



Biosecurity in an Era of Disruptive Technological Change and Increased Geopolitical Tensions

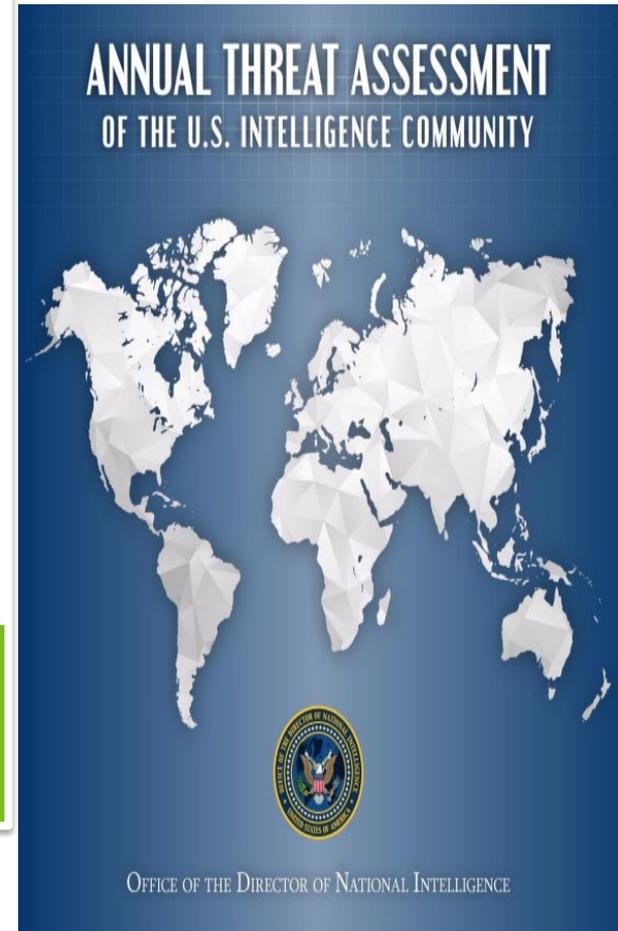
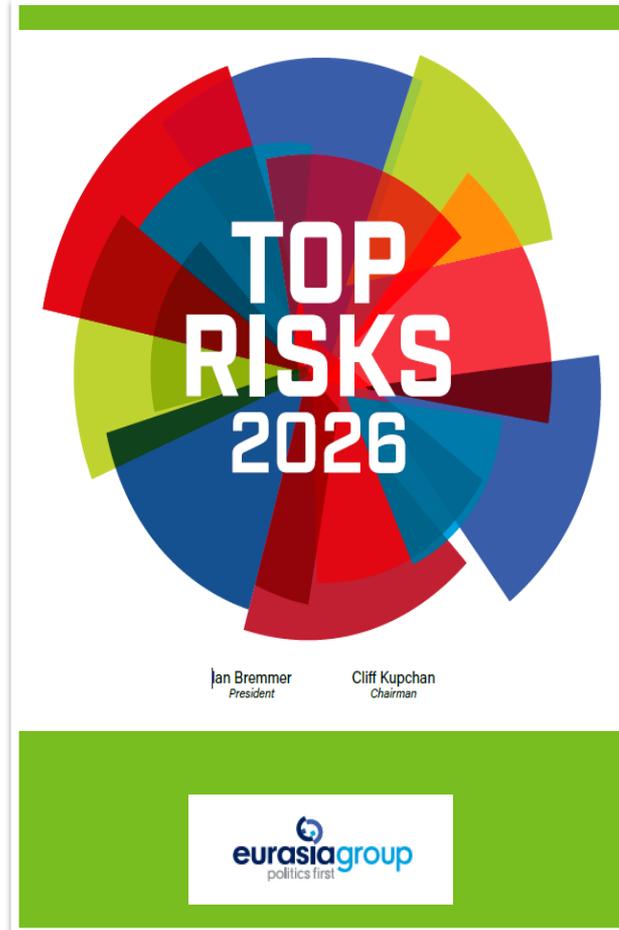
Dr. George Poste

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Complex Adaptive Systems Initiative, Arizona State University
george.poste@asu.edu**

**BioSecurity and Pandemic Resilience: Winter 2026
BIOE 122, EMED 122/222, PUBLPOL 122/222
Stanford University School of Medicine, January 21, 2026**

Slides available @ <https://casi.asu.edu/presentations/>

Global Risk: Escalating Complexity, Volatility and Uncertainty



Biosecurity

- **more than protection against infectious diseases (natural or engineered)**
- **identification and mitigation of a broad spectrum of interdependent biology-driven events with the potential to disrupt societal stability and/or increase the risk of conflict**
- **governments can no longer view biosecurity as limited to traditional public health challenges**

Biosecurity

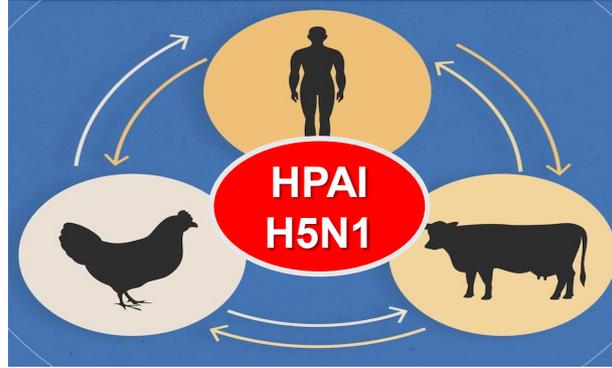
- **increased importance of the commercial bioeconomy in global trade, foreign policy and military strategy**
- **substantial expansion of theoretical dual-use applications from convergence of advances in biotechnology, synthetic biology and AI**
- **US and PRC race for global technological domination**

The Relentless Ever-Changing Dynamics of Infectious Diseases

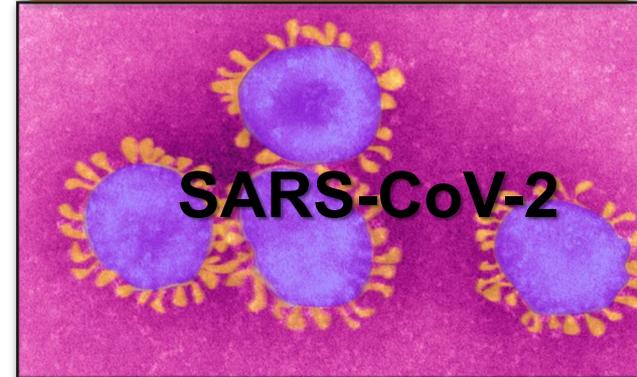
**old foes resurgent:
Rx – resistance**



**omnipresent
pandemic threats**



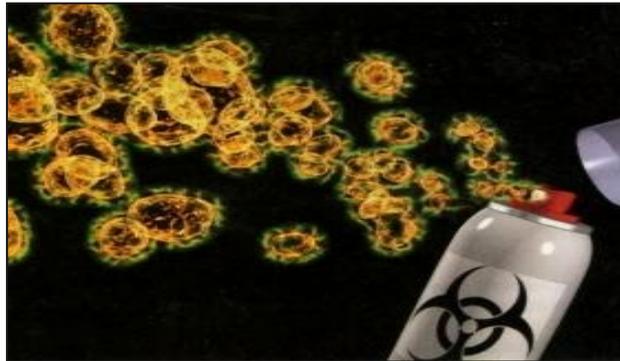
**new foes:
emerging infectious
diseases**



**climate change and
new vector ranges**



**bioterrorism and
bioweapons**



**dual-use
research of concern**



Comfort and Complacency: The Enemies of Vigilance and Preparedness



6 of the 18 most alarming **antibiotic resistance threats** cost the U.S. more than **\$4.6 billion annually**



Vancomycin-resistant *Enterococcus* (VRE)



Carbapenem-resistant *Acinetobacter* species (CRAsp)



Methicillin-resistant *Staphylococcus aureus* (MRSA)



Carbapenem-resistant *Enterobacterales* (CRE)



Extended-spectrum cephalosporin resistance in *Enterobacterales* suggestive of extended-spectrum β -lactamase (ESBL) production



Multidrug-resistant (MDR) *Pseudomonas aeruginosa*

www.cdc.gov/DrugResistance



U.S. Department of Health and Human Services
Centers for Disease Control and Prevention



Rude Shocks: (False) Comfort and Complacency in the COVID Pandemic

- **chronic neglect of public health investment in an era of globalization of commerce and transport**
- **risk warnings long ignored**
- **COVID just latest in repeated neglect-panic-fund-forget historical cycles in preparedness, response, resilience and recovery (PR3) against the threat of infectious/parasitic diseases**

Biosecurity:

- **epidemics can be as devastating as pandemics at the local level**
 - **dengue, yellow fever, Marburg, Ebola, Zika, Chikungunya, mPox, cholera**

Biosecurity:

- **next major epi-pandemic (Agent-X) may have very different features to COVID-19**
 - **transmissibility R_0 ; symptomatic: asymptomatic ratio; duration of fomite shedding**
 - **lethality; organ morbidity patterns; post-infection sequelae**
 - **different high-risk cohorts (children vs adults)**
 - **GI vs respiratory spread vs vector-borne**
 - **contaminated surfaces vs aerosols**
 - **environmental persistence and decontamination**
 - **zoonotic source(s) and reverse zoonose risk**

Silos Subvert Solutions! **The Imperative for Integrated Biosecurity Policies and Preparedness**



Silos: The Enemy of Robust Preparedness

- **integrated whole-of-government approach and stable long-term investment in Response, Resiliency & Recovery (PR3) capabilities**
 - **multiple US government agencies with ill-defined/over-lapping responsibilities and poor coordination of decision authorities**
- **‘One Health’**
 - **inter-dependencies of human, animal and ecosystem dynamics in pandemic/epidemic diseases**
 - **growing frequency of zoonotic infections from ecosystem perturbations**
 - **insufficient investment/capabilities**

Silos: The Enemy of Robust Preparedness

- **limited proactive engagement of industry for rapid scale-up of counter-measures**
- **incentives for industry to invest in high-risk, high-cost R&D for ‘market failures’**
 - **antimicrobial resistance (AMR)**
 - **neglected tropical diseases (NTD)**
- **reshoring of countermeasure manufacturing for robust supply chains**

KFF

The independent source for health policy research, polling, and news.

