0 billion RMB (560 million US dollar)

Fundamental	**Capacity building**	**Great challenges**
Quantatitvie analysis and prediction of biosystems		Chemical biosynthesis
Rational desigen and rebuilding of genome		NP biosynthesis
Regulation of the biological functions and phenotypes		Stress resistance
		Disease treatment



Synthetic Biology Related Industry in China





2015-2024: 591 financing events, with a total of 90.9 billion Chinese Yuan (approx. 13 billion US dollars)

2021: 26.5 billion Chinese Yuan (approx. 3.6 billion US dollars)

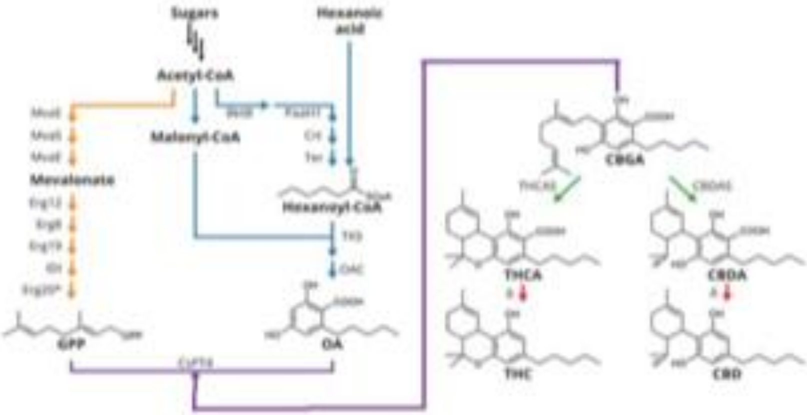
Bioeconomy of China reaches 22 trillion RMB ($3.28 trillion) in 2025

Universities and Institutes for SynBio in China

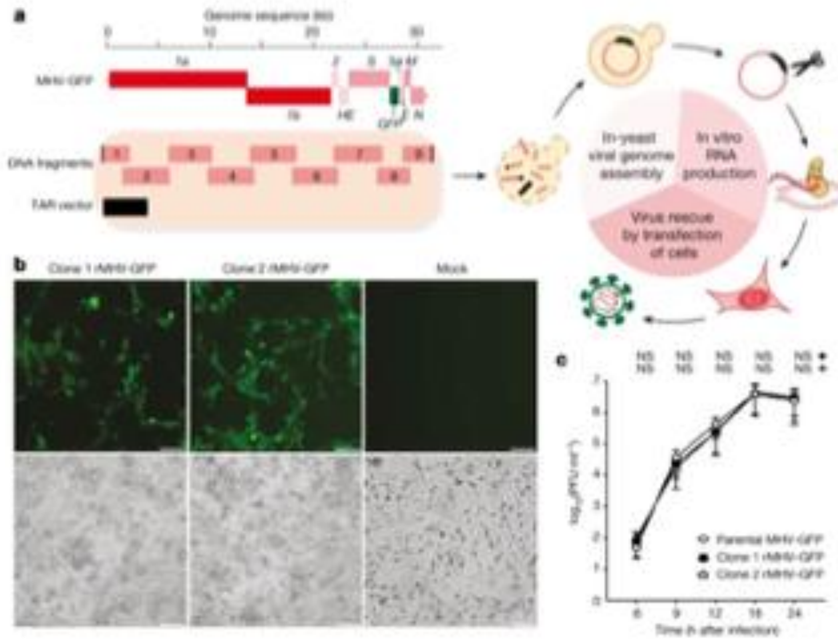
- Based on projects funded by the NSFC, more than ***1000*** institutes are working on synthetic biology projects

Global DNA Synthesis Market: 7.16 billion RMB
China DNA Synthesis Market: 0.9 billion RMB

Biosynthesis of Cannabinoid in Yeast Cells



Artificial Design and Synthesis of a SARS-CoV-2 Genome



Traditional ways to manage drugs and toxin challenged!

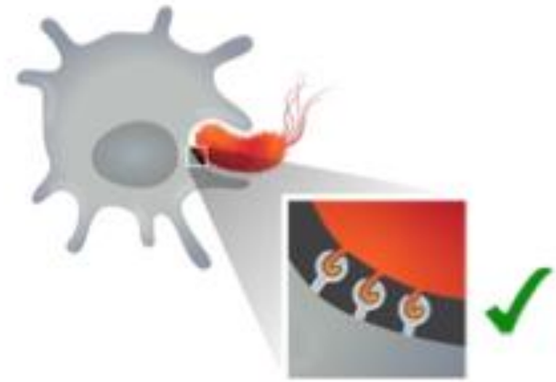
Traditional ways to deal with the infectious agents challenged!

Luo *et al.,* Nature, 2019, 123-125.

