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SPECIAL COMPETITIVE STUDIES PROJECT

Benchmarking Biotech

Assessing U.S.-China Competition Across the Bioeconomy

A Letter from SCSP's President and CEO

For most of the last century, American leadership in biotechnology was largely taken for granted by policymakers. The United States built the modern biotechnology industry and turned federally funded research into the drugs, crops, and materials that define modern life. But that leadership is increasingly the result of investments made decades ago; the United States is running on borrowed time while failing to secure its future position.

China recognizes the stakes. Over the past two decades, Beijing has moved from distant follower to a serious competitor across biopharmaceuticals, agricultural biotechnology, and industrial biotechnology. It has done so by executing a whole-of-state strategy that treats biotechnology the way it has long treated semiconductors: as a domain to be won by aligning policy, capital, infrastructure, data, regulation, and industrial capacity. In 2025, the congressionally chartered National Security Commission on Emerging Biotechnology warned that U.S. policymakers had a three-year window to secure America's lead or risk ceding it to China. Our report reaches a similarly urgent conclusion: the United States retains the overall lead today, but China is positioned to surpass it by 2030 if current trajectories continue.

What makes this competition distinct is that the global industry is deeply linked and operates across a timeline of decades. Influence accumulates slowly across supply chains, data, manufacturing capacity, and regulatory speed, compounding in whichever direction its national ecosystem rewards. The United States still leads on frontier innovation. China controls the inputs and industrial throughput that determine if innovations translate into products a country can depend on.

This scorecard is intended to make the competition clear: where America's advantages are durable, where they are eroding, and where the balance has already shifted. In that sense, it carries forward the mission of the original Special Studies Project: to give policymakers a clear-eyed assessment of a generational strategic challenge. The United States still has the breakthrough innovative capacity and the deepest talent base necessary to compete and win. None of that is guaranteed to last. What follows is our assessment of where the United States stands and what it must do now to lead in biotechnology through 2030 and beyond.

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Special Competitive Studies Project

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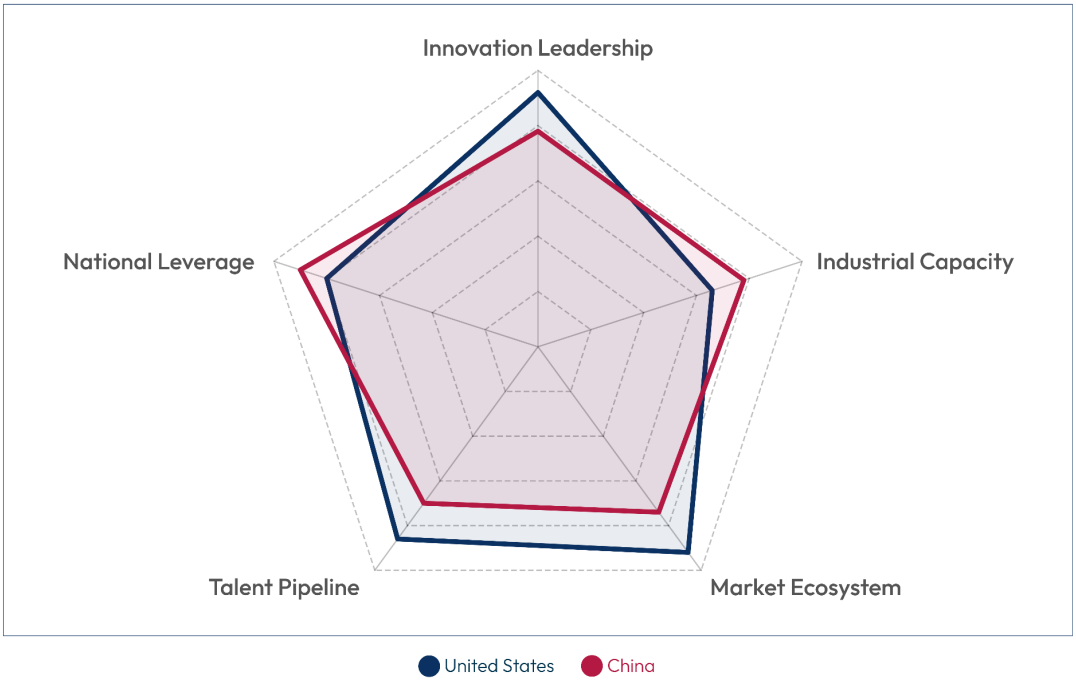
Executive Summary

Biotechnology is at the forefront of innovation in the 21st century. The United States and China are locked in an intense competition for the best and newest cures, crops, and materials, each one striving to out-innovate the other. The biotechnology competition will not be won by a single breakthrough product or control over one critical input, but by the ecosystem that repeatedly converts discovery into products at scale. That makes leadership slower to lose and slower to seize. Collaboration can still accelerate shared scientific and health goals, but it does not erase strategic competition—particularly when one country uses state power, non-reciprocal access, or market control to build advantage at the other's expense. American leadership in biotechnology is real, but it is also inherited—the return on a research base and commercial pipeline built decades ago, still compounding today. What has shifted is the shape of the contest itself: China is no longer contesting one or two fronts but pushing into a widening set of biotechnology subfields at once, forcing the United States to defend ground on more axes than it once had to. As the Chinese government uses its increasing influence over domestic industry to guide the field's development in the state's interests, the United States needs to swiftly develop and implement a coordinated national policy to protect its position of biotechnology leadership, and ultimately its economic and national security. Who will hold the lead depends on a combination of factors: basic research capacity to turn novel discoveries into commercial hits, control over critical inputs such as talent, data, and manufacturing, policy and regulatory efficiency, and more.