Global Disease Outbreaks: A 2025 Snapshot and Implications for the U.S.

Authors: Kellie Moss, Jennifer Kates, and Josh Michaud

Published: Oct 29, 2025

- **BIOE 122, EMED 122/222, PUBLPOL 122/222
- 2023-2025**

**Slides available @
<https://casi.asu.edu/presentations/>**

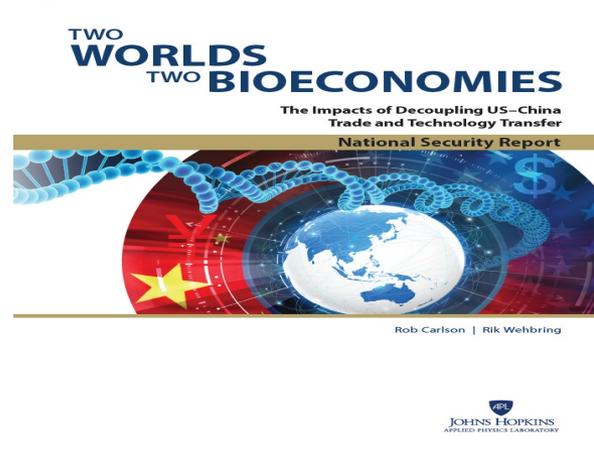
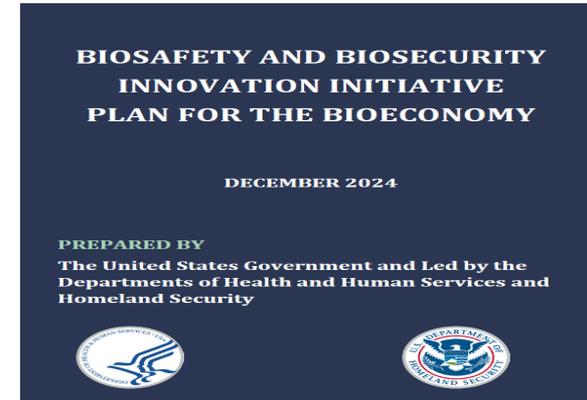
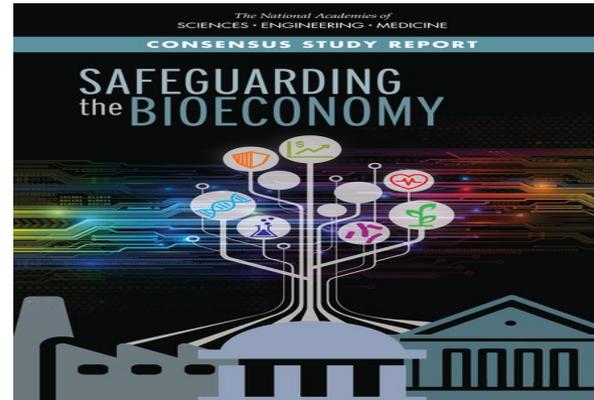
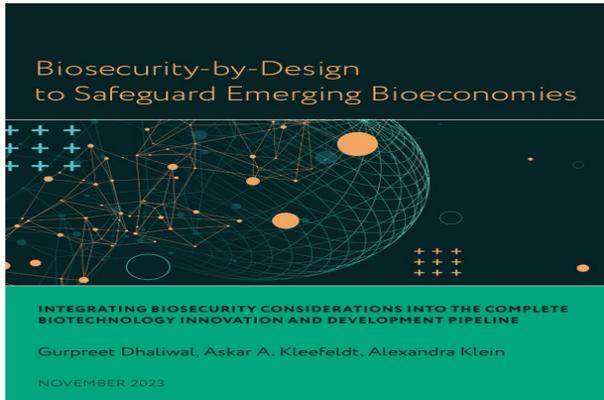
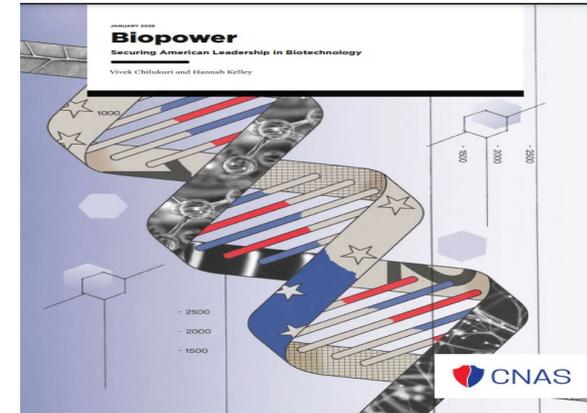
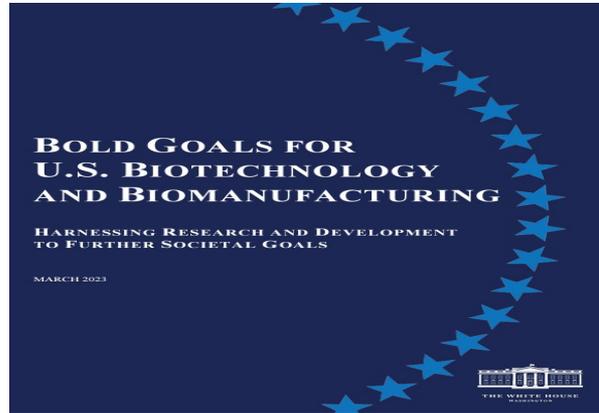
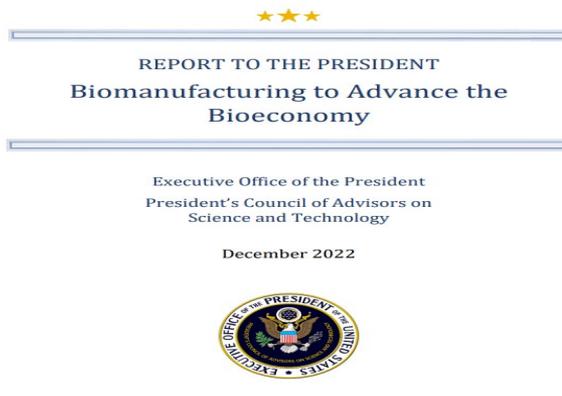
Biosecurity Implications of the Convergence of Biotechnology and Artificial Intelligence (BIOxAI)

The US-PRC Race for Global Dominance in Commercial and Military Applications



OBJECTS IN MIRROR ARE CLOSER
THAN THEY APPEAR

The Race for Commercial Superiority in the Global Bioeconomy





The Competition for Global Dominance of Commercial and Military Applications of BIOxAI

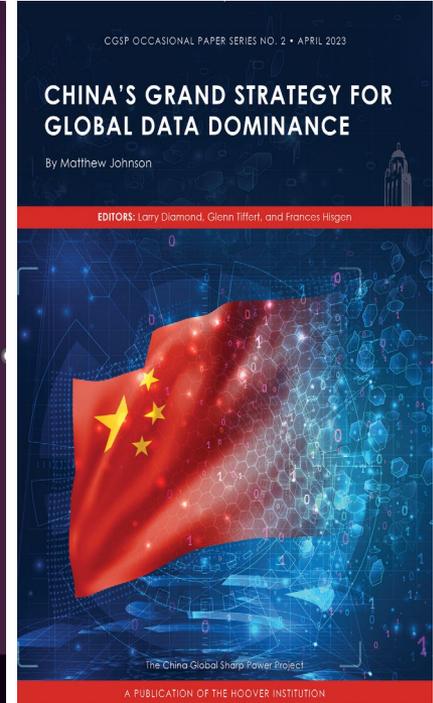
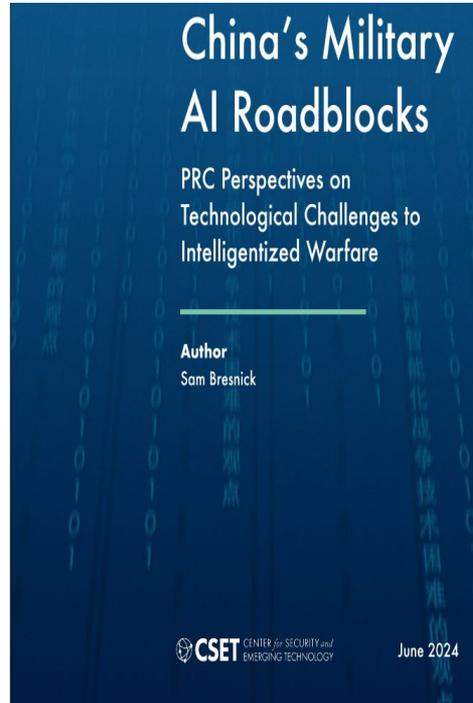
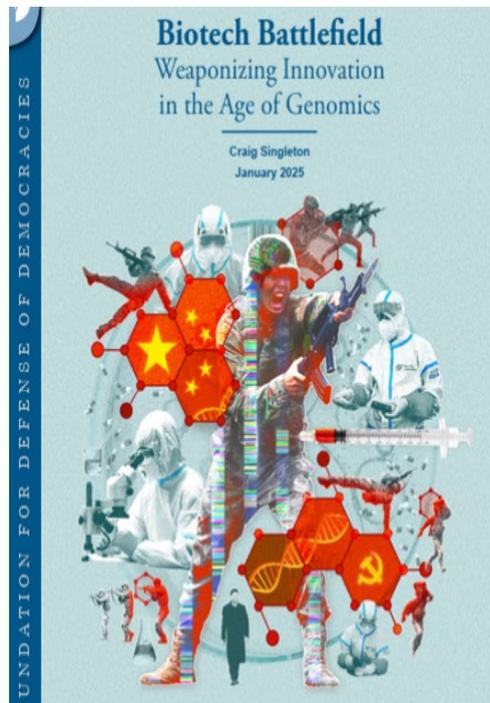
commercial