Thao et al. *Nature*, 2020, 582: 561-565.

New challenges revealed!

"*Confronting risks of mirror life*" (Adamala et al., *Science*, 2024)



38 authors total

Conclusions from the *Science* Paper


Confronting risks of mirror life

Mirror bacteria could plausibly be created by life scientists within the next 10–30 years.

- No known researchers are actively working toward mirror bacteria
- Timelines are uncertain:
  - < 10 years with a $500 m–$1 b effort
  - AI could accelerate timelines

"***Unless compelling evidence emerges that mirror life would not pose extraordinary dangers, we believe that mirror bacteria*** *and other mirror organisms…* ***should not be created***.

We therefore recommend that ***research with the goal of creating mirror bacteria not be permitted,*** *and that* ***funders make clear that they will not support such work***.

Governance of a subset of enabling technologies should also be considered…"

AI x Bio Challenges

- ✓ **AI increases the possibility of unintentional biotechnology misuse**

  AI tools could effectively expand the capability and speed of synthetic biology in rational design and synthesis of control reagents.

- ✓ **AI reduces barriers for deliberate abuse of biotechnology**

  LLMs could facilitate a structured approach to specific inquiries related to bioweapon development, from experimental guidance to trouble-shooting assistance.

- ✓ **AGI will generates novel knowledge breaking current governance principles**

  such as sequence based gene identificatior and pathway based biosynthesis analysis

News in focus

SCIENTISTS LAY OUT SAFETY GUIDELINES FOR AI-DESIGNED PROTEINS

Tools that can devise protein structures should be used safely and ethically, say researchers in the field.

nature > news > article

NEWS | 08 March 2024

Could AI-designed proteins be weaponized? Scientists lay out safety guidelines

AI tools that can come up with protein structures at the push of a button should be used safely and ethically, say researchers in the field.

By Ewen Callaway

Could chatbots help devise the next pandemic virus?

An MIT class exercise suggests AI tools can be used to order a bioweapon, but some are skeptical

Technology Security and its Governance **NOT NEW** to the World

Albert Einstein and other members of the ***Emergency Committee of Atomic Scientists*** in Princeton in 1946

The Atomic Energy Act of 1946

Molecular biologists in 1974 at ***Asilomar*** called attention to the dangers associated with their new methods of ***recombinant DNA***

Scientific community played key role!

What we have been working:

1. Domestic Policy, Strategy and Law
2. Technical solution
3. Global Policy and Collaboration
4. Education

1. Policy, Regulation, and Law

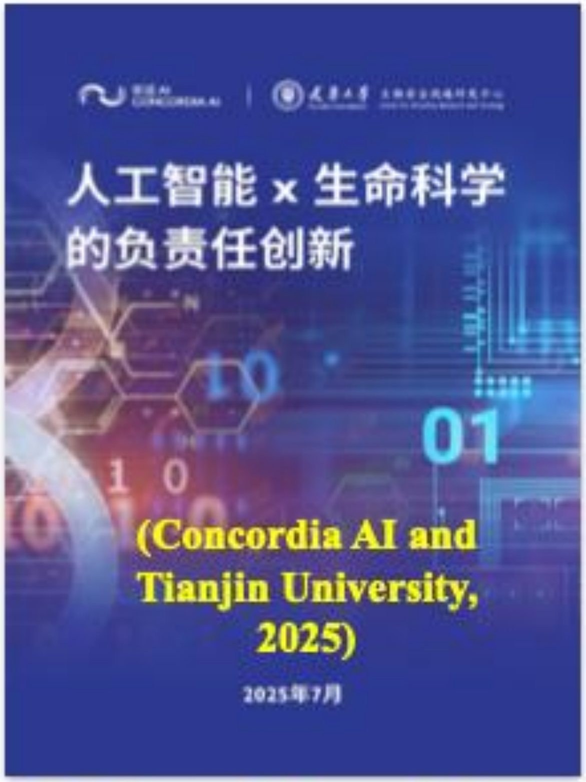
"Safety Management Guidelines for Biotechnological R&D" (2016)

Issued by the Ministry of Sciences and Technology of China on July 12, 2017

China Biosecurity Law (2020)

- ✓ Chapter I General Provisions
- ✓ Chapter II Biosecurity Risk Prevention and Control System
- ✓ Chapter III Prevention and Control of Major New or Sudden Outbreaks of Infectious Diseases and Epidemics in Animals and Plants
- ✓ **Chapter IV Security of Biotechnology Research, Development, and Application**
- ✓ Chapter V Biosafety of Pathogenic Microbe Laboratories
- ✓ Chapter VI Security of Human Genetic Resources and Biological Resources
- ✓ Chapter VII Prevention of Bioterrorism and Biological Weapon Threats
- ✓ Chapter VIII Biosecurity Capacity Building
- ✓ Chapter IX Legal Liability
- ✓ Chapter X Supplemental Provisions
- ✓ Chapter XI General Provisions

Biosecurity Challenges of the AI x Bio Convergence



1) National and International AI x Bio Observatory for Horizon Scanning and Risk Assessment
2) Develop proactive AI x Bio risk management frameworks and thresholds
3) Prepare for Catastrophic Scenarios and Emergency Preparedness Plans

2. Technical solution

Biosafety and Biosecurity of Synthetic Biology (2021)

National Key R&D Program – Synthetic Biology, Project No. 2020YFA0908600

Goals:

- ✓ Establishing a biosafety and biosecurity knowledge management platform of synthetic biology
- ✓ Constructing semi-quantitative or quantitative framework for identifying and predicting biosafety and security risks of synthetic biology research
- ✓ Developing a biosafety and biosecurity management and implementation plan (i.e., regulatory and legal) for synthetic biology research and application in China
- ✓ Improving public understanding and trust for synthetic biology research and application
- ✓ Participating in the global governance of synthetic biology development and application

Team: Tianjin University; Fudan University;
Shanghai Institute of Nutrition and Health, Wuhan Institute of Virology, Chinese Academy of Sciences;
Institute of Bioengineering, Chinese Academy of Military Medical Sciences

2. Technical solution

Knowledge management platform of synthetic biology

1 Multi-source heterogeneous database

1) Global typical biosafety biosecurity incident case database
2) Synthetic biology biosafety and biosecurity databases
3) Database description

2 Knowledge Management Platform

1) Dynamic display of database knowledge graph
2) Biosafety and biosecurity keyword search
3) Map of relevant biological laboratories
4) Intelligent identification system for relevant scientific and technological personals

Knowledge management platform framework of "storage-extraction-sharing-reuse"

Dynamic display of risk factor and correlation

Relevant Biological Laboratories Map Query

Visualization function for government, researchers, policy makers and government to achieve first-hand data

A quantitative and dynamic model to analyze potential dual-use risks in synthetic biology research

Quantitative and Dynamic Model (System Dynamic - Vensim)

2. Technical Solution

Global DNA Synthesis Market: 7.16 billion RMB

China DNA Synthesis Market: 0.9 billion RMB (FY2023 Data)

Survey of DNA Synthesis Industry in China (Sept 2004 - March, 2025)

- **DNA Synthesis Screening tools and databases:**
  - Multiple software used
  - Varying screening standards: 50 nt *vs*. 200 nt, and more
  - Databases: local, monthly or even annually updated
- **DNA Synthesis Screening practice:**
  - Not real-time screening (*vs*. typical 1 day DNA synthesis turnaround)
  - Expert judgment insufficient
  - Too much rely on customers identity for Y/N decision
  - Very low profit margin
- **DNA Synthesis Screening – Reporting Systems**: Yes or No
- **Domestic *vs*. International orders**:
  - Low standards on domestic, high on international orders
- **DNA shipping:** No special requirements for domestic orders
- **Information and sample storge**: Varying practices between companies
- **Cost increase for DNA Syntheses Screening "*Mandate*":** Worry about economic impact

2. Technical solution

Traditional approach: Responding to specific risks individually

Comprehensive technical strategy through-out the entire "Design-Build-Test-Learn" SynBio R&D cycles

3. Global Policy and Collaboration

"Proposal for the Development of a Model Code of Conduct for Biological Scientists" (2016)

Proposal for the development of a model code of conduct for biological scientists under the Biological Weapons Convention

Submitted by China and Pakistan

Tianjin Biosecurity Guidelines (2022)

The Tianjin Biosecurity Guidelines for Codes of Conduct for Scientists

1. Ethical Standards

2. Laws and Norms

3. Responsible Conduct of Research

Selected as one of the achievements in "*Publication to Mark the 50th Anniversary of the Entry into Force of the Biological Weapon Convention (BWC)*"

Side Events of BWC Conferences

(Palace of Nations 2018)

(Palace of Nations 2022)

(Palace of Nations 2022)

《The Global Security Initiative - Concept Paper》 of P.R. China (02.21.2023)

2023年2月21日，外交部发布《全球安全倡议概念文件》，阐释了全球安全倡议的核心理念与原则，列出20项重点合作方向，具有鲜明的行动导向。其中，在第十四项“加强生物安全风险管理”中，《概念文件》表示“加强生物安全风险管理。共同倡导负责任的生物科研，鼓励各利益攸关方自愿采纳《科学家生物安全行为准则天津指南》。共同加强实验室生物安全能力建设，降低生物安全风险，促进生物科技健康发展”。

14. Strengthen biosecurity risk management. Jointly advocate responsible bioscience research and encourage all stakeholders to refer to the ***Tianjin Biosecurity Guidelines for Codes of Conduct for Scientists*** on a voluntary basis. Jointly strengthen the building of biosecurity capability of laboratories, reduce biosecurity risks and promote the healthy development of biotechnology.

3. Global Policy and Collaboration

参加2019年华盛顿中美合成生物学生物安全"二轨会谈"
美国重要政府部门

US Department of Health & Human Services 美国卫生与公众服务部;
US Department of Health & Human Services, Office of the Assistant Secretary for Preparedness and Response 美国卫生与公众服务部，备灾和应对副部长办公室;
US Department of Homeland Security 美国国土安全部;
US Government accountability Office 美国政府问责局;
US Department of State 美国国务院;
Defense Threat Reduction Agency 美国国防威胁压制局;
US Department of Commerce 美国商务部;
US Navy 美国海军;
US Department of Energy 美国能源部;
US Department of Agriculture 美国农业部;
US Army Corps of Engineers 美国陆军工程兵团;
White House Office of Science and Technology Policy 美国白宫科技政策办公室;
DARPA 美国国防部先进研究项目局。

In July 2019, the Johns Hopkins University Center for Global Health and Tianjin University Center co-hosted the "*Track II Dialogue*" on synthetic biology biosafety and biosecurity between China and the United States in Washington DC, with participations from all major agencies of the Chinese and US governments.

3. Global Policy and Collaboration

OVERARCHING FINDINGS

- Synthetic biology has the potential to have a positive impact on international economies, sustainability, human health, and security. China and the United States, as 2 leaders in synthetic biology, have both the opportunity and the responsibility to help set the pace and the standards for promoting responsible conduct in research.
- The international governance structure for biological sciences is currently ill-equipped to deal with the challenges brought on by emerging biological technologies. It will require increased investment and a concerted global effort to create norms that support biosafety and security.
- Although the existing tools used to manage biosafety and biosecurity have direct applications to new challenges posed by synthetic biology, there is also a need for novel and expanded approaches to biosafety and biosecurity.
- Sufficient governance of synthetic biology will require a combination of hard law, soft law, internal governance, guidelines, and international collaboration. Some work has been done in this area, such as the model code of conduct for biological scientists proposed by China and Pakistan to the Biological Weapons Convention (BWC). However, more work is needed to develop additional governance structures.
- International, multidisciplinary dialogues should continue to discuss opportunities to support synthetic biology while also proactively identifying and managing risks.

3. Global Policy and Science Diplomacy

"*U.S. - China Track 2 Dialogue*" on Biological Security, Organized by the Nuclear Threat Initiative (NTI) China Arms Control and Disarmament Association (CACDA) (2019, 2025), Beijing, China

NTI
BUILDING A SAFER WORLD

CACDA-NTI Dialogue: Promoting Effective Biotechnology Governance & Biosecurity
January 2025

U.S. China Dialogue on the Challenges of Emerging Infections, Laboratory Safety, Global Health Security and Responsible Conduct in the Use of Gene Editing in Viral Infectious Disease Research

(US National Academy of Sciences and Chinese Academy of Sciences)

8-10 January 2019, Harbin, China

Mirror Life: progress since the *Science* paper

Growing Scientific Consensus Against Creating Mirror Life

- UK Government Office for Science Expert Roundtable on Mirror Life
- Spirit of Asilomar Summit
- UNESCO IBC
- German Central Committee on Biological Safety (ZKBS)

Ongoing Discussions About Where to Draw the Lines

- Paris Conference on Risks from Mirror Life
- Manchester Technical Workshop
- US National Academies of Science, Engineering, & Medicine Workshop
- And many others…

Cross–campus biosafety and biosecurity education program at Tianjin University

- ✓ For students with various backgrounds
- ✓ > 3,500 students registered so far for the courses
- ✓ New college biosecurity text book to be published in April, 2025

Biosecurity training for local governments and organizations

iGEM

Biosecurity trainings for foreign scholars

"Biosecurity Diplomacy for Young Scientists from the Global South" workshop

"Lancang-Mekong Future Diplomat Training Program: People-centered Public Health Cooperation" workshop.

"International Training Course on Biosafety Laboratory Management and Technology" organized by Wuhan P4 Facility .

Summary

- ✓ Dual-use risks of biotechnology worth attention
- ✓ Our recent efforts of policy, technology and education in dealing with dual-use issues in China
- ✓ Our engagement in the global dialogues highlighting importance for global south to participate and shape future global biotechnology governance and policy

Thanks!

Weiwen Zhang, Ph.D.
Beiyang Chair Professor of Synthetic Biology
National Laboratory of Synthetic Biotechnology
Center for Biosafety Research and Strategy
(CBRS) (http://tjusa.tju.edu.cn/)
Tianjin University
Tianjin, P. R. China
Email: wwzhang8@tju.edu.cn