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Regaining American Biotechnology Strength

The State of U.S. Biosecurity

PREPARED FOR THE

American Biosecurity Initiative

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About This Report

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Method Note

This literature review treats U.S. capacity across the bioeconomy—our ability to discover, develop, and manufacture biotechnology and its products—as a critical component of our national security. We reviewed credible reports that examine our biotechnology sector through a national security lens, not solely an economic competitiveness one.

For the purposes of this paper, biotechnology spans biopharmaceuticals, biomanufacturing, agricultural biotechnology, bioindustrial materials and chemicals, and defense applications.

This is a synthesis of existing public literature, not original research. Sources are drawn from federal government and congressional commissions, think tanks, universities, trade and standards bodies, and management consultancies. A full literature map at the end of the document points readers who want to go deeper to the best sources on each topic.

Executive Summary

American medicine is a national security asset, as vital as the defense industrial base, the energy grid, and the semiconductor supply chain. The biotechnology sector that sustains our ability to produce medicines and other critical biomaterials is increasingly contested. Biotechnology has joined semiconductors and artificial intelligence as a domain of global power, and America's long-standing lead is narrowing. In the semiconductor industry, we invested over $50 billion to bring the sector back to our shores; in 5G telecommunications, the United States ceded ground that it still has not recovered. These examples serve as a warning that leadership in a strategic sector cannot always be won back and that, even when it can, the cost is sizable. That is why we must preserve our advantage.

This literature review examines U.S. biosecurity: the nation's ability to invent, manufacture, and safeguard biotechnology and its products to both manage threats from and realize the benefits of biotechnology. When considered through a national security lens rather than solely an economic one, the literature depicts a capacity under pressure from abroad and a hollowing out at home. To navigate toward a more secure and resilient future, the United States must capitalize on its strengths in innovation and discovery and double down on domestic manufacturing and partnerships with trusted allies.

Over two decades, Beijing has converted state planning, guaranteed domestic markets, procurement preferences, and the fusion of its civilian and military sectors into a durable biotech advantage. China no longer competes only on cost; it now sits at the frontier in advanced manufacturing, synthetic biology, genomic sequencing, clinical trials, research and development, talent, and AI-driven discovery. Its grip on the world's pharmaceutical inputs gives it more than just market share, it confers a coercive advantage. A government that supplies the raw materials behind much of American medicine can slow or withhold them on its own timeline, with little warning, at the moment demand and need is highest. This is leverage that Beijing has already used in other strategic sectors, including critical minerals.

At home, the biotechnology sector's foundation has thinned through years of decisions to prioritize cost over resilience. Only about a tenth of the active ingredients in U.S. generic drugs are still made domestically, and, for many essential medicines, there is no American source at all. A lack of available public and private capital creates a national security vulnerability. Funding for domestic manufacturing and commercial scale production is receding even as competitors pour in state capital. U.S. leadership in biotechnology has atrophied, much as it has in other industries that we historically dominated, and our workforce is not prepared for growth. Individually these challenges are manageable; together and unaddressed they describe a slow, sure forfeiture of advantage.

The consequences are not hypothetical. If we want to develop and access the next cancer therapies, produce everyday medicines affordably, and keep American families healthy, we need to maintain and scale a strong biotechnology sector. Persistent drug shortages already disrupt hospital care and weaken the country's ability to respond to pandemics, disasters, and mass casualty events. The military also draws on the same low-margin, thinly sourced base for the medicines that sustain the force. In the future, biotechnology will also produce cutting-edge biomaterials with enhanced performance and applications that we will not be prepared to manufacture. We have inadvertently built concentrated dependence in a sector critical to our defense, readiness, and deterrence, not to mention our economic competitiveness.

Neither indiscriminate protectionism nor isolation will solve these problems. Building U.S. resilience will happen through strategic action to reduce biosecurity risks. We must secure the

specific inputs that critical products depend on, build and pool capacity and establish standards with trusted allies to reach a scale the United States cannot achieve alone, deploy advanced biomanufacturing to bypass chokepoints, and reinvest in the fundamentals of our bioeconomy including in research funding and a skilled workforce. The choice is not whether to invest in our biosecurity, but when. Acting now costs a fraction of what it will take to rebuild these capabilities once they are gone. The price of delay is both lost economic competitiveness and weakened national security. The window for action is narrowing—roughly two years and closing—not the decades that might be expected for a problem this complex. Meeting that challenge on this timeline will demand a sustained, durable, and bipartisan commitment that outlasts any single administration or budget cycle.

1. Biosecurity as a National Security Imperative

A thriving biotechnology sector shapes how nations develop and deploy medicines, feed themselves, produce chemicals and materials, sustain and protect their forces, and respond to pandemics. Much like semiconductors, wireless technologies, and artificial intelligence, biotechnology has increasingly become a foundational domain of geopolitical competition. U.S. and allied capacity to discover, develop, and manufacture across the bioeconomy is critical not only to our national economy but to our national security.

Biosecurity is the capacity to prevent, withstand, respond to, and recover from biological threats while continuing to deliver essential goods and medicines. Dependence is most immediate and tangible in pharmaceuticals, where it is already measurable and its consequences are already apparent in our homes and hospitals. But pharmaceuticals are just one part of a larger contest over biotechnology leadership.

The United States still leads the world in bioinnovation, but the margin is narrowing quickly and the trend lines point in the wrong direction. In an era of intense strategic competition, the question is not only how to slow China's pace but how to make America stronger. This requires us to rebuild domestic capacity while forging deliberate, durable international partnerships. Capability, once lost, is far more expensive to reclaim than to keep, and production gaps create national security vulnerabilities that cannot be quickly reversed. This literature review identifies where American leadership in biotechnology and biosecurity stands, how it is being contested from abroad and eroded at home, and what is at stake if the United States fails to act.

2. Threats From Abroad

China's sweeping industrial policy, developed over decades, demonstrates its willingness to play a long game to own the complete innovation-to-production cycle in strategic technology sectors.[1] Biotechnology is key among them, with implications for not only conventional pharmaceutical supply chains but also medicines, therapies, and advanced materials. The National Security Commission on Emerging Biotechnology (NSCEB) warns that China is following a familiar model: scaling domestic champions, absorbing foreign know-how, and embedding itself deeply into global supply chains.[2] China's 15th Five-Year Plan (2026–2030) emphasizes strengthening domestic biomanufacturing to drive economic growth and reduce foreign dependencies, and its government procurement policies further entrench domestic

[1] Blaugher et al. (U.S.-China Economic and Security Review Commission), *Made in China 2025: Evaluating China's Performance* (2025).
[2] National Security Commission on Emerging Biotechnology (NSCEB), *Charting the Future of Biotechnology: Final Report* (2025).

preference.[3] Through its policy of Military-Civil Fusion, China integrates its academic and private sectors with its defense establishment, so that public and private advances in biotechnology can directly enhance military strength.[4]

The NSCEB and related academic and think tank research show that China is no longer competing only in low-cost manufacturing; it is advancing in biomanufacturing, synthetic biology, genomic sequencing, medical AI, and contract development and manufacturing.[5] For the United States, this translates into lost capacity, weaker leverage, and deeper dependence on our strategic competitors. This creates seven distinct biosecurity risk dimensions:

Supply chain security. Upstream chokepoints can disable downstream production of finished medicines and therapeutics regardless of where they are made. As the White House's 2021 100-day review emphasized, if a Chinese supplier dominates a small molecule, intermediate, or specialized chemical input, an active pharmaceutical ingredient (API) plant in India, Europe, or even the United States may still be vulnerable to interruption.[6]

Preparedness for natural and man-made threats. The United States must be able to withstand and respond to shocks of any origin while continuing to deliver essential medicines. When critical medicines are concentrated in foreign production, our margin for response narrows, and our ability to protect our population diminishes. Recent assessments highlight China's rapid expansion in biomanufacturing, including large facilities for novel proteins and chemicals, positioning it to challenge U.S. dominance in biopharmaceuticals and related sectors.[7,8] China's rapidly growing clinical trial and research base could accelerate its drug discovery.[9]

Clinical trials. China is building an integrated drug development ecosystem in which clinical trial infrastructure serves as a strategic competitive advantage. Combined with a streamlined regulatory system and strong manufacturing base, it could accelerate the path from discovery to proof of concept and commercialization. This has intensified the debate, largely between industry and government, over U.S. drug regulation and U.S.-China biopharmaceutical ties. While the near-term benefit could be faster access to new medicines, the long-term risks include erosion of U.S. innovation capacity, economic competitiveness, and control over pharmaceutical supply chains as China's capabilities expand beyond early-stage clinical trials.[10]

R&D capabilities and talent. China has built an integrated biotechnology innovation ecosystem by investing in domestic talent and geographically concentrated research clusters that bring together AI, biotechnology, hospitals, universities, startups, contract research organizations

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[3] Green & Parker (International Institute for Strategic Studies (IISS)), *China's 15th Five-Year Plan*, (2026).
[4] U.S. Department of State, International Security Advisory Board, *Report on Biotechnology in the PRC's Military-Civil Fusion Strategy* (2024).
[5] Schuerger et al. (Georgetown Center for Security and Emerging Technology (CSET)), *China and Medical AI: Implications of Big Biodata for the Bioeconomy* (2024); Gaida et al. (Australian Strategic Policy Institute (ASPI)), *ASPI's Critical Technology Tracker* (2023).
[6] The White House, *Building Resilient Supply Chains: 100-Day Reviews Under Executive Order 14017* (2021).
[7] Puglisi & Chou (Georgetown CSET), *China's Industrial Clusters: Building AI-Driven Bio-Discovery Capacity* (2022).
[8] Sedzro (China Briefing), *Positioning for Growth: Navigating China's Biomanufacturing Industry* (2026).
[9] National Security Commission on Emerging Biotechnology (NSCEB), *The Future of U.S.-China Biotechnology Competition* (2025).
[10] NSCEB, *The Future of U.S.-China Biotechnology Competition* (2025); Graham (Atlantic Council), *Pharmaceuticals Are China's Next Trade Weapon* (2025).

(CROs), and government research institutes.[11] These hubs are designed to accelerate discovery by tightly linking research, experimentation, and commercialization. Companies capitalize on this geographic concentration with targeted training programs that attract top candidates and with aggressive recruiting, including from the United States and its allies, to increase the gravity pulling funding and scientists toward Chinese ecosystems. U.S. efforts are often fragmented by shifting federal priorities, funding uncertainty, and differing state policies, which has resulted in a world-class U.S. scientific workforce that is comparatively weaker in translating research into large-scale engineering, manufacturing, and regulatory execution than its Chinese counterpart.

Data and AI. China is amassing genomic, protein, and biomedical data at scale and is pairing it with AI for drug discovery. Under the 2021 Data Security Law, which lets the state claim access to any data it deems relevant to national security, Chinese institutions are able to pool pre-competitive data that companies would never be required to share in the United States. The asymmetry of abundant training data on one side with fragmented and siloed data on the other—aided by clinical trial volume reported at nearly 120 percent of the U.S. level in 2024—is a decisive advantage in AI-driven discovery.[12]

Manufacturing platforms and system diversity. The United States need not produce every medicine or material domestically, but it does need enough resilient and allied capacity to ensure continuity of care during major disruptions and to deny adversaries leverage over essential medicines and the biomanufactured materials critical to national security.

Ensuring safety and standards. Reliance on foreign supply of pharmaceuticals, ingredients, and raw materials could impact the quality and integrity of medicines, putting patient safety at risk. Limited visibility into upstream facilities and the regulators that oversee them makes those risks harder to detect. GAO has found that a majority of the drug manufacturing establishments serving the U.S. market are located overseas and that FDA's foreign inspection program has faced persistent backlogs and staff vacancies.[13] The United States plays a pivotal role in writing the global standards the world follows through bodies such as the International Council for Harmonisation (ICH), ensuring that safety and quality norms align with our own. If we cede leadership in the field, our ability to demand high standards and to insist that the world meets them will diminish. The combination of weaker oversight, lower transparency, and lower standards slows mitigation and erodes strategic preparedness.

3. Vulnerabilities at Home

The United States has long been the world's leading innovator of medicines and biotechnologies, but the foundation beneath that leadership is weakening. The existing literature points to five challenges that, taken together, underscore how our dominant position has been eroded over the past two decades. Within our toolkit, we have dozens of policy levers that have weakened or gone dormant, as well as some we have failed to build to keep up with an ever changing industry. This erosion has compounded over years of bipartisan neglect and short-term cost-driven choices.

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[11] Puglisi & Chou (Georgetown CSET), *China's Industrial Clusters: Building AI-Driven Bio-Discovery Capacity* (2022).

[12] Green & Parker (IISS), *China's 15th Five-Year Plan*, (2026); DigiChina (Stanford University), *Translation: Data Security Law of the People's Republic of China* (2021); NSCEB, *The Future of U.S.-China Biotechnology Competition* (2025).

[13] U.S. Government Accountability Office (GAO), *Drug Safety: FDA Has Faced Persistent Challenges Overseeing Foreign Drug Manufacturing (GAO-24-107359)* (2024).

Deepening dependence on foreign suppliers. The United States increasingly relies on foreign sources for the ingredients, inputs, and research behind our medicines, depending disproportionately on conventional pharmaceutical supply chains originating in China. Estimates vary by methodology, but all point to significant U.S. exposure to Chinese pharmaceutical inputs, whether directly through imports or indirectly through third-country manufacturing such as India.[14] The Council on Foreign Relations' 2025 economic security task force documents how far this has gone: barely a tenth of the active ingredients in American generic drugs are still made domestically, Chinese-made ingredients now appear in roughly a quarter of the drug volume sold in the United States, and for most of the active ingredients in the medicines the FDA deems essential there is no domestic manufacturing source, with a fifth of those ingredients sourced only from China.[15]

This happened through decades of decisions that traded resilience for cost. As the White House's 2021 supply chain review found, roughly 87 percent of generic ingredient facilities now sit overseas, an arrangement that lowered costs by trillions over the past decade while leaving the health system "vulnerable to shortages of essential medicines."[16] The FDA has identified the same structural challenge, tracing chronic shortages to a supply chain that has grown longer, more complex, and more fragmented as production moved overseas and companies leaned on contract manufacturers.[17] The effects of that fragility are already being felt in American hospitals, which now spend approximately 20 million staff hours and nearly $900 million a year managing shortages, more than double their 2019 figures.[18]

U.S. Pharmacopeia analysis of Drug Master Files shows that global manufacturing capacity for APIs remains highly concentrated overseas, with the United States holding only a modest share of facilities relative to foreign producers.[19] Even a limited slowdown in exports, customs processing, or domestic supply preference during a crisis could magnify shortages and disrupt U.S. care delivery. India is also indispensable to the U.S. generic drug market, supplying a large share of finished generics and hosting many FDA-registered manufacturing facilities.[20] This can obscure India's own upstream dependence on China for APIs, intermediates, and key starting materials (KSMs) across key categories of medicines.[21]

Weakening investment in manufacturing and innovation. The United States spent decades building an open innovation ecosystem, with strong public and private research institutions, robust funding for foundational R&D, and an established go-to-market pipeline for new drugs. That strength has eroded as our commercialization and manufacturing base has slowed.[22] The

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[14] Wosińska et al. (Brookings Institution), *U.S. Drug Supply Chain Exposure to China* (2025); Graham (Atlantic Council), *Pharmaceuticals Are China's Next Trade Weapon* (2025).
[15] Muzinich et al. (Council on Foreign Relations (CFR)), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies* (2025).
[16] The White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews Under Executive Order 14017* (2021).
[17] U.S. Food and Drug Administration (FDA), *Drug Shortages: Root Causes and Potential Solutions* (2020).
[18] Vizient, Inc., *New Vizient Survey Finds Drug Shortages Cost Hospitals Nearly $900M Annually in Labor Expenses* (2025).
[19] Duman (U.S. Pharmacopeia), *Global Manufacturing Capacity for APIs Remains Concentrated* (2026).
[20] The White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews Under Executive Order 14017* (2021).
[21] Bollyky et al. (CFR), *The Pharma Choke Point* (2026); Graham (Atlantic Council), *The US Is Relying More on China for Pharmaceuticals — and Vice Versa* (2023).
[22] Muzinich et al. (CFR), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies* (2025).

NSCEB diagnoses a country that out-innovates the world yet makes it "unnecessarily difficult to commercialize and scale" its own best ideas.[23]

Much of our biotechnology, and in particular biopharmaceutical, innovation traces back to taxpayer-funded research. Bayh-Dole succeeded in moving those discoveries from the lab to the market, but it was not designed to ensure they are manufactured at home. Keeping more of that taxpayer-funded production onshore is a lever the United States has underused.

The capabilities that we lose do not repatriate cheaply. As we have lost the feedback loop between the lab and the factory, both our manufacturing and our innovation bases have suffered. Lost manufacturing capacity drags innovation capacity down with it, and neither is easy to rebuild without a concerted strategy.[24] The trend is accelerating: CSIS reports a sharp post-pandemic decline in biomanufacturing investment, including a 20 percent drop in biopharmaceutical venture funding in early 2025, even as our competitors pour state resources into gaining a lead.[25]

Dormant emergency authorities and an unready stockpile. The tools meant to backstop a crisis will not meet the moment when they are most needed. The Strategic National Stockpile does not meet several of its own statutory requirements, and during recent emergencies jurisdictions were unclear how to draw from it.[26] Defense Production Act authorities that could pull domestic manufacturing of critical medicines forward are invoked only sporadically for medical countermeasures.[27] Preparedness depends on levers the United States already has but rarely pulls.

Narrowing lead vis-à-vis our competitors. China could soon overtake America in the areas where it still leads like genetic engineering, vaccine research, and agricultural technology.[28] Without action, the United States risks being "relegated to producing yesterday's tech as China captures the market for tomorrow's."[29] While China grew in prominence by making generics cheaply, it is now competing to develop and deploy the next generation of medicine and biotechnology.[30] Within five years, CFR notes, U.S. pharmaceutical companies went from licensing essentially no drugs from China to sourcing about a third of their new drug candidates there,[31] and ITIF finds that China has already overtaken the United States as a site for certain clinical development.[32]

While our own research and development decreased, controls on dual-use life sciences exports and the governance of biomedical data have not kept pace with the science, leaving the United

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[23] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025).
[24] The White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews Under Executive Order 14017* (2021).
[25] Wessner & Sharma (Center for Strategic and International Studies (CSIS)), *Rebuilding Resilience in U.S. Pharmaceutical Manufacturing* (2025).
[26] GAO, *Public Health Preparedness: HHS Should Address Strategic National Stockpile Requirements and Inventory Risks (GAO-23-106210)* (2022).
[27] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025).
[28] Muzinich et al. (CFR), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies* (2025).
[29] Muzinich et al. (CFR), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies* (2025).
[30] China has developed and executed this capacity across sectors including clean energy and electric vehicles. See, e.g., Nahm, *Collaborative Advantage: Forging Green Industries in the New Global Economy* (2021).
[31] Muzinich et al. (CFR), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies* (2025).
[32] Barbosu (Information Technology and Innovation Foundation (ITIF)), *How Innovative Is China in Biotechnology?* (2024).

States both less aware of its exposure and less able to protect the data that increasingly drives discovery.[33] As trials, procurement, and production chase lower costs and lighter regulation abroad, the United States cedes the manufacturing, clinical trial, and standard-setting leadership that shape which therapies reach which patients on which terms.[34]

Declining talent base. Human capital is an emerging constraint on U.S. biotechnology leadership: nearly a fifth of the life sciences workforce is 55 or older and approaching retirement, threatening a significant loss of leadership and expertise in the coming years.[35] The pipeline meant to power future bioscience industries is running dry, and skilled roles go unfilled. A large majority of pharmaceutical manufacturers report a mismatch between the skills they need and the workforce available.[36] Likewise, the federal government's biotech workforce and its STEM pipeline have not scaled to the needs of this growing sector, and the U.S. immigration and visa pathways for attracting the world's best scientists have tightened.[37] The U.S. bioeconomy cannot grow without enough skilled workers to sustain it,[38] and, while one of America's greatest strengths has always been its talent, we are not educating a bioliterate workforce.[39]

Taken together, these five trends are concerning but not yet irreversible. That is precisely the case for acting now, before we lose the capabilities and talent that have long underpinned our biotechnology leadership and the country's biosecurity.

4. National Security Implications

The United States has little time to act before today's vulnerabilities harden into a durable strategic disadvantage. The National Security Commission on Emerging Biotechnology gave the United States a three-year window to hold or regain its lead in April 2025, leaving little more than two years now, and months later judged that window to be closing faster than it had projected.[40] If the United States cannot translate scientific leadership into resilient production, it will continue exporting both its supply chains and its industrial learning. China's integration of science and manufacturing capitalizes on this gap, enabling faster iterations and market dominance. Combined with the biosecurity risk dimensions above, this translates directly into national security risk and degraded readiness.

Compounded with the vulnerability created by the erosion of our domestic capability, China's rise in biotechnology and manufacturing is a threat to the United States. We must act decisively in the short term to counter this threat and strengthen our biosecurity.

The most immediate national security consequence of pharmaceutical dependence on China and India is reduced resilience during emergencies. Shortages of antibiotics, sedatives, vasopressors, chemotherapy agents, contrast media, and supportive care drugs can degrade

[33] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025).
[34] Barbosu (ITIF), *How Innovative Is China in Biotechnology?* (2024); Muzinich et al. (CFR), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies* (2025).
[35] Muzinich et al. (CFR), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies* (2025).
[36] Wessner & Sharma (CSIS), *Rebuilding Resilience in U.S. Pharmaceutical Manufacturing* (2025).
[37] NSCEB, *Charting the Future of Biotechnology* (2025); National Academies of Sciences, Engineering, and Medicine (NASEM), *Safeguarding the Bioeconomy* (2020).
[38] NASEM, *Safeguarding the Bioeconomy* (2020).
[39] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025).
[40] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025); NSCEB, *The Future of U.S.-China Biotechnology Competition* (2025).

the healthcare response to pandemics, natural disasters, and mass casualty events.[41] During COVID-19, HHS, FDA, and partner agencies had to rely on regulatory flexibility, emergency authorizations, and extraordinary monitoring to manage acute stress on the supply of critical hospital medicines.[42] Dependence on foreign suppliers also erodes supply chain visibility and limits preparedness for rapid response to shortages.

For military readiness, the Department of War relies on the same generic pharmaceutical ecosystem that supplies the civilian health system. If disruptions impair the availability of essential medicines, military treatment facilities, battlefield care, and related federal health systems may all be affected.[43] Critical supplies like antibiotics, anesthetics, sedatives, emergency fluids, and pain control depend on exactly the low-margin products most susceptible to shortage. In a major conflict, the United States would likely face surging demand for selected medicines at the same moment that global shipping, production, and logistics became vulnerable to attack or disruption, as recent conflict in the Middle East has shown when shipping routes are cut off. This makes the case for strategic stockpiles and domestic surge capacity.

The impacts of coercive actions would be felt off the battlefield and in American homes. If China restricts access to its clinical trials, curtails manufacturing or access to its manufactured goods, or refuses U.S. participation in data collaborations, American access to the next generation of cures would narrow sharply.

The exposure extends well beyond medicine. Modern defense is increasingly looking towards biotechnology to someday supply materials as much as medicines. This includes biomanufactured inputs for energetics and propellants, lubricants and coatings, protective materials, and fuel and food produced closer to the point of need. U.S. agricultural biotechnology is also critical to both feed our nation and ensure economic security, which is why the Department of War recently announced a partnership with the United States Department of Agriculture to implement the National Farm Security Action Plan.[44] The Department of War has recognized the criticality of biosecurity, investing in domestic and distributed biomanufacturing through efforts such as BioMADE and the Distributed Bioindustrial Manufacturing Program to reduce logistical vulnerability and produce critical materials on demand.[45] The NSCEB goes further, treating biotechnology as foundational to future military power, where leadership in biomanufacturing and synthetic biology can determine whether the United States can supply and sustain its forces without depending on an adversary's factories.[46] The same logic that argues for stockpiles of medicines argues for a resilient, allied biomanufacturing base for the materials a modern military cannot fight without.

National security is threatened when a supply chain fails, not only when that failure is accidental but also when a competitor breaks it intentionally. China has repeatedly shown a willingness to convert supply dominance into coercive leverage, restricting exports to pressure other governments. The U.S.-China Economic and Security Review Commission describes this as a

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[41] FDA, *Drug Shortages: Root Causes and Potential Solutions* (2020); American Society of Health-System Pharmacists, *Drug Shortages Statistics* (2024).
[42] The White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews Under Executive Order 14017* (2021).
[43] Graham (Atlantic Council), *Pharmaceuticals Are China's Next Trade Weapon* (2025).
[44] U.S. Department of Agriculture (USDA), *National Farm Security Action Plan* (2025).
[45] GAO, *Defense Industrial Base: DOD Efforts to Develop Domestic Biomanufacturing (GAO-26-107797)* (2025).
[46] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025).

deliberate weaponization of supply chains.[47] The Atlantic Council calls pharmaceuticals "China's next trade weapon," noting that China is the largest single supplier of critical U.S. pharmaceutical inputs by volume and that roughly a quarter of the Department of War's own drug purchases are exposed to Chinese supply.[48]

Because this dependence is unidirectional, upstream chokepoints let a single supplier disable downstream production, magnify shortages, and degrade U.S. care delivery precisely when it matters most.[49] When medicine supply chains are this concentrated, they can become instruments of pressure. They are levers an adversary can pull unilaterally, on its own timeline and with limited warning, making concentrated dependence a national security problem, not merely a trade one.[50]

NASEM estimated the U.S. bioeconomy at roughly $950 billion in 2016 and argued that these capabilities are strategically important and increasingly contested.[51] The NSCEB goes further, describing biotechnology as a foundational domain of geopolitical competition in which leadership in innovation and scale may shape future military, healthcare, agricultural, and industrial power. China's advances in dual-use biotech heighten these risks by potentially enabling its military advantage.

A protectionist response of isolation would deepen our vulnerabilities rather than relieve them. We have a short window of time to reinvest in our biosecurity before a domestic vulnerability becomes a national security crisis.

5. Future Outlook

This literature review has collected and synthesized a complex constellation of problems, some arising internally, alongside the erosion of our domestic capacity, and others arising externally, from our competitors and adversaries. These challenges do not lend themselves to a one-dimensional solution. Because we cannot address all these gaps at once, we must be deliberate, using the right tools aimed at the points of maximum leverage. Not all dependence is equally disadvantageous, and we should prioritize exposure by its potential for coercive pressure rather than by volume or cost.[52] Where a foreign chokepoint could disable downstream production of a critical medicine or material, we must act. In other, less sensitive, domains, we should let the market decide. Blanket protectionism is expensive, slow, and untargeted, and it fails because it ignores these distinctions.[53]

America can and should build on its strengths along four complementary paths:

Targeted resilience. Rather than reshoring everything, harden the specific chokepoints—the key starting materials and active ingredients behind defined critical medicines—to deny adversaries

[47] U.S.-China Economic and Security Review Commission (USCC), *2025 Report to Congress, ch. 9, Chained to China: Beijing's Weaponization of Supply Chains* (2025).
[48] Graham (Atlantic Council), *Pharmaceuticals Are China's Next Trade Weapon* (2025).
[49] Bollyky et al. (CFR), *The Pharma Choke Point* (2026).
[50] Wosińska et al. (Brookings Institution), *U.S. Drug Supply Chain Exposure to China* (2025).
[51] NASEM, *Safeguarding the Bioeconomy* (2020).
[52] Bollyky et al. (CFR), *The Pharma Choke Point* (2026); Wosińska et al. (Brookings Institution), *U.S. Drug Supply Chain Exposure to China* (2025).
[53] Wessner & Sharma (CSIS), *Rebuilding Resilience in U.S. Pharmaceutical Manufacturing* (2025).

the chance to weaponize dependence.[54] Concentrating effort on the greatest points of coercive leverage buys the most resilience most efficiently.

A trusted network of allies. Coordinate capacity and standards across trusted partners, including by treating India as a collaborator in building China-independent chains. Scaling with allies lets the United States compete with China in ways it cannot alone, and shared, U.S.-aligned standards reinforce durability.[55]

New production technologies. Advanced biomanufacturing can make critical inputs without relying on the legacy chemical supply chain, letting the United States compete on its inventive strengths rather than where China is already entrenched.[56] These new technologies offer opportunities to leapfrog chokepoints that would be difficult to overcome with legacy brute force approaches.

A stronger domestic foundation. The three aforementioned paths all depend on renewing fundamentals: sustained public funding for research and development, a workforce pipeline that trains and retains skilled talent at every level, and immigration and research policies that attract and keep the world's best scientists and engineers. Absent these foundations, the other paths are fraught with uncertainty.

Across all four domains, we already have the building blocks in place to address these challenges. The next step is not new legislation or new programs. Instead, leaders on both sides of the aisle must commit to capitalize on the authorities and programs that already exist.

These paths are braided intentionally, so that each strengthens the others at points of risk. Targeted resilience depends on finding signals in the noise of supply chain data and private company activity; a trusted network depends on building and maintaining trust across a complex web of allies and partners; new production depends on overcoming technological and engineering risk; and a strong foundation depends on our willingness to invest in our own security. While today's asymmetry favors China, these braided strategies aim to rebalance that dependence. This is not a call to decouple from China but instead to use engagement to make coercion too costly, rather than succumbing to the allure of an isolationism that is ineffective in our global reality.[57] These paths let us buy back resilience at a cost proportionate to risk and far more cheaply now than after the capacity has been lost. A durable solution must start now, be sustained through changes in administrations, and enjoy the bipartisan support that this critical national security issue deserves.

Appendix A. Evidence Base: Annotated Literature Map

This reading list maps the sources behind the report to allow readers to go deeper on each of the themes.

Cross-Cutting Foundations

[54] Wessner & Sharma (CSIS), *Rebuilding Resilience in U.S. Pharmaceutical Manufacturing* (2025).
[55] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025); Roades et al. (Duke-Margolis Institute for Health Policy), *Building a Resilient Pharmaceutical Supply Chain: The Role of International Collaboration* (2025); Gaida et al. (ASPI), *ASPI's Critical Technology Tracker* (2023).
[56] NSCEB, *Charting the Future of Biotechnology: Final Report* (2025).
[57] Graham, Atlantic Council, *The US Is Relying More on China for Pharmaceuticals — and Vice Versa* (2023).

National Security Commission on Emerging Biotechnology (NSCEB), *Charting the Future of Biotechnology: Final Report* (2025). The definitive U.S. reference: a bipartisan congressional commission's finding that biotechnology is a national-security priority and that the United States has a narrow window to respond to China.

National Security Commission on Emerging Biotechnology (NSCEB), *The Future of U.S.-China Biotechnology Competition* (2025). A focused follow-on that benchmarks where the two countries stand, including clinical-trial, investment, and capability trends.

Muzinich et al., Council on Foreign Relations (CFR), *U.S. Economic Security: Winning the Race for Tomorrow's Technologies (Task Force Report No. 83)* (2025). A bipartisan task force placing biotechnology alongside AI and quantum; its biotech chapter is the best source of defensible U.S.-dependence figures.

National Academies of Sciences, Engineering, and Medicine (NASEM), *Safeguarding the Bioeconomy* (2020). The foundational valuation of the U.S. bioeconomy (roughly $950 billion) and a taxonomy of its risks; essential background for treating the sector as strategic infrastructure.

Threats from Abroad

Blaugher et al., U.S.-China Economic and Security Review Commission (USCC), *Made in China 2025: Evaluating China's Performance* (2025). A staff scorecard on China's decade-long industrial plan, including biopharma and high-performance medical devices.

U.S. Department of State, International Security Advisory Board (ISAB), *Report on Biotechnology in the PRC's Military-Civil Fusion Strategy* (2024). A federal advisory board's account of how Beijing fuses civilian biotechnology with military aims.

Puglisi & Rask (Georgetown Center for Security and Emerging Technology (CSET)), *China, Biotechnology, and BGI: How China's Hybrid Economy Skews Competition* (2024). Traces the state-linked ownership and subsidy behind BGI/MGI and how China's hybrid economy distorts fair competition.

Green & Parker (International Institute for Strategic Studies (IISS)), China's 15th Five-Year Plan, (2026). An analyst brief on China's 2026-2030 plan; useful for its explicit prioritization of domestic biomanufacturing and reduced foreign dependence as stated national goals.

DigiChina (Stanford University), *Translation: Data Security Law of the People's Republic of China* (2021). A primary source translation of the PRC law authorizing state access to data deemed relevant to national security; the basis for the paper's point that China can pool precompetitive biomedical data that U.S. firms are not required to share.

Schuerger et al. (Georgetown CSET), *China and Medical AI: Implications of Big Biodata for the Bioeconomy* (2024). How China pairs vast biodata with artificial intelligence to pursue leadership in the bioeconomy.

Puglisi & Chou (Georgetown CSET), China's Industrial Clusters: Building AI-Driven Bio-Discovery Capacity (2022). Documents seventeen state-designated biomedical clusters and bibliometric evidence of rising AI-plus-bio research output.

Gaida et al. (Australian Strategic Policy Institute (ASPI)), *ASPI's Critical Technology Tracker* (2023). A bibliometric ranking showing China leads across most critical technologies, including several biotechnology subfields.

Barbosu, (Information Technology and Innovation Foundation (ITIF)), *How Innovative Is China in Biotechnology?* (2024). A multi-method assessment concluding Chinese biotechnology has become materially more innovative, not merely cheaper.

Ko, *Biofactories: Behind China's Lead in Biomanufacturing* (SSRN working paper) (2026). Argues Chinese policy has pivoted from biotechnology broadly toward biomanufacturing specifically through 2030; useful for intent, but it is a preprint.

Singleton (Foundation for Defense of Democracies (FDD)), *Biotech Battlefield* (2025). A hawkish but densely sourced monograph on BGI/MGI-PLA ties and the security stakes of Chinese genomics.

Sedzro (China Briefing), *Positioning for Growth: Navigating China's Biomanufacturing Industry* (2026). A market guide that captures the scale and state backing of China's biomanufacturing push; treat its figures as reported secondhand.

Vulnerabilities at Home

The White House, *Building Resilient Supply Chains: 100-Day Reviews Under Executive Order 14017* (2021). The cornerstone federal assessment; establishes that roughly 87 percent of generic API facilities sit overseas and sets out a resilience strategy.

U.S. Food and Drug Administration (FDA), *Drug Shortages: Root Causes and Potential Solutions* (2020). The definitive root-cause analysis: markets fail to reward quality, and low margins drive a race to the bottom.

Duman (U.S. Pharmacopeia), *Global Manufacturing Capacity for APIs Remains Concentrated* (2026). A Drug Master File analysis showing how little active-ingredient capacity remains in the United States.

American Society of Health-System Pharmacists, *Drug Shortages Statistics* (2024). The gold-standard longitudinal dataset on active U.S. drug shortages.

Vizient, Inc., *Beyond the Shortage: The Hidden Cost of Drug Supply Chain Disruptions* (2025). A provider survey quantifying the labor cost and patient-safety toll of shortages (roughly $900 million a year).

Wessner & Sharma (Center for Strategic and International Studies (CSIS)), *Rebuilding Resilience in U.S. Pharmaceutical Manufacturing* (2025). Diagnoses the binding constraints—regulation, capital, geographic concentration, and talent—and warns that tariffs alone will backfire.

Nahm, *Collaborative Advantage: Forging Green Industries in the New Global Economy* (2021). See Chapter 5, a scholarly account of how China came to specialize in scaling and manufacturing innovation, illustrating the innovation-to-production model behind China's industrial strategy across strategic sectors.

U.S. Government Accountability Office (GAO), *Drug Safety: FDA Has Faced Persistent Challenges Overseeing Foreign Drug Manufacturing (GAO-24-107359)* (2024). Documents the foreign inspection backlog and that a majority of establishments serving the U.S. market are overseas.

U.S. Government Accountability Office (GAO), *Public Health Preparedness: HHS Should Address Strategic National Stockpile Requirements and Inventory Risks (GAO-23-106210)* (2022). A federal audit finding the Strategic National Stockpile falls short of several statutory requirements; support for the paper's "dormant authorities and unready stockpile" claim.

National Security Implications

U.S.-China Economic and Security Review Commission, *2025 Report to Congress, ch. 9: Chained to China — Beijing's Weaponization of Supply Chains* (2025). Frames Chinese supply-chain dominance as deliberate, coercive statecraft rather than incidental concentration.

Wosińska et al. (Brookings Institution), *U.S. Drug Supply Chain Exposure to China* (2025). The most careful public estimate of U.S. exposure and of how concentrated supply becomes leverage.

Graham (Atlantic Council), *Pharmaceuticals Are China's Next Trade Weapon* (2025). A trade data analysis of China's dominance of critical pharmaceutical inputs and the exposure of U.S. defense purchases.

U.S. Government Accountability Office (GAO), *Defense Industrial Base: DOD Efforts to Develop Domestic Biomanufacturing (GAO-26-107797)* (2025). Reviews Department of War biomanufacturing investment, including BioMADE and distributed manufacturing programs.

Hassabis et al., *An Open Letter: In Support of Mandatory Nucleic Acid Synthesis Screening* (2026). An expert consensus call to mandate DNA synthesis screening against AI-enabled misuse; valuable as testimony to elite consensus, not as evidence.

U.S. Department of Agriculture (USDA), *National Farm Security Action Plan* (July 2025). A comprehensive strategy to integrate American agriculture into the nation's broader defense and security framework.

Future Outlook

Bollyky et al. (Council on Foreign Relations (CFR)), *The Pharma Choke Point* (2026). Maps the specific chokepoints in the drug supply chain and argues for targeted de-risking over blanket decoupling.

Roades et al. (Duke-Margolis Institute for Health Policy), *Building a Resilient Pharmaceutical Supply Chain: The Role of International Collaboration* (2025). The affirmative case for allied coordination as a more efficient path to resilience than onshoring alone.

Graham (Atlantic Council), *The US Is Relying More on China for Pharmaceuticals — and Vice Versa* (2023). A useful counterweight that debunks inflated dependence figures and underscores the interdependence between the two economies.