- **healthcare, agriculture, ecosystem resources, space exploration**
- **novel materials, sensors, biohybrids, robotics**
- **automation of discovery research and bioprocess manufacturing**
- **supply chain resilience**

The Competition for Global Dominance of Commercial and Military Applications of BIOxAI

military

- PRC military (PLA)-civil fusion for national objectives





The Competition for Global Dominance of Commercial and Military Applications of BIOxAI

diplomacy and foreign affairs

- global trade policies, tariffs, sanctions, export controls, supply chain protection
- political alliances (economic, military) and international scientific collaborations (soft power)

safety

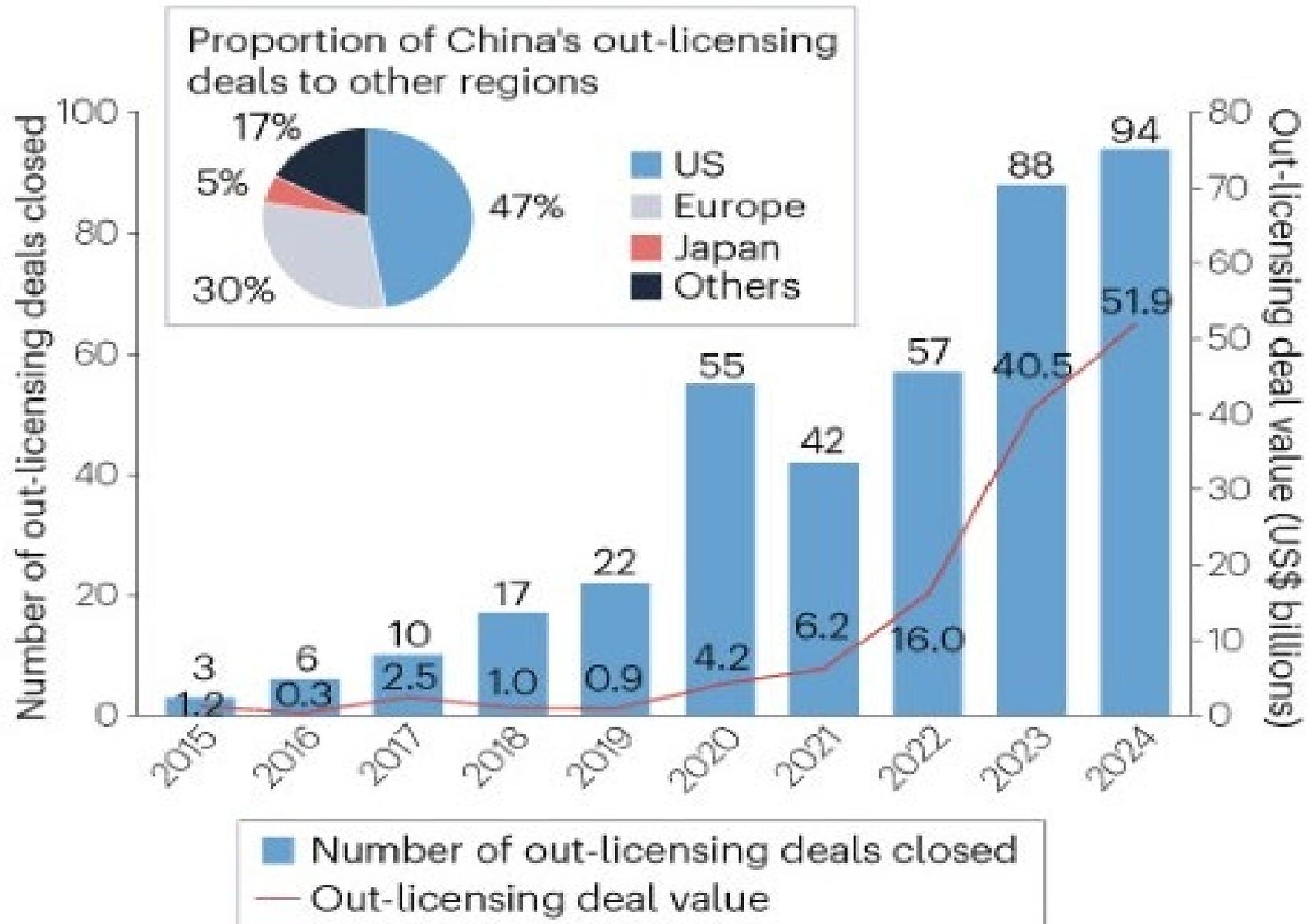
- legislation, regulation and guardrails
- international harmonization
- cyber-biosecurity and industrial/military espionage
- laboratory error and inadvertent environmental release



Dependence on Global Supply Chains for US (and EU) Biopharmaceuticals

- **off shoring manufacturing**
 - **adverse consequences of short-termism**
 - **tax benefits, labor costs, environmental regulations**
- **finished dosage forms (FDFs)**
 - **oral (78%) injectables 55%**
- **active pharmaceutical ingredients (APIs)**
 - **88%**
- **key starting materials (KSMs)**
 - **80% from China and India**

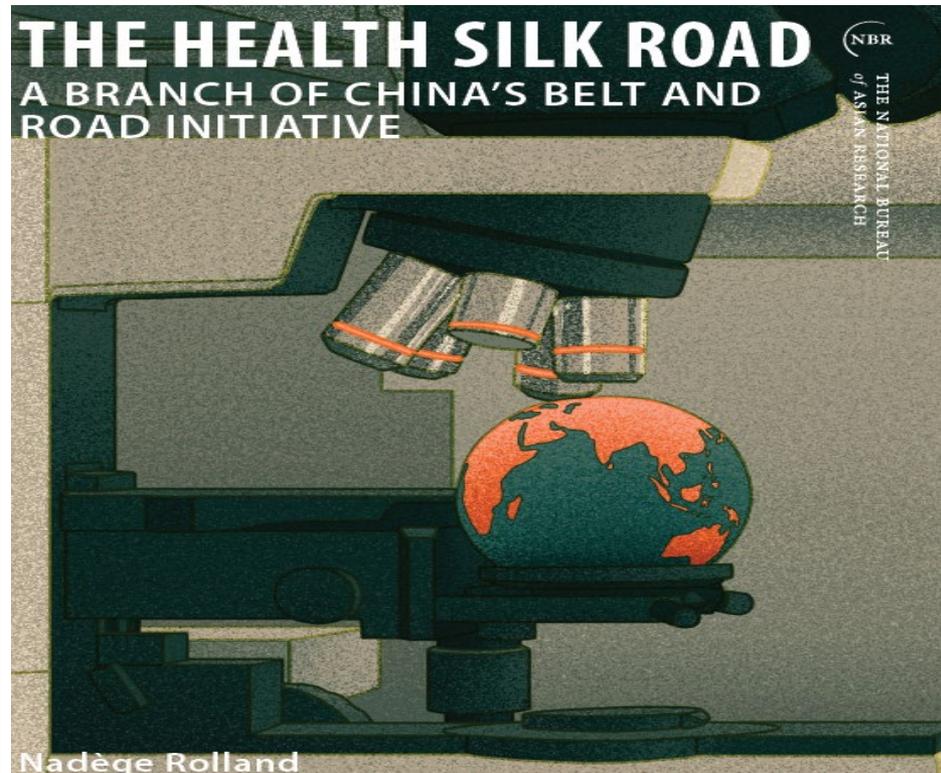
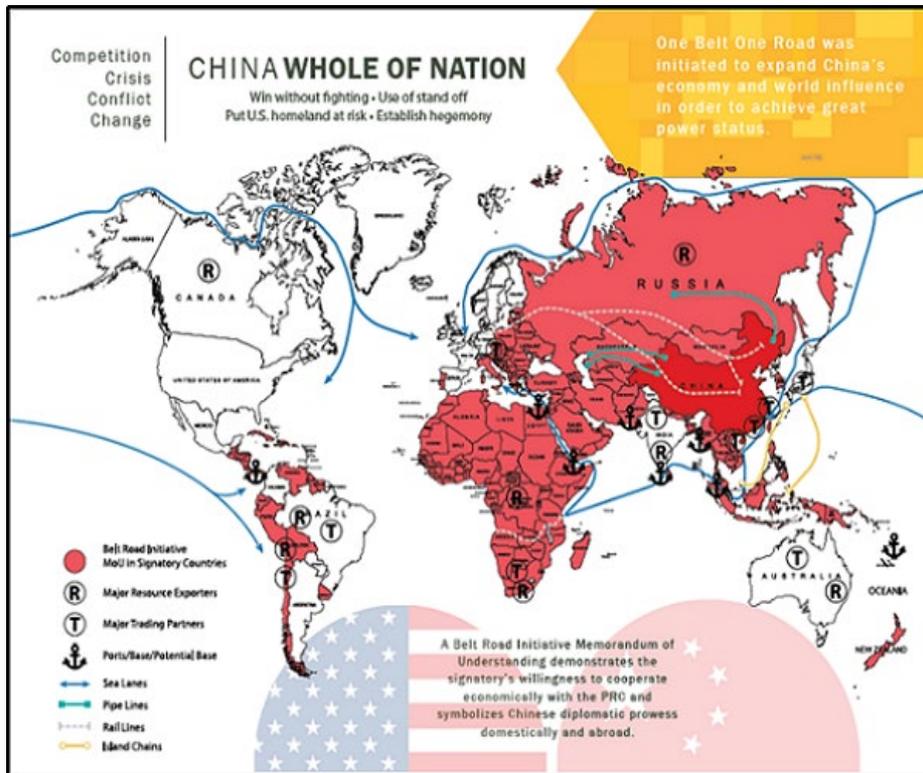
Chinese Biopharmaceutical Out-licensing Deals (2015–2024)



PRC and Targeted Biotechnology and Pharmaceutical Espionage

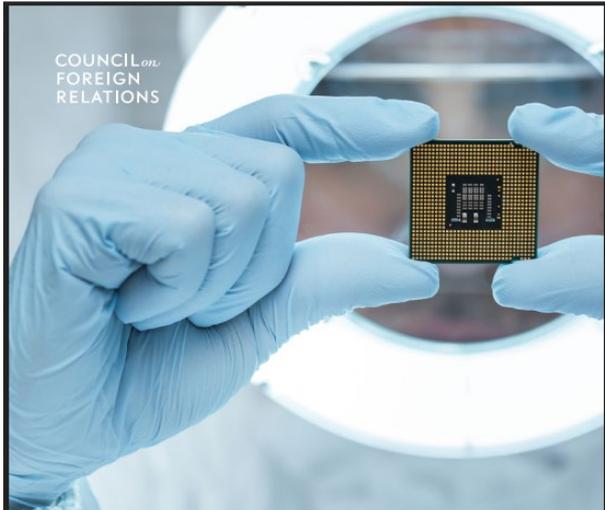
- **US House Committee on Oversight and Accountability (2024)**
 - **escalation of PLA industrial espionage “to weaponize genomic and medical data”**
- **2022 CuckooBees multiyear cyberespionage campaign sponsored by PLA Winnti APT (APT41) hackers**
 - **exfiltration of estimated hundreds of gigabytes of research innovation and IP**
- **2020 efforts to hack Pfizer and Moderna COVID-19 mRNA vaccine production (Operation Warp Speed)**
- **breach of 23andMe consumer genomics database**

China's Belt and Road Initiative



- location of military bases, food (Africa) and infrastructure (indebtedness)
- 'health diplomacy' (soft power)
 - danger of vacuum left by US withdrawal from international organizations

COUNCIL *on* FOREIGN RELATIONS



Independent Task Force Report No. 77

Innovation and National Security

Keeping Our Edge

James Manyika and William H. McRaven, *Chairs*
Adam Segal, *Project Director*

COUNCIL *on* FOREIGN RELATIONS

TASK FORCE REPORT NO. 83

U.S. ECONOMIC SECURITY

Winning the Race for Tomorrow's Technologies

Justin G. Muzinich, Gina M. Raimondo, and James D. Taiclet, *Chairs*
Jonathan E. Hillman, *Project Director*

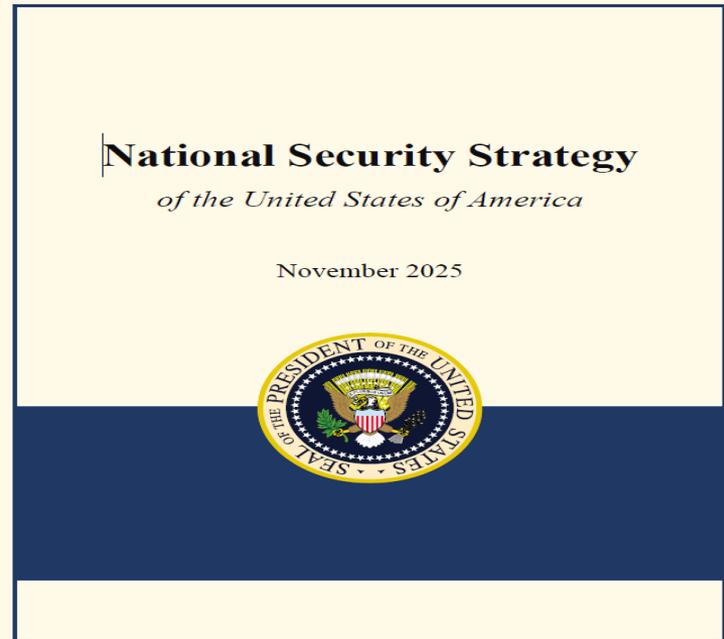


NSCEB
National Security Commission
on Emerging Biotechnology

DECEMBER 2025



The Future of U.S.–China Biotechnology Competition



**The Convergence of Biotechnology
Synthetic Biology and Artificial Intelligence (BIOxAI)**

Dramatic Expansion of the Dual-Use Dilemma

The Expanded Dual-Use Risk Threat from BIOxAI

- **modification of known pathogens**
- **resurrection or synthesis of extinct or difficult to acquire pathogens**
- **de novo design and creation of novel pathogens**
- **new methods for large scale production, extend shelf life, easier dissemination, prolonged environmental persistence and impose need for more complex decontamination procedures**

The Expanded Dual-Use Risk Threat from BIOxAI

- **alter pathogen virulence**
 - **chronic disease versus acute disease/lethality**
- **evade diagnostic detection**
- **circumvent host immunity and known countermeasures (Rx, vaccines)**
- **alter infectivity transmission rates (R_0) and route(s) of transmission**
- **change host range vulnerable age-groups, additional species**
 - **alter affected organ/cell types (trophism)**

PRESIDENT DONALD J. TRUMP

The WHITE HOUSE



▮ PRESIDENTIAL ACTIONS

IMPROVING THE SAFETY AND SECURITY OF BIOLOGICAL RESEARCH

Executive Orders

May 5, 2025

**Open AI Models and Biological Research:
Democratization of Innovation or National Security Threat?**

Proponents of Open Source of AI Models

- **transparency and accessibility as catalysts to accelerate AI research and democratize innovation**
- **public release of model weights allows greater scrutiny, enhancing safety, security and mitigation of flaws and biases**
- **US restrictions versus PRC open-source models might encourage more countries to adopt PRC standards/tools that will not align with liberal democratic values?**

Dangerous Historical Assumptions Regarding Bioweapon (BW) Development

- **BW creation requires expert (tacit) knowledge that is relatively sparse**
- **risk is not increased by open-source publication of laboratory protocols or access to foundational AI models**

LLM Risk Biosecurity Threat Assessment



ANTHROPIC
AI



Research Report

BARBARA DEL CASTELLO, HENRY H. WILLIS

Assessing the Impacts of Technology Maturity and Diffusion on Malicious Biological Agent Development Capabilities

August 11, 2025



Working Paper

JOSH DETTMAN, EMILY LATHROP, AURELIA ATTAL-JUNQUA, MATTHEW NICOTRA, ALLISON BERKE

Prioritizing Feasible and Impactful Actions to Enable Secure Artificial Intelligence Development and Use in Biology

WR-A4213-1 RAND Global and Emerging Risks

September 2025



Expert Insights
PERSPECTIVE ON A TIMELY POLICY ISSUE

ROGER BRENT, GREG MCKELVEY, JR.

Contemporary Foundation AI Models Increase Biological Weapons Risk



Dec. 2025

NATIONAL ACADEMIES
Sciences
Engineering
Medicine

Disseminating *In Silico* and Computational Biological Research

Navigating Benefits and Risks

Convened April 3–4, 2025



Proceedings of a Workshop

NIST AI 800-1
Initial Public Draft

Managing Misuse Risk for Dual-Use Foundation Models

U.S. AI Safety Institute

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.AI.800-1.ipd>

July 2024



U.S. Department of Commerce
Gina M. Raimondo, Secretary

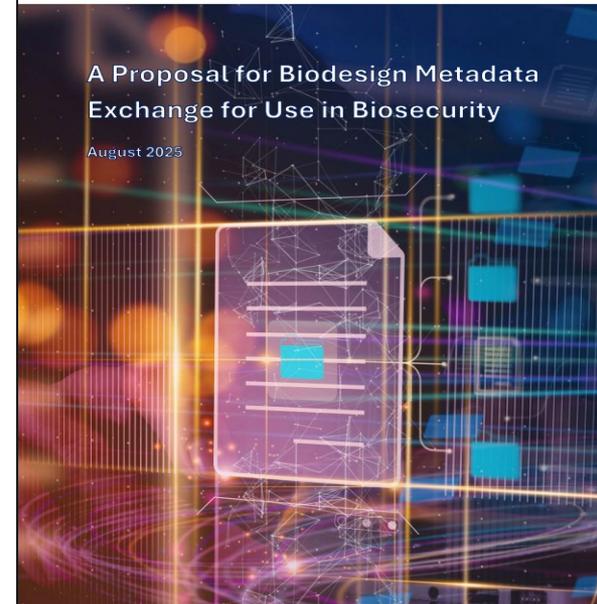
National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Under Secretary of Commerce for Standards and Technology

NTI:bio

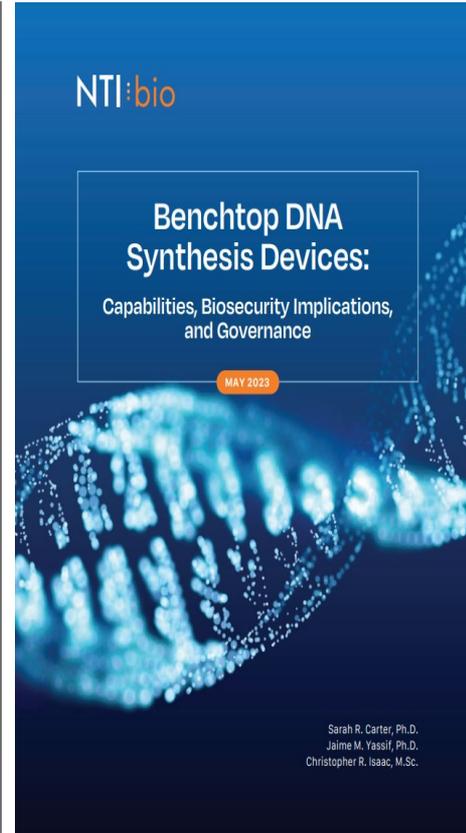
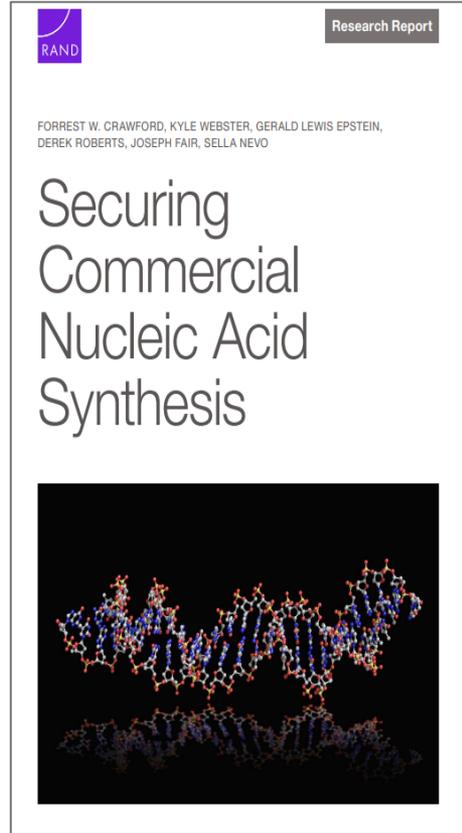
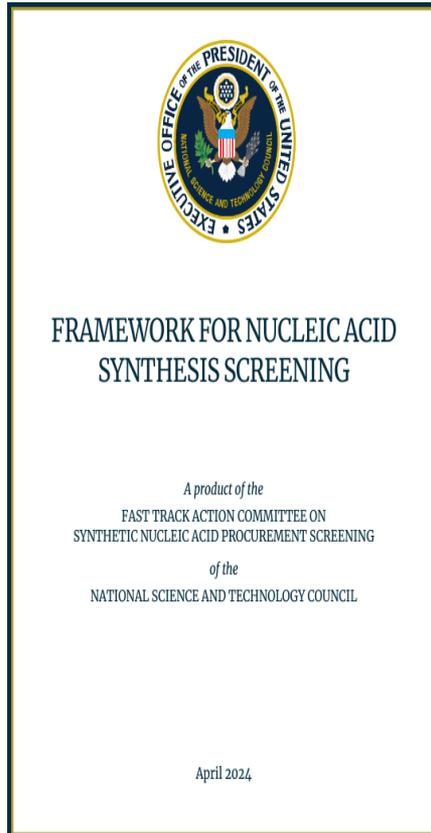
LATTICE

A Proposal for Biodesign Metadata Exchange for Use in Biosecurity

August 2025



Secure Screens for Synthesis of Sequences of Concern (SOCs)



- all viruses described as potential pandemic pathogens
- all known viruses capable of human-to-human transmission

Responsible Biodesign: AI and Proteins of Concern (POC)

RESEARCH ARTICLES

BIOSECURITY

Strengthening nucleic acid biosecurity screening against generative protein design tools

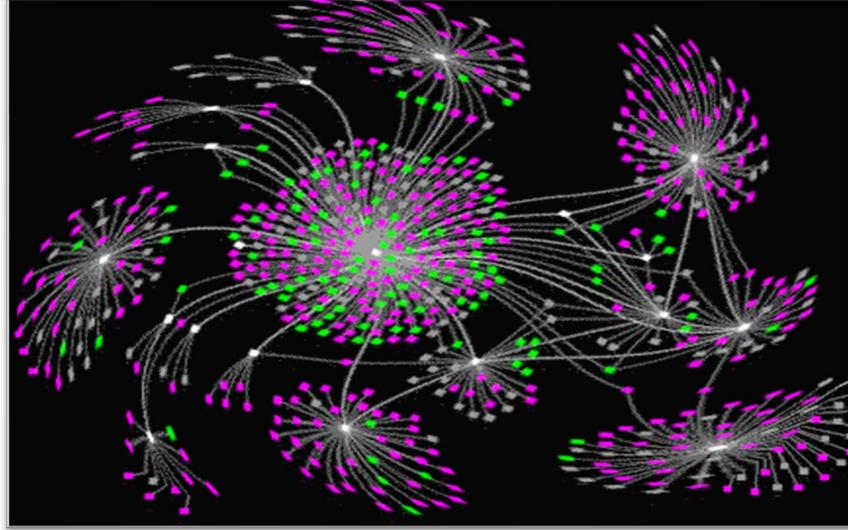
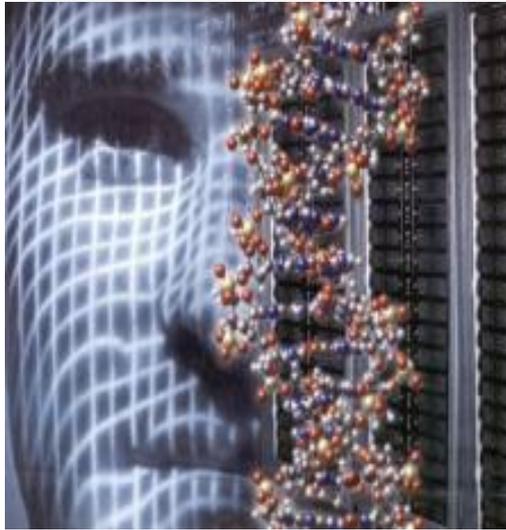
Bruce J. Wittmann^{1*}, Tessa Alexanian^{2†}, Craig Bartling^{3†},
Jacob Beal^{4†}, Adam Clore^{5†}, James Diggans^{6†},
Kevin Flyangolts^{7†}, Bryan T. Gemler^{3†}, Tom Mitchell^{4†},
Steven T. Murphy^{4†}, Nicole E. Wheeler^{8†}, Eric Horvitz^{1*}

From: B. J. Wittmann et al. (2025) Science 10.1126 8578

- design of POC using DNA sequences that evade detection by current biosecurity safety software for nucleic acid sequences of concern (SOC)
 - POC variants that retain ‘wild-type’ POC features
- 72 biohazardous proteins and generation of 72,000 synthetic homologs
- patch creation for detection vulnerabilities

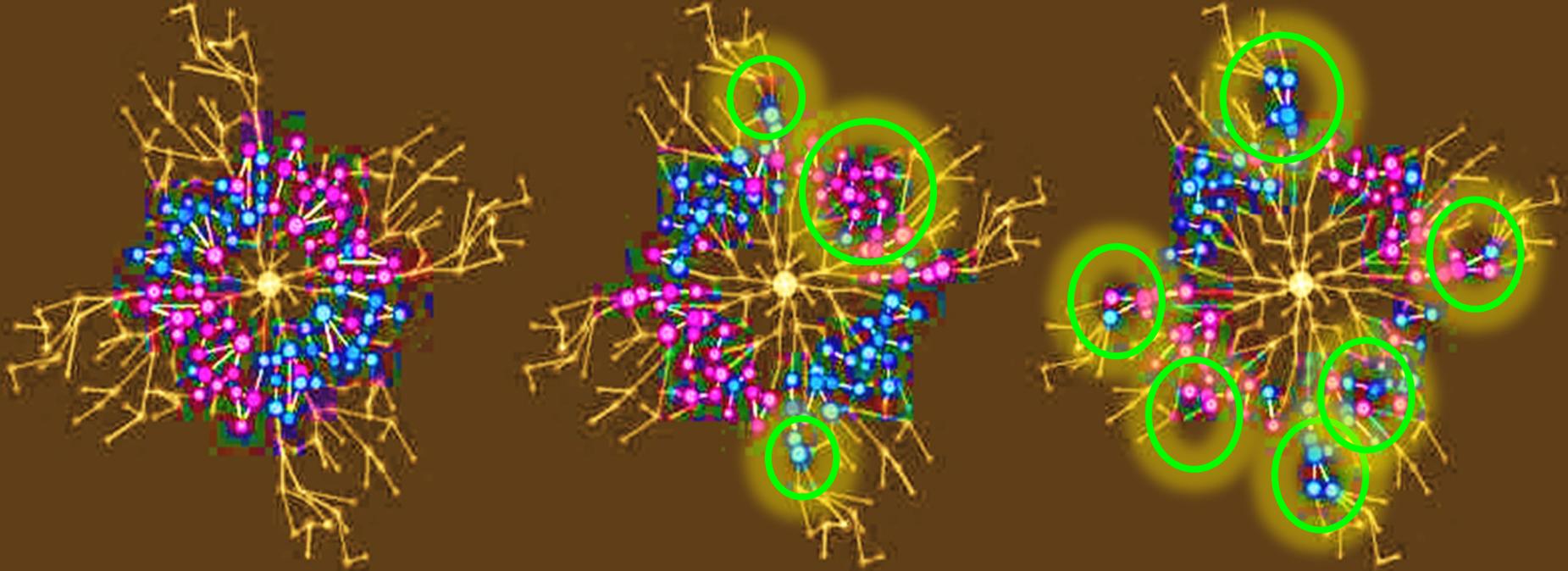
Precision Health: A Dual-Use Trojan Horse?

Detection of Altered Molecular Signaling Networks in Disease:
A New Taxonomy of Disease and Subtype Classification



MDx Signatures of Disease Predisposition and
Targeted Rx for Molecular Disease Subtypes

Precision Health: Mapping System State Shifts Cumulative Perturbations in Molecular Signaling Networks in the Health to Disease Continuum



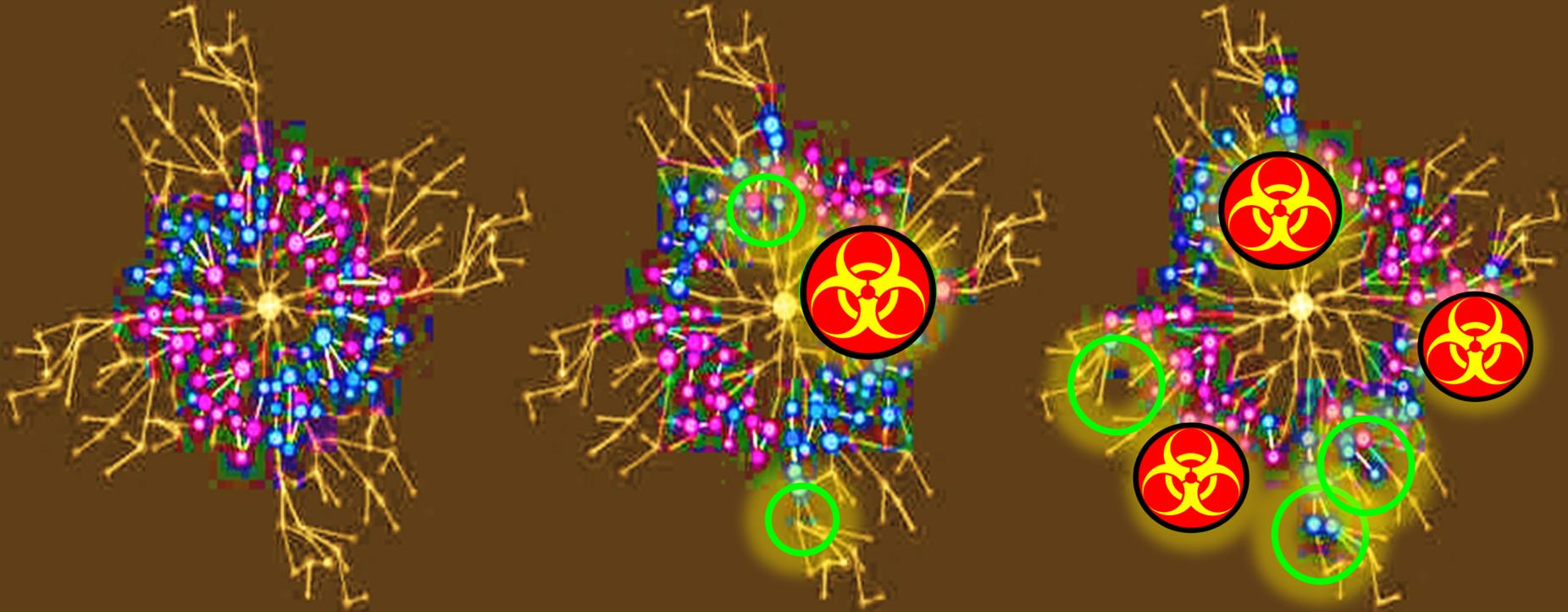
$T_{1(n)}$ health

$T_{2(n)}$ subclinical disease

$T_{3(n)}$ overt disease

- identification of diagnostic biomarkers and therapeutic targets in dysregulated networks
- DrugMechDB (2023) 4583 Rx indications, 5666 pathways
32,249 molecular interaction networks across 14 biological parameters

Molecular Information Networks: a Limitless Range of Targets for Nefarious Dual-Use Activities



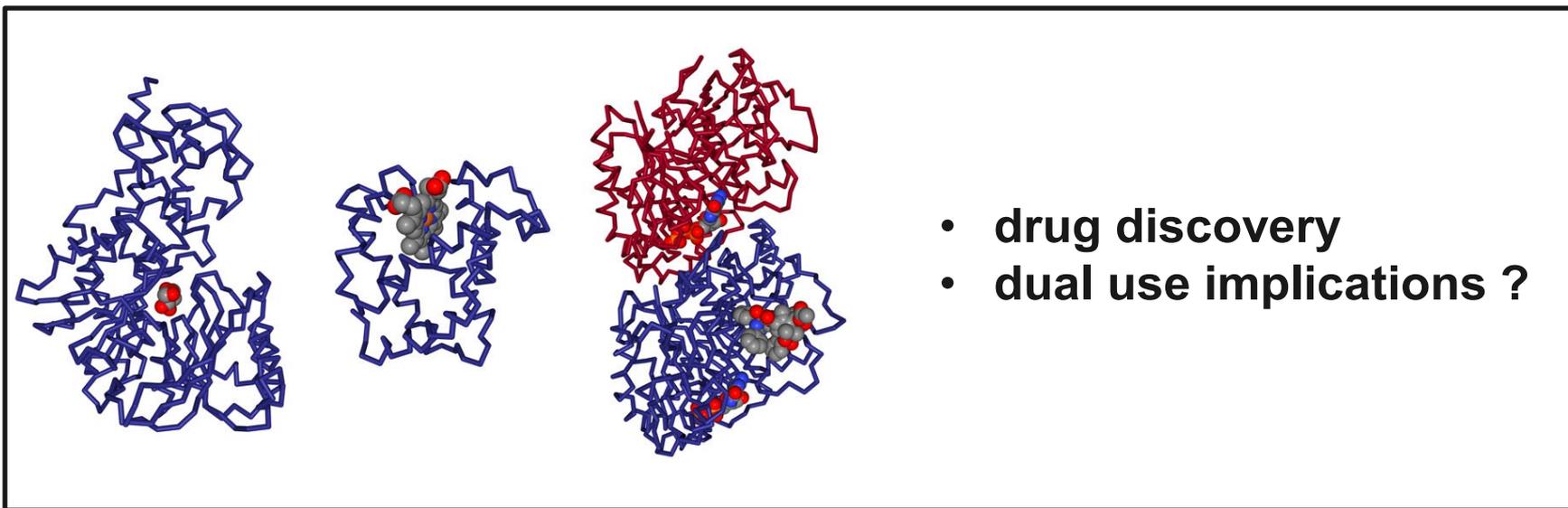
health

acute disease:
single-target

chronic disease:
multi-target pleiotropic

- more feasible for design of next-generation chemical weapons versus more complex viral vector targeting

AI, Protein Structure Modeling and Identification of Ligand Binding Sites (Pockets)



The Human Omnibus of Targetable Pockets

Kristy A. Carpenter¹ and Russ B. Altman^{1,2,3,4*}

Journal of Cheminformatics (2025) 17:180
<https://doi.org/10.1186/s13321-025-01125-x>

- open-source data set of over 2.4 million known and computationally predicted ligand binding pockets
 - all PDB and AlphaFold2 structures of the canonical human proteome



Robust Biosecurity Measures Should Be Standardized at Scientific Cloud Labs



COMMENTARY — Nov 8, 2024

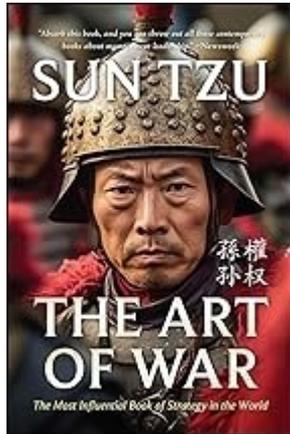
- **global surveillance challenge is analogous to monitoring activities in high security (BSL 3-4) pathogen facilities**
 - **located in adversarial nations**
 - **increasing ease of software deception**

Global Expansion of High Biosafety Level (BSL-3/4) Laboratories



- **COVID-19 pandemic highlighted gaps in preparedness resources for handling high-risk pathogens**
- **plans announced to build 27 new BSL-4 facilities**
 - **Russia (15), PRC (4), India (4), Kazakhstan, Singapore, Philippines, US (1)**
- **staff training and (re)certification in stringent-biohazard containment protocols to limit risk of containment breach**

All Warfare is Based on Deception



- media warfare
- psychological warfare
- lawfare

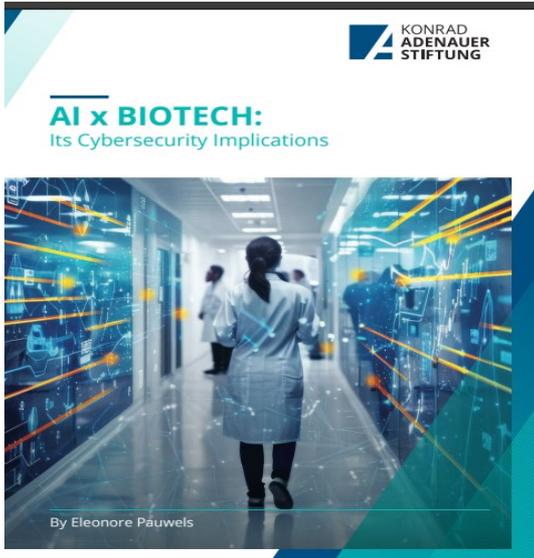
**PRC-PLA
Strategic Support Service**

**Russian Federation
Distributed Info-War-Groups**



Cyberbiosecurity

- **critical infrastructure and mass societal disruption**
- **health systems disruption, EHR contamination, PHI release**
- **food and medicine supply chains**
- **cyber-espionage theft of IP and trade secrets in strategic technologies**
- **disinformation to influence public perceptions and trust**
 - **vaccines, GMOs, synthetic biology**
 - **public health policies (COVID-19 lockdown)**



Global Challenges Require Global Solutions

**The Eroding Commitment to
International Coordination in Public Health**

Global Problems Require Global Solutions

- **nation-focused economic and military competitiveness in advanced technologies versus global cooperation to mitigate shared threats**





FDA

**U.S. FOOD & DRUG
ADMINISTRATION**



USAID
FROM THE AMERICAN PEOPLE

CDC

**CENTERS FOR DISEASE
CONTROL AND PREVENTION**

NIH

**National Institutes
of Health**

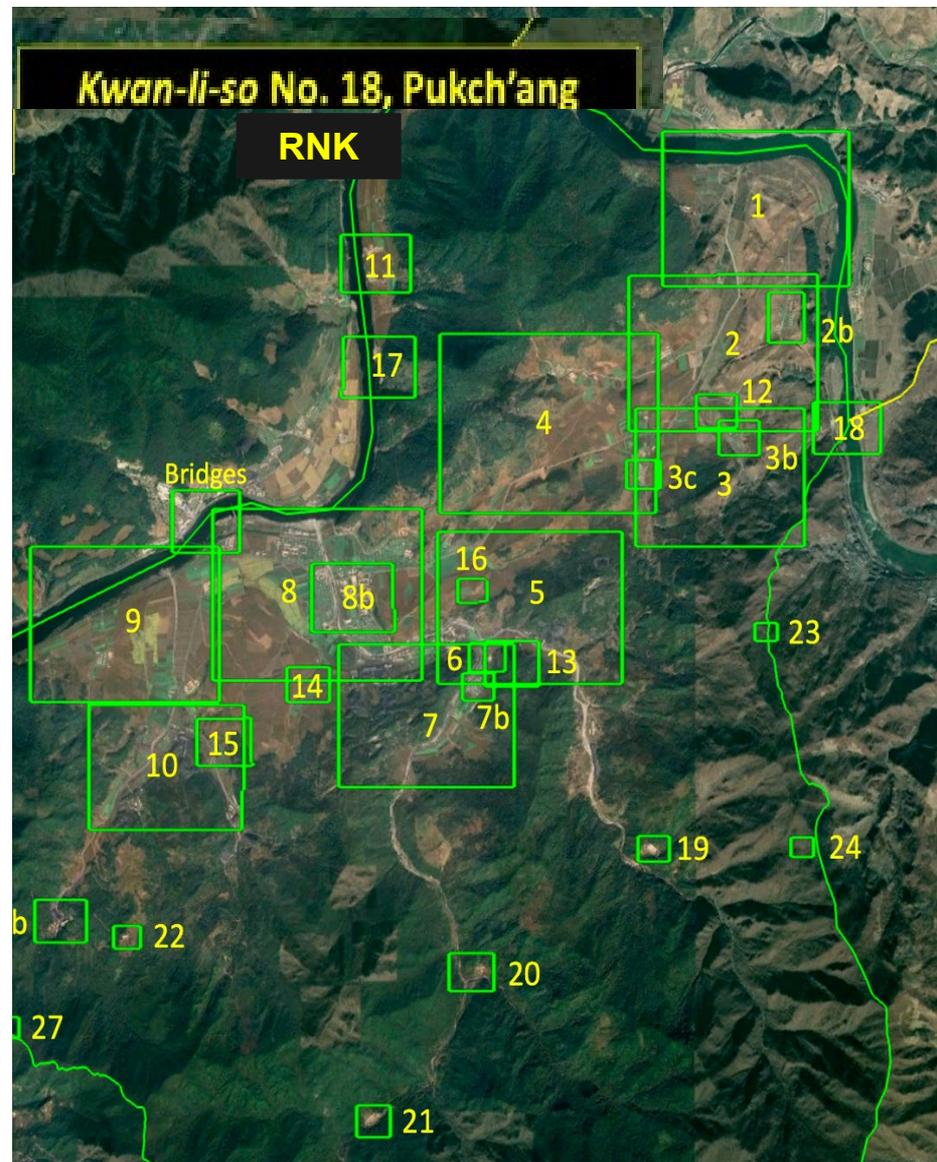
Compliance with Biological Weapons Convention



four signatory nations assessed as likely to have active offensive BW programs (the CRINK axis)



Satellite Surveillance of Bio-Production Sites of Concern



The Danger Within?



2025
REPORT TO CONGRESS
of the
**U.S.-CHINA ECONOMIC AND
SECURITY REVIEW COMMISSION**

ONE HUNDRED NINETEENTH CONGRESS
FIRST SESSION

NOVEMBER 2025

Printed for the use of the
U.S.-China Economic and Security Review Commission
Available online at: www.USCC.gov

“US universities inadvertently act as incubators for China’s technological and military advancements. American institutions risk facilitating the very narrative that the Chinese government seeks to use to outcompete and surpass the United States.”

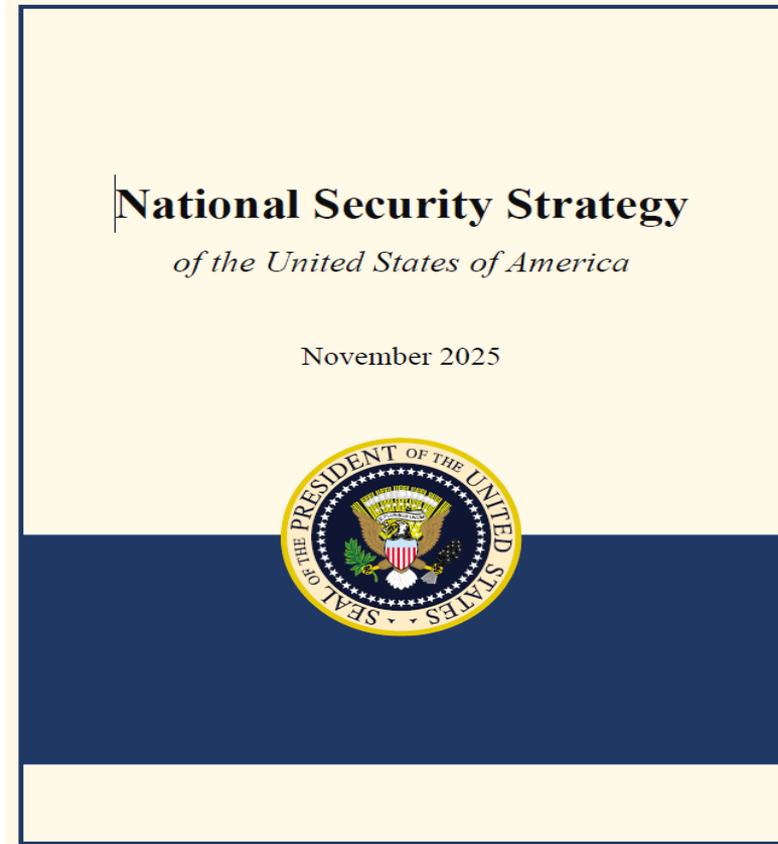
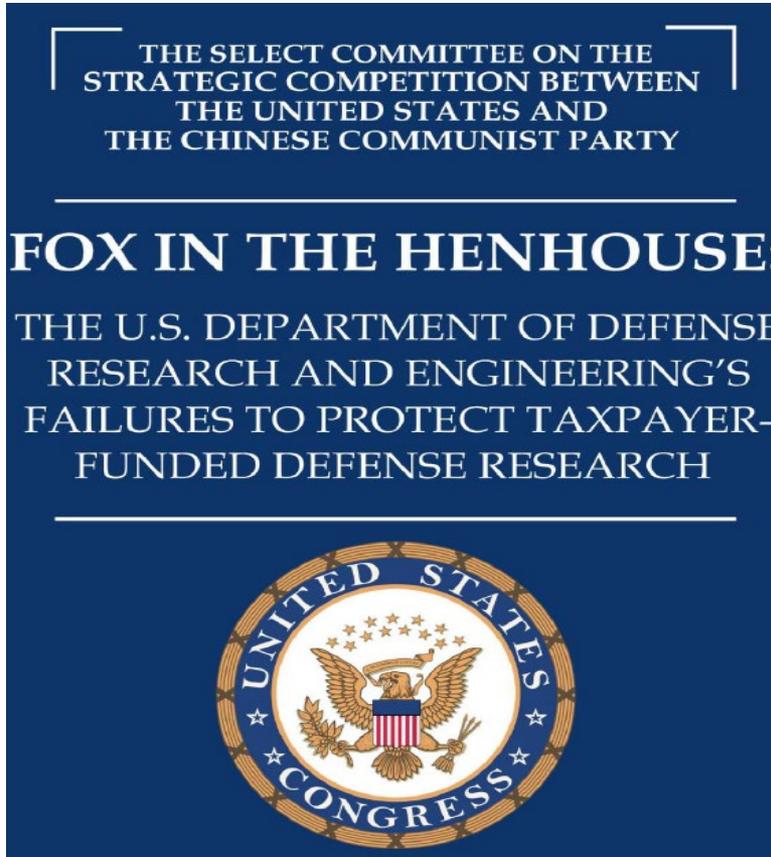
John Moolenaar
**Chair, US Congress Select Committee/
on the Chinese Communist Party**
2025 Letter to American University Presidents

US Universities and the PRC (CCP)*

- **espionage targeting of specific US labs/researchers in emerging technologies**
 - **data and IP theft**
- **infiltration of clandestine CCP intelligence officers**
- **CCP funding actively courted by many universities yet disdaining cooperation with US intelligence and/or law enforcement**

*W. Inbeden Provost, UT Austin, National Affairs (2025) #65

New Controls on US-China Scientific Collaborations



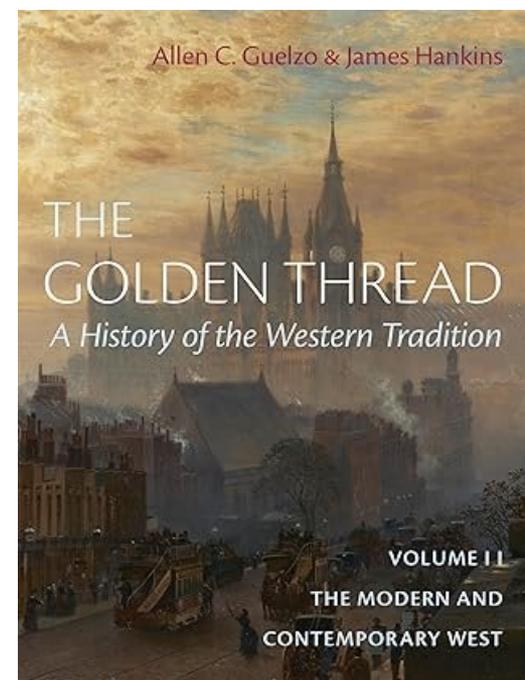
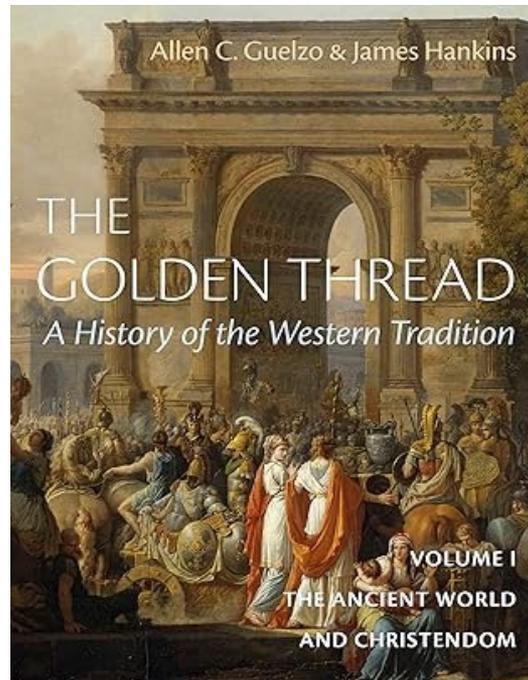
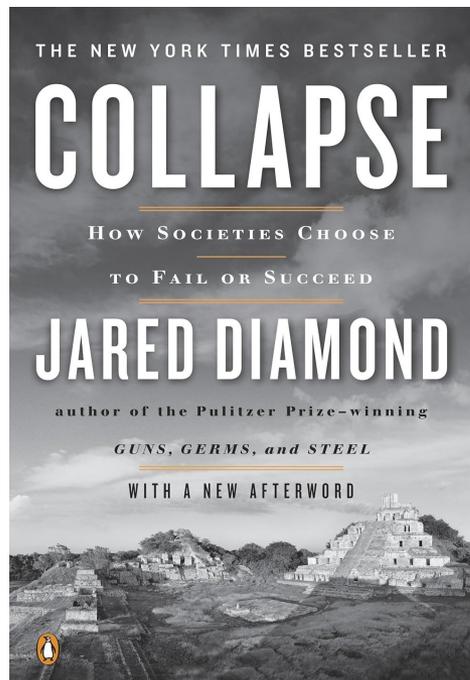
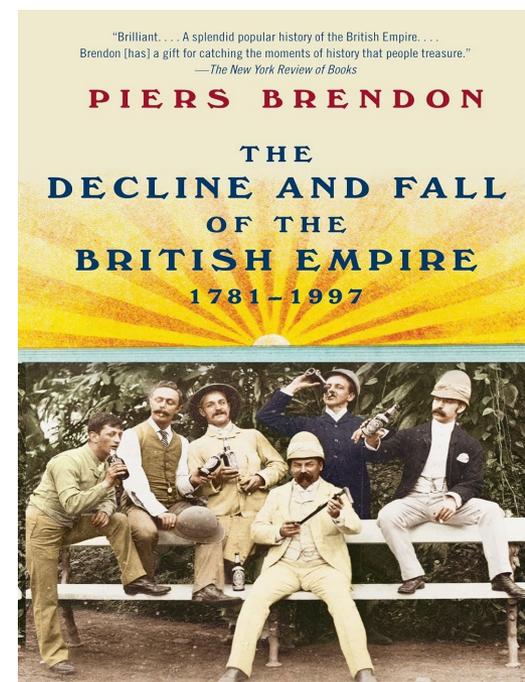
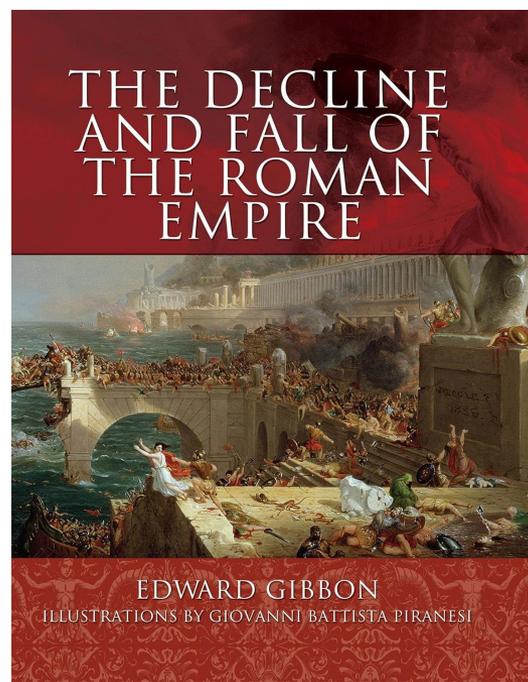
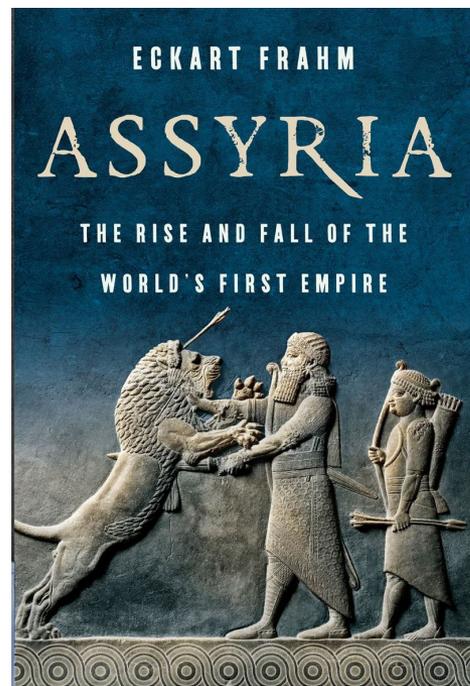
- **Securing American Funding and Expertise from Adversarial Research Exploitation (SAFE) Act**
 - amendment 163 to National Defense Authorization Act
 - ban federal funding to US scientists who have collaborated with PRC, Russia, Iran or RNK in past 5 years

WHY?!

- **disruptive change has been a consistent feature throughout history**
- **so why are major threats and existential risks all-too-often ignored?**
- **the cocoon of comfort, complacency and denial**

WHY?!

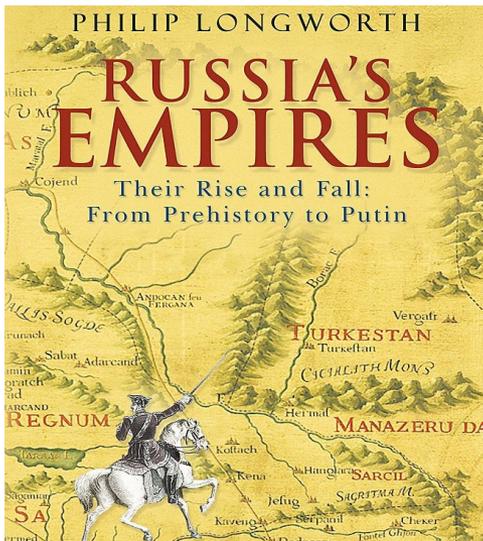
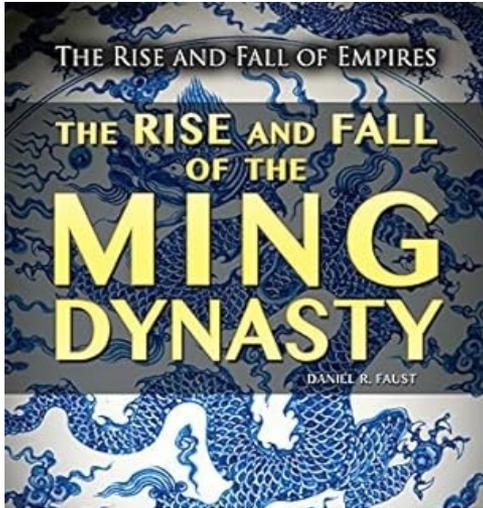
- **vested interests in sustaining the status quo (power, control and influence)**
 - **politicians, public institutions, corporations**
 - **outmoded foreign policies and military strategies**
- **history records that nations and civilizations fall gradually and then suddenly due to prolonged failure to confront and adapt to escalating complexities and conflicts**



Dangerous Symptoms

- **comfort and complacency erode public awareness of global challenges and widespread apathy about societal governance and policy**
- **mis-, dis- and mal-information proliferates without correction and erodes public trust in institutions and their leadership**
- **escalation of political and societal divisions**
 - **polarization, creeping governance paralysis and hollow performative theatrical politics**
- **growing distrust of expertise and abandonment of evidence-based policy**

Ideologies Based on Perceived Historical Humiliation and Desire to Re-Establish Former Greatness



A Pending Shift in the “Rules-Based” Global Order?

- **PRC desire to eclipse US global commercial and military dominance**
- **Russian aspirations to force US-NATO schism**
- **PRC-BRICS campaign to usurp US dollar as dominant transactional currency**

Mobilization of Whole-of-Government Capabilities to Counter Existential Threats

- **the Cold War brought a sense of urgency to government decision making and whole of society engagement**
 - **USG (and allies), academia, industry**
- **similar engagement for biosecurity has not yet taken hold**

Leadership



- transcending short-termism and kicking the problem down the road
- sophisticated analysis of the consequences of continued neglect and failure to act
- moving beyond the current media “gotcha circus” that drives political timidity
- acknowledge complexity(ies) and where uncertainties exist
- communicate the unavoidable need for painful choices



**“Politicians the world over
know what needs to be done,
just not how to get re-elected
having done it.”**

**Jean-Claude Juncker
Former EU Commissioner
The Economist 7 Sept. 2024**

Biosecurity in an Era of Accelerating Technology Disruption and Escalating Geopolitical Tensions

Biosecurity

- **historical and current policies dominated by reactive responses to threats versus proactive mitigation**
- **must expand risk analysis beyond pathogenic microorganisms to identify and mitigate an increasing range of biology-driven threats to societal stability**
- **complex interactions of technological ecological, socio-economic, cultural, commercial and political factors**
 - **global to local**

Biosecurity

- **the US-China competition for technological superiority to dominate the global commercial and military applications of the convergence of biotechnology-synthetic biology with AI (BIOxAI)**
- **rapid proliferation of dual-use technologies from (BIOxAI)**
 - **pace of innovation outstripping development of legislation and oversight to mitigate risk**

Biosecurity

- **from silos to solutions**
 - **the case for creation of a new Cabinet Post for The Department of Biosecurity**
 - **integrate a whole of government approach**
 - **technology, commerce, foreign policy and defense**

Slides available @ <http://casi.asu.edu/presentations>