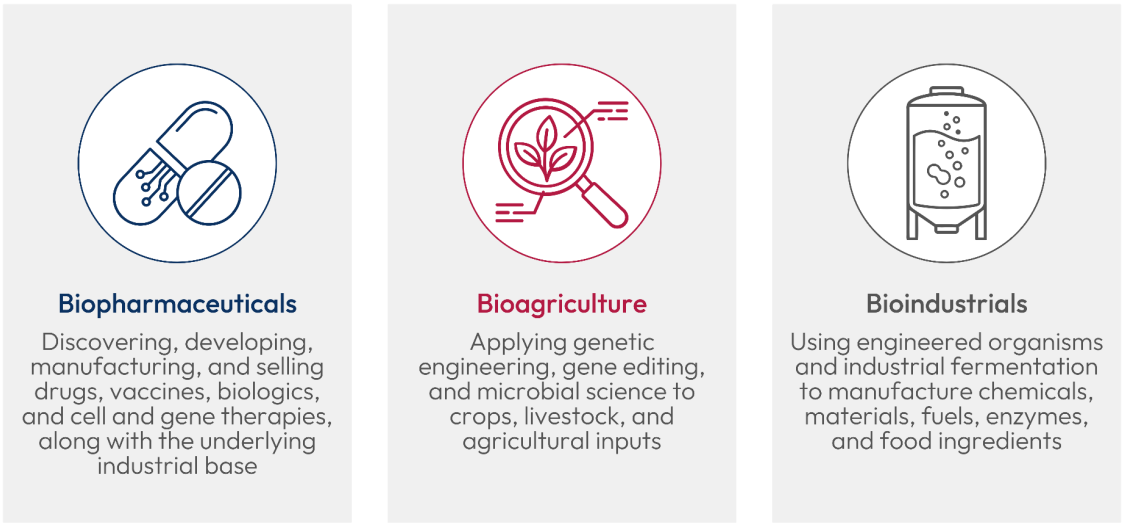
This scorecard is a snapshot in time, where in 2026 the United States leads. By 2030, the trajectory points to China doing so.

Tech Scorecard: Biotechnology



Scope Note

This assessment evaluates and compares leadership in biotechnology between the United States and the People's Republic of China. Biotechnology is the use of biology and living organisms to make useful products and technologies. It spans three critical subfields — biopharmaceuticals, bioagriculture, and bioindustrials — each of which is evaluated here through its own specific inputs and outputs. This assessment looks across all three to determine which nation is competitively ahead in the sector as a whole.



- **Biopharmaceuticals** cover the discovery, development, manufacturing, and sale of drugs, vaccines, biologics, and cell and gene therapies, along with the underlying industrial base.
- **Bioagriculture** covers the application of genetic engineering, gene editing, and microbial science to crops, livestock, and agricultural inputs.
- **Bioindustrials** cover the use of engineered organisms and industrial fermentation to manufacture chemicals, materials, fuels, enzymes, and food ingredients.

Much of the analysis in this report leans on data from the biopharmaceutical industry. That is partly a judgment about where the value is concentrated, as biopharmaceuticals command the largest markets, attract the deepest government investment in both countries, and carry the most immediate national security exposure. It is also a judgment about what can be measured accurately. Since drugs must be registered to be sold, the biopharmaceutical sector generates a relatively complete public record of pipeline entries, trials, and approvals; bioindustrial capacity, by contrast, must often be inferred from trade flows and company disclosures. Biomanufacturing is treated throughout this report as a cross-cutting capability rather than a fourth end-use subfield. It is the production layer that converts biological discoveries into commercial products across biopharmaceuticals, bioagriculture, and bioindustrials, including the facilities, equipment, processes, workforce, and supply chains required to manufacture at scale.

Several adjacent areas fall outside the scope of this report's comparative assessment. Biomaterials and explicitly military biotechnology applications are growing in both countries, but available data does not support a market comparison with a confidence comparable to the three subfields outlined above. This limitation is especially important in the case of China: funding and activity associated with Beijing's military-civil fusion campaign remain opaque, meaning sparse public data should not be interpreted as evidence of limited investment or capability.

Introduction: What it Means to Lose the Biotech Race

Few technologies reach as far into daily life as biotechnology does. It is responsible for producing the medicines Americans take, the seeds that fill American fields, and an increasing share of the chemicals, materials, and fuels moving through America's industrial economy. The value of the global bioeconomy is estimated to reach $30 trillion by 2030.[1] Few other critical technologies are predicted to have this type of impact and touch health, food, energy, materials, and military capability all at once. And few other technologies measure failure in human lives rather than market share. As a result, leadership in biotechnology is a national security concern, rather than purely an economic one.

Leadership in biotechnology cannot be won or lost with a single chokepoint. Leverage is distributed across biotechnology supply chains, manufacturing capacity, data holdings, and regulatory speed, accumulating quietly in each of these places at once. A country that supplies the precursors to another's medicine supply has a lever it can pull for geopolitical gain. A country that produces the first viable countermeasure in a pandemic controls the terms on which others receive it. China has weaponized its control of supply chains before, and it already holds key inputs for hundreds of essential American drugs. The costs of that exposure are shortages that can force geopolitical concessions and leave American lives dependent on the actions of an adversary.

Right now, the United States leads in biotechnology, but narrowly, and more by inheritance than design. Its position is a return on research investments made decades ago, sustained by a capital market that rewards the strongest performers. China's position is the product of two decades of national strategy that is now producing cascading results. The Congressionally chartered National Security Commission on Emerging Biotechnology (NSCEB) assesses that without decisive action by the U.S. government, China's rapid growth could allow it to overtake the United States within the next three years.[2]

China has moved from distant follower to near-peer in under two decades, in large part due to state efforts to force rapid catch-up among domestic firms. For twenty years, the conventional wisdom believed that China could manufacture cheaply, run trials quickly, and improve on Western discoveries, but could not originate them. Now,

[1] The Global Bioeconomy, Nature Finance (2024).

[2] Charting the Future of Biotechnology, National Security Commission on Emerging Biotechnology (2025).

Chinese firms originate a growing share of the molecules that Western pharmaceutical companies license, develop, and sell, which means the discovery step increasingly happens in China even when the product reaches an American patient under an American label. Beijing is not trying to copy the United States; it seeks to out-invent it.

AI will accelerate that effort and change what national advantage in biology consists of. As it replaces empirical discovery with prediction, the binding constraint shifts from scientific insight to the volume and quality of biological data available for training. Beijing anticipated this and has legislated to shield its genomic data from external access.

Data compounds because biotechnology has no single finish line to reach first. The first team to validate a drug target is frequently not the one that captures the market; the molecule that succeeds is often a later entrant that binds more selectively, doses more conveniently, or manufactures more cheaply. The same holds in agriculture, where the trait that reaches farmers at scale is rarely the trait discovered first. A lead in discovery converts into durable advantage only when a country can move a finding through development, approval, and manufacture faster than a competitor can improve on it—the stretch where the American system is weakest and China's is strongest.

The United States retains enduring advantages, sufficient to sustain its lead today but not indefinitely. American basic research remains the deepest in the world and continues to generate the discoveries that everything downstream is built from. American capital markets fund the high-risk bets that biotechnology demands and that state-directed investment funds poorly. The best scientists in the world still, for now, come to American institutions. But each of these is contingent rather than permanent.

China's advantages run the other way. State-directed capital is patient in ways venture funds are not, and prioritizes investments central to Beijing's geopolitical ambitions. A permissive regulatory posture toward somatic and agricultural gene editing moves work from bench to trial to field faster than the American system permits. A combination of national security and data localization laws restrict the outbound flow of human genetic material, giving the government access to biological data on terms no American company faces.

At the end of the day, leadership in biotechnology is not exclusively about which country's firms capture the market. It is about which country sets the terms on which

biology is discovered, made, priced, and sold—and which country is positioned to withhold those things from the other.

Background: Two Models of Biotechnology Innovation

The United States and China have formidable biotechnology ecosystems, but they were built according to different logics and succeed at different things.

American biotech is organized around discovery and commercialization.

U.S. biotechnology rests on a reinforcing sequence: federal grants fund university laboratories, university discoveries are licensed to startups under the Bayh–Dole framework–which allows universities, non-profits, and small business to own and commercialize inventions made using federal research money–and venture capital finances the long and mostly unsuccessful process of turning those discoveries into products.[3] Research capacity is distributed across the university system, while industrial and synthetic biology capacity often sits in national laboratories.

This structure originates novel science and converts it into approved, marketed products more effectively than any other national ecosystem. American firms built the modern biopharmaceutical industry and still capture the largest share of its revenue.[4] However, the physical capacity to make things has been substantially offshored, leaving the United States dependent on foreign suppliers.

The Chinese model is organized around throughput and national strategy.

China's biotechnology capacity is concentrated by design in several provincial locations: Shanghai, Suzhou, Beijing, and Shenzhen.[5] High-quality research is produced by top Chinese universities and institutes, and startups receive local and national government funding to turn academic discoveries into commercial realities. Much of the Chinese model echoes that of American discovery on purpose, much like how China's new tier of state laboratories mirrors the U.S. national-lab structure.[6]

What distinguishes the Chinese system is the industrial layer that follows the science. A dense domestic network of contract research and manufacturing organizations can move a candidate from concept to clinic at a speed and cost that is difficult to match.

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[3] Changing the Rules of Discovery: How the Bayh-Dole Act Transformed Tech Transfer, University of Minnesota (2026).

[4] Tristan Gaudiaut, U.S. Accounts for Nearly Half of the Global Pharma Market, Statista (2026).

[5] Shimite Obialo, How China Became the Biotech Industry's Back-Office, Forbes (2026).

[6] Zhenzhen Chen et. al, Ascending the Summit: National Laboratories as the Upgrading path for driving national value chains, Development Economics (2025).

Recent regulatory reforms in China have compressed approval timelines while also bringing drug safety and quality standards up to par with international standards. For years, the Chinese system optimized for iterating on existing discoveries and industrializing them quickly, but national policy has called for shifting this strategy towards a more novel, innovative approach.

The two systems finance innovation in different ways.

American biotechnology is financed by private investors who prioritize investments more likely to produce a profit, which biases funding toward assets with defined return profiles. Biotechnology startups aim to go public or eventually become acquired by a large pharmaceutical or agricultural giant. Patent timelines also shape competitive strategy, as the industry is constantly searching for the next blockbuster (billion-dollar) enterprise to capitalize on, regardless of where it comes from.

Chinese biotechnology is financed substantially by the state through guidance funds and provincial vehicles that can sustain investment across cycles. It is also heavily influenced by government priorities, including food security and cancer treatments, which incentivize Chinese startups to align their goals with national ones to secure more funding. While American firms typically carry an asset through to commercialization, Chinese firms increasingly license their intellectual property (IP) to Western pharmaceutical companies, monetizing the science while leaving global marketing, regulatory navigation, and branding to a partner.

But China's remaining constraints in Western markets are twofold. The first is regulatory. The FDA has been reluctant to accept clinical data drawn solely from Chinese patients, a barrier China is actively working to address through multi-regional trials and domestic regulatory reform. The second is market risk. Regulatory unpredictability that comes from operating in Chinese jurisdiction causes multi-national corporations to shy away from long-term operations in China. IP protections are also stronger in the United States, while companies worry about sharing proprietary data in China.

Talent exchange is growing between both the United States and China.

The United States has historically drawn the best scientists in the world into American biotech laboratories and retained a large share of them. China has built its advantage domestically, graduating STEM students at a scale no other country approaches while using state talent programs to recruit senior researchers back from abroad.

This distinction is not a strict dichotomy. American and Chinese researchers often collaborate on research problems, co-author papers, contribute to standard-setting together, and take up adjunct faculty positions at the other's institutions. It has become increasingly common for a Chinese student to study abroad in the United States, work for a few years, and then return to China when they receive a better offer to conduct research or join industry.

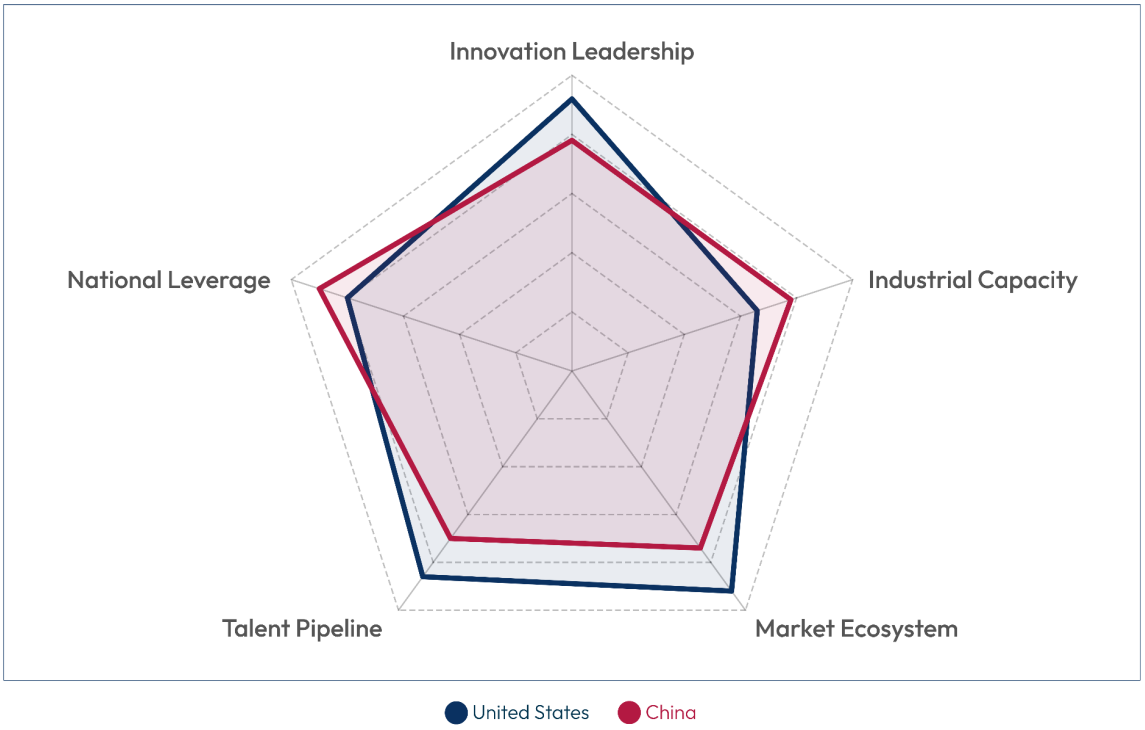
Overall, the systems are entangled, which complicates any policy response.

Neither the American nor Chinese sphere can fully detach from the other. Western firms run early trials and manufacture drug substances in China. Chinese firms raise capital and seek approvals in the West. Scientists, students, and molecules are constantly crossing in both directions. Nearly every instrument that aims at protecting one system (export controls, procurement restrictions, data protections) hurts both, because each biotech sector is partially built out of the other. Therefore, leadership is assessed by not only which nation is ahead but how much of each side's position depends on continued access to its competitor.

SCSP Tech Scorecard: America's biotechnology lead is shrinking.

Overall, the United States has a slight lead over China in biotechnology, with an edge in Innovation Leadership, Market Ecosystem, and Talent Pipeline. Current trends suggest that China is poised to overtake the United States in almost all categories of positional advantage –and therefore, biotechnology as a whole–by 2030.

Tech Scorecard: Biotechnology



What is the SCSP Tech Scorecard?

SCSP developed a comparative analysis framework to provide a comprehensive view of the state of the tech competition between the United States and China across a variety of key technologies.[7] The scorecard compares quantitative and qualitative metrics across the five categories SCSP has determined are needed for technology leadership: Innovation Leadership, Industrial Capacity, Market Ecosystem, Talent Pipeline, and National Leverage.

The specific metrics considered are technology-specific and will vary between reports based on the technology readiness level and resource needs of each technology. Data are compiled from open source analysis, subscriptions, and expert surveys.

For more information, see the appendix.

[7] Tech Scorecard Methodology, Special Competitive Studies Project (2026).

Innovation Leadership: The U.S. leads on output, but China is closing fast on inputs.

Leader: United States	Trending Towards: China

Innovation leadership is the most contested pillar of the biotechnology competition, and the most difficult to assess. Biotechnology inherently has a longer translational lag than most other technology sectors. For instance, a new molecular drug that reaches a regulator's desk today entered preclinical work a decade ago, and the research that generated it was funded years before that. The United States still leads on nearly every measurement of ***realized innovative output***, including first-in-class drugs, genetically modified crops. China, however, leads or is at parity on several leading indicators of ***innovative input***, including certain research metrics, patents, clinical trial starts. That does not mean China leads in every dimension of research, for the United States retains an advantage in foundational, discovery-oriented science and in the institutions that convert that science into first-in-class products.

Therefore, looking at only outputs produces a comfortable but misleading picture of American dominance. The United States maintains an unrefuted lead in Innovation Leadership overall, resting on three advantages that are difficult to replicate quickly: a foundational research base that still generates disproportionate mechanistic novelty, a capital market that finances decades-long risk, and a demonstrated capacity to convert both into approved first-in-class products at seven times the Chinese rate.[8]

Yet, China has already reached parity with or surpassed the United States on nearly every leading indicator—high-quality publication share, early-stage pipeline share, first-in-human molecule starts, and novel trial initiations. Most importantly, the biotechnology pipeline is measured in years, not quarters, and the output distribution advantage that the United States has is not one that is poised to last for long. If China's current input position and historical sector trends hold, the first-in-class figures that anchor the American lead will begin to shift within three to four years, if not sooner.

[8] SCSP analysis of FDA and NMPA data. Derived by isolating novel drug approvals to the first molecule approved globally against a given target or mechanism. See Novel Drug Approvals for 2025, Food and Drug Administration (2025); Ran Jing, et. al, Approvals by the China NMPA in 2025, BioBusiness Briefs (2026).

China now leads in the volume of biological research and, increasingly, in its quality.

The quality and quantity of a nation's scientific research are the earliest observable predictors of future discovery and the pipeline to innovation, and China surpassed the United States in total biotechnology publication volume years ago. In 2023 alone, China published over 87,000 biotechnology articles compared to the United States' roughly 18,000.[9] Publication volume can be inflated, but the quality gap of these publications has also rapidly closed. Chinese-affiliated researchers make up 31% of the top decile of most-cited biotechnology publications, compared to their American counterparts at 21%.[10] This difference in quality stands firm even when isolated to the top 1% of publications, or the top 100 publications.[11]

Institutional quality further demonstrates China's lead in this area. In 2025, half of the world's top ten leading institutions for high-quality bioscience publications were located in China, while only three were in the United States.[12] Chinese research capacity is concentrated in a small number of elite institutions that receive sustained, targeted state investment and increasingly produce work comparable to their American peers.[13] That concentration lets Beijing channel resources toward strategic priorities and accumulate visible, high-citation output quickly. American research capacity instead thrives across a wide base of universities, national laboratories, and corporate research arms, focusing on basic research and discovery. That structure trades concentrated output for broad coverage, but does not necessarily reflect downstream productivity.

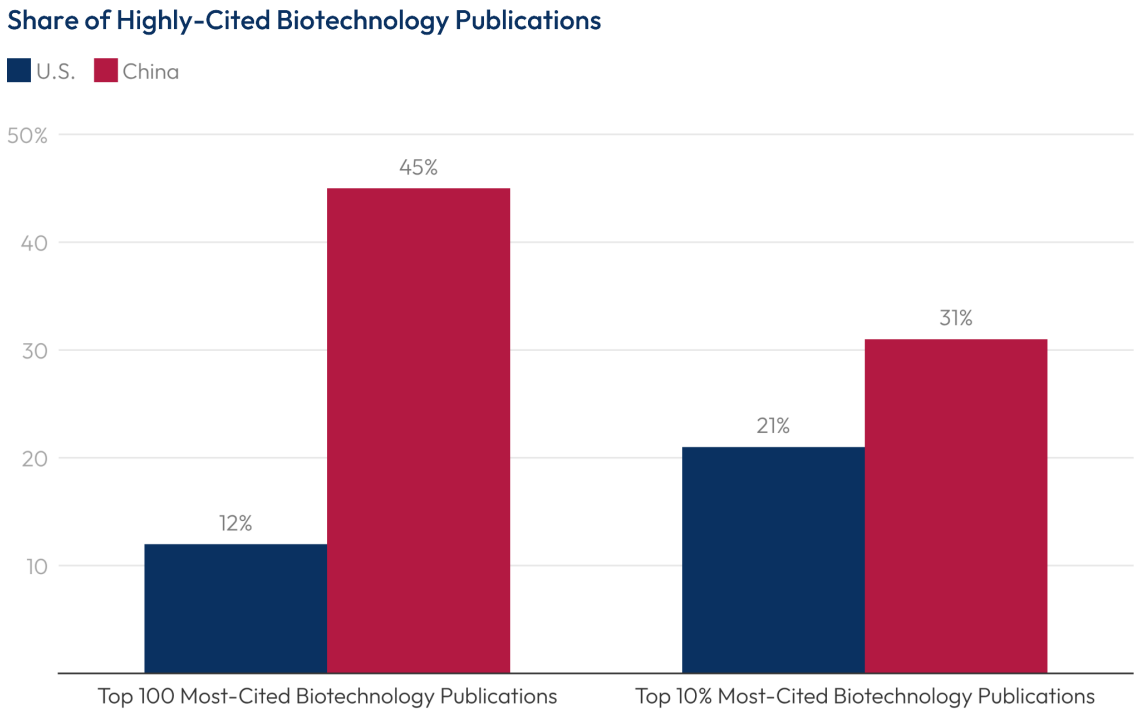
[9] Biotechnology R&D and Publications Output, National Science Board (2025).

[10] Justin Riggi, How China is Outperforming the United States in Critical Technologies, Information Technology and Innovation Foundation (2025).

[11] SCSP analysis of OpenAlex datasets. See OpenAlex, OpenAlex (last accessed 2026).

[12] Quality was defined by limiting publications to those in top international journals, such as Science and Nature. See 2026 Research Leaders: Leading Countries/Territories, Nature Index (last accessed 2026).

[13] Imran Khalid, China Displaces the U.S. as Global Leader in Research, with 9 of top 10 Institutions, Informed Comment (2025).



Sources: SCSP analysis of OpenAlex datasets; Justin Riggi, How China Is Outperforming the United States in Critical Technologies, Information Technology and Innovation Foundation (2025).

The composition of research demonstrates how differently the two countries pursue innovation. Across biotechnology-relevant subjects, China produces the most high-quality research globally in areas including industrial, environmental, and medical biotechnology, and pharmacology—research areas that are typically weighted more toward applied and translational work.[14] The United States retains the lead in biochemistry and cell biology—disciplines concentrated in more foundational and discovery-oriented research.[15] As a result, the United States is still producing more of the science that first-in-class drugs are built on, even as China produces more science overall.

Patent counts favor China, but patent quality continues to favor the United States.

The first expression of an invention is a patent application filing, and here China leads in raw counts. In 2024, China published roughly 76,600 biotechnology and pharmaceutical patent applications against approximately 54,400 in the United States, a ratio of about

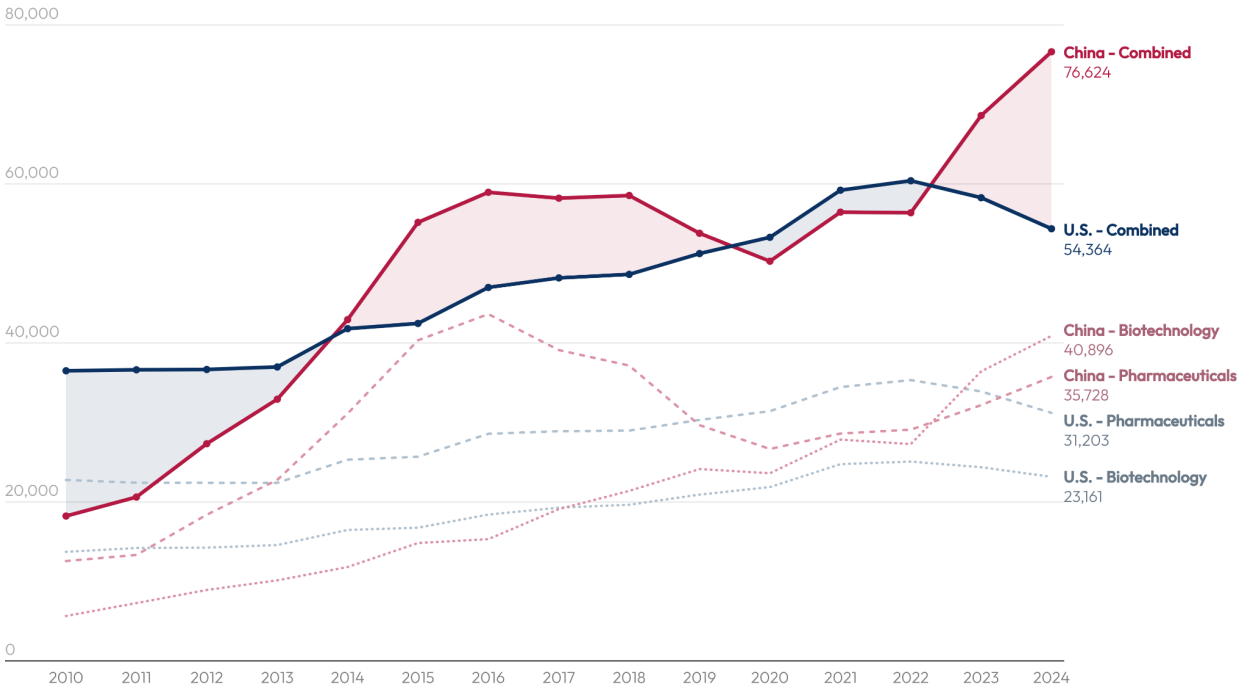
[14] Topic Explorer, Nature Index (last accessed 2026).

[15] Topic Explorer, Nature Index (last accessed 2026).

1.4 to one.[16] While roughly 90% of China's patent applications come from Chinese inventors, more than half of U.S. patent applications originate from foreign entities. This suggests that the United States attracts more foreign inventors hoping to commercialize in U.S. markets, while China's innovation ecosystem remains more self-contained.[17] Filings have risen in both countries over the past fifteen years, and the lead has changed hands twice: China first pulled ahead in 2014, the United States surged ahead between 2020 and 2022, and China is in the lead today.[18] Chinese patents rose by more than a third in two years while American output fell for three consecutive years.[19]

The Patent Lead Has Changed Twice – and China's Latest Surge is Biotechnology-Led

Number of patent publications by applicant's origin, 2010-2024.



Source: Total Patent Publications by Technology, 2010-2024, World Intellectual Property Organization IP Statistics Data Center (last accessed 2026).

[16] Total Patent Publications by Technology, 2022-2024, World Intellectual Property Organization IP Statistics Data Center (last accessed for biotechnology and pharmaceuticals in 2026).

[17] Are Patents Indicative of Chinese Innovation?, ChinaPower (2016).
Bao Tran, US Patent Statistics: Key Trends and Insights, Patent PC (2024)

[18] Total Patent Publications by Technology, 2022-2024, World Intellectual Property Organization IP Statistics Data Center (last accessed for biotechnology and pharmaceuticals in 2026).

[19] Total Patent Publications by Technology, 2022-2024, World Intellectual Property Organization IP Statistics Data Center (last accessed for biotechnology and pharmaceuticals in 2026).

However, the volume of applications alone is a poor proxy for value, and the bar for filing a domestic patent in China compared to the United States varies widely. Patent quality still favors the United States. International filings under the Patent Cooperation Treaty (PCT) cost more and reserve an applicant's right to enter the national phase in over 150 member countries within 30 months. That optionality across markets makes PCT counts a better proxy for commercial intent than raw application totals, even though the PCT itself is not an examination gate.[20] Measured in PCT filings, the United States leads China by roughly 1.6 to one.[21] Still, neither measure captures achievement directly, because filing counts themselves are an institutional performance metric in both countries. Academic and government-funded research systems in the United States and China alike reward the act of filing, regardless of whether anything is ever commercialized, which inflates the numbers on both sides.[22] What patents do reliably indicate is the volume of R&D output that it is worth protecting.

American firms spend far more on research and development.

Private research and development (R&D) spending demonstrates companies' willingness to invest a share of their revenue in future inventions and the intent to convert the research they produce into commercial products. Currently, U.S. companies account for approximately 54% of global private biotechnology R&D investment; Chinese companies account for roughly 4%.[23] However, this asymmetry in private research investment is a function of differing capital ecosystems in each country, rather than ambition. American capital markets will fund a decade of negative cash flow against a distant and uncertain payoff, and firms are willing to accept that risk profile because the payoff of a blockbuster drug justifies it.[24] Chinese firms operate in a market that has not historically rewarded that pattern of spending, and as a result employ a more cautious investment strategy.[25]

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[20] Patent Cooperation Treaty: A Guide for Those Seeking International Patent Protection, Sierra IP Law (2025).

[21] PCT Publications by Technology, 2010-2026, World Intellectual Property Organization IP Statistics Data Center (last accessed for biotechnology and pharmaceuticals in 2026).

[22] Wenbin Rao, et al., Why the Chinese Government is Reducing Domestic Patent Filing Subsidies and How Rights Holders can Adapt, World Trademark Review (2025); Eli Dourado. The Number of Patents Has Exploded Since 1982, and One Court Is to Blame, Mercatus Center (2015).

[23] Trelysa Long, Tracking R&D Leadership: US Advantage Narrowing as China Gains Ground, Information Technology and Innovation Foundation (2026).

[24] Ben Glickman, Funding for Risky Biotechs Is Returning, Wall Street Journal (2026).

[25] Priyanka Boghani, VC Funding for China Plunges Due to Investor Caution, City Wire (2023).

This gap in research spending is certainly real, but the dollar share understates how much research China is actually conducting. Rather than relying heavily on private R&D investment, Chinese firms operate against a backdrop of state research funding and subsidized infrastructure that outsizes the amount of R&D spending a U.S. firm would have to invest on its own.[26] Unit costs are also simply lower in China. The Information Technology and Innovation Foundation estimates that for every $100,000 in R&D expenditure, a Chinese firm can field roughly 2.3 researchers for each one a U.S. firm can field.[27] Therefore, when looking at total dollar expenditure, research spending systematically understates the volume of research activity China is supporting.

In biopharmaceutical innovation, China's share of the drug pipeline is concentrated at the front end, but the United States leads in output.

Drug discovery and pharmaceutical innovation constitute the largest segment of the biotechnology industry, making innovation in this domain a useful proxy for assessing Innovation Leadership across the biotechnology sector as a whole. The drug development pipeline runs from discovery through preclinical testing, three phases of human trials, and finally regulatory review. Each stage costs more than the last and eliminates most of what enters it.[28] Understanding the shift in early- to late-stage pharma innovation requires analyzing each stage of the pipeline.

Historically, the United States has been seen as the "zero-to-one" power, able to ground its drug discoveries in basic scientific research, while China accelerates the "one-to-one hundred," scaling up the inventions through more rapid clinical trials and advanced manufacturing.[29] For years, China produced functional "me-too" or "me-better" drugs, iterating on American molecules to improve efficacy, reduce side effects, or deliver

[26] Trelysa Long, Tracking R&D Leadership: US Advantage Narrowing as China Gains Ground, Information Technology and Innovation Foundation (2026).

[27] Robert Atkinson, China Is Rapidly Becoming a Leading Innovator in Advanced Industries, Information Technology and Innovation Foundation (2024).

[28] Drug Development Pipeline: A Complete Guide to All Phases, IntuitionLabs (2025).

[29] Elizabeth Economy & Chenjian Li, Bottom-Up vs. Top-Down: Inside the US and Chinese Innovation Systems with Chenjian Li, China Considered Podcast, Hoover Institution (2025).

them in more convenient forms.[30] Yet, China is increasingly introducing first-in-class drugs and biologics to clinical trials that are based on domestic discoveries.[31]

However, the biopharmaceuticals race is not always won by the first competitor to break through, but rather who wins on quality. The "me-better" drugs, which may be an improved version of the original drug, can be the product that eventually finds the most commercial success and functions as the true winner.[32] For instance, the immunotherapy drug Keytruda, originating in the Netherlands, was not the first immune checkpoint inhibitor for cancer treatment. Yervoy, developed by the U.S.-based Bristol Myers Squibb, was approved three years earlier in 2011 and hailed as a breakthrough, but Keytruda targeted a more versatile and effective pathway that, combined with Merck & Co.'s superior clinical trial strategy, eventually outcompeted the original. Keytruda now generates $30 billion a year; Yervoy produces a tenth of that.[33] So while China continues to catch up in the novel innovation pipeline, creating substantially better versions of Western drugs may still be a winning strategy for commercial success.

At the front of the drug pipeline, the two countries are close to parity. China's global share of the number of early-stage programs (including discovery, preclinical development, and early clinical testing) reached 32.3% in 2024, against 37.4% for the United States.[34] Recent studies also indicate that the sheer number of drug introductions in China has shifted from mainly generic or 'me-too' drugs to novel molecular entities.[35] Among first-in-human molecules entering clinical trials, China reached a statistical tie with the United States in 2023 and has held it since.[36] Excluding generics and traditional Chinese medicines, China is narrowly ahead on novel clinical trial starts, roughly 2,400

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[30] Claudia Lin, Partnership with Chinese Biotech Companies: Understand the Pros and Cons by Understanding the Journey, BioXconomy (2026).

[31] William Soliman, Biotech Innovation in China: From Fast Follower to Emerging Leader, Accreditation Council for Medical Affairs (2026).

[32] China's Super Me-Too Drug Development: A New Pharma Frontier, Pharma Advancement (2026).

[33] Alex Yule, Checkpoint Therapy's Second Act: Hope, Hype, or Hard Truths?, Alacrita (last accessed 2026); Bristol-Myers Squibb Company's Revenue by Segment,Bullfincher (2025); Merck Announces Fourth-Quarter and Full-Year 2024 Financial Results, Merck (2025).

[34] Richard Pazdur & Steven Usdin, The Geography of Pharmaceutical Innovation: The US and China in a New World Order, JAMA (2026).

[35] Cindy Dubin & Jay Yu, China is Disrupting the Global Biopharma Drug Discovery Landscape, PharmaCircle Weekly Intelligence (2025).

[36] Richard Pazdur & Steven Usdin, The Geography of Pharmaceutical Innovation: The US and China in a New World Order, JAMA (2026)

against approximately 2,200.[37] These numbers suggest that the gap is closing fast between the U.S. and China in early-stage drug development.

Who Leads at Each Stage of the Drug Development Pipeline

The United States and China are compared across the pathway from laboratory discovery to approved medicine.

Sources: Justin Riggi, How China is Outperforming the United States in Critical Technologies, Information Technology and Innovation Foundation (2025); Richard Pazdur and Steven Usdin, The Geography of Pharmaceutical Innovation: The US and China in a New World Order, JAMA (2026); Panel Jia Barwick et. al, From Free Rider to Innovator: The Rise of China's Drug Development, SSRN (2026); GlobalData; China's Evolution in Global Drug Development and Clinical Trials: Strategic Intelligence, (2025).

Across the pipeline as a whole, the picture reverses. The United States holds roughly 40% of global programs in drug development against China's 20%.[38] While China enters the drug-development pipeline at near-American volume, the United States leads in the later stages of drug development, bringing a higher proportion of its innovative drugs to approval.[39]

To earn approval, a drug product must navigate ten to twelve years of development, billions of dollars in investment, and multiple human trials.[40] The result is then approved by each country's respective authority. In 2025, the Food and Drug Administration (FDA) approved 34 innovative drugs with a domestic sponsor, and China's National Medical Products Administration (NMPA) approved 39.[41] While these numbers are close

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[37] Panel Jia Barwick, et al., From Free Rider to Innovator: The Rise of China's Drug Development, SSRN (2026).

[38] China's Evolution in Global Drug Development and Clinical Trials: Strategic Intelligence, GlobalData (2025).

[39] U.S. Clinical Trials Market Size, Share and Trends Analysis (Report By Phase: By Indication And Segment) - Industry Analysis, Share, Growth, Regional Outlook and Forecasts, 2026-2035, Nova One Advisor (2025).

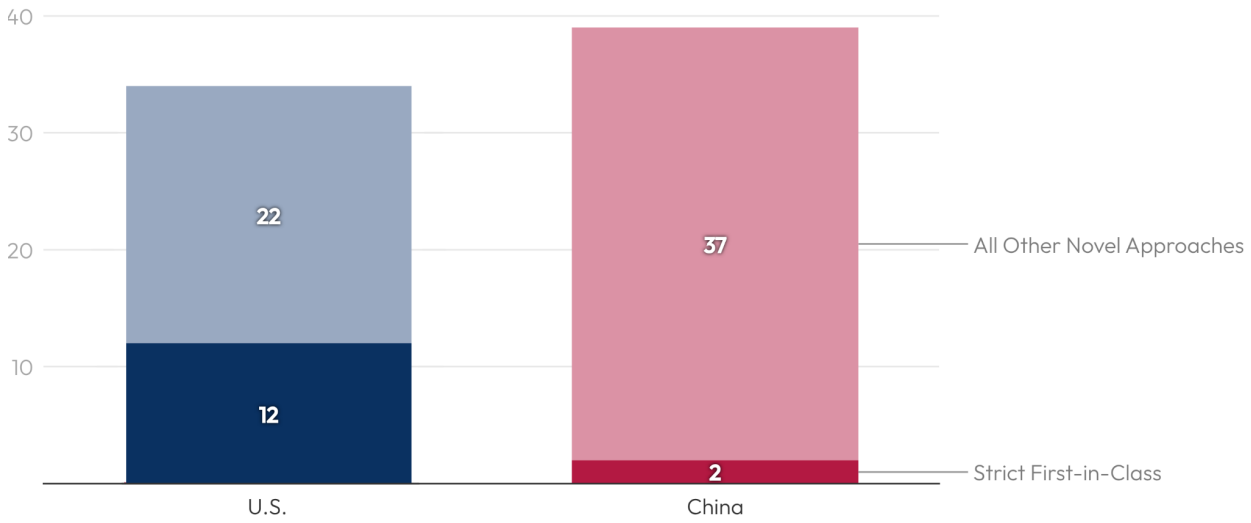
[40] Caroline Mitchell, The Drug Discovery Process, Taconic Biosciences (2024).

[41] SCSP analysis of FDA and NMPA data. Derived by isolating approvals to domestic sponsors, non-biologic and non-traditional Chinese medicine drugs, and non-generic (novel) drugs. See Novel Drug Approvals for 2025, Food and Drug Administration (2025); Ran Jing, et. al, Approvals by the China NMPA in 2025, BioBusiness Briefs (2026).

together, they do not suggest parity, as the two agencies have different standards for approval and classification.

Therefore, the comparison only becomes meaningful when strictly looking at "first-in-class:" the first molecule globally approved against a given target or mechanism, applied identically to both cohorts.[42] On that basis, roughly 35% of the American cohort qualifies against approximately 5% of the Chinese cohort.[43] This metric most directly measures Innovation Leadership at the output stage—showing the number of drugs that actually enter the market—and it is where the American lead has persisted for years.

Domestic Novel Drug Approvals and First-in-Class Share, 2025



Source: SCSP analysis of FDA and NMPA data. See Novel Drug Approvals for 2025, Food and Drug Administration (2025); Ran Jing, et. al, Approvals by the China NMPA in 2025, BioBusiness Briefs (2026).

China's approvals still skew toward generics and me-better molecules that iterate on drugs originating in the United States or Europe.[44] However, China-originated molecules are now clearing the FDA on their own merits, showing that as China increases its quantity and quality of innovation into the beginning of the drug pipeline, there will be

[42] Daichao Zhai, et al., Global first-in-class drugs approved in 2023–2024: Breakthroughs and insights, The Innovation (2025).

[43] SCSP analysis of FDA and NMPA data. Derived by isolating novel drug approvals to the first molecule approved globally against a given target or mechanism. *See* Novel Drug Approvals for 2025, Food and Drug Administration (2025); Ran Jing, et al., Approvals by the China NMPA in 2025, BioBusiness Briefs (2026).

[44] Joanne S. Eglovitch, Study: China Outpaces the U.S. in Cancer Approvals, Lags Behind on First Approvals, Regulatory Affairs Professionals Society (2026).

more results at the other end of the pipeline soon.[45] In anywhere between five to ten years, critical discoveries could emerge from China's biopharma landscape.

In bioagricultural innovation, America holds a shrinking lead as China powers ahead.

Beyond human health, agricultural biotechnology represents another foundational pillar of the biotechnology sector. Agricultural biotechnology demonstrates a similar pattern to biopharmaceuticals, in that the United States comes out ahead on innovation output but lags in early indicators such as R&D spending or research publications. Innovation in agricultural biotechnology can mainly be measured off of approvals for gene-edited (GE) plants and animals. Though it can take years for an invention or modification to commercialize in the agricultural pipeline, the regulatory environment is not as lengthy as the drug development pipeline.

The United States has long held an advantage in bioagricultural innovation. Most recently, the United States registered 226 novel genetically modified crops worldwide against China's 90.[46] The FDA has approved five animal species for genetic modification, enabling modification of pigs, cattle, and others for traits such as heat and disease resistance, while China has approved none.[47] In agricultural biopesticides, the United States again leads on novel approvals.[48]

But China is investing in both direct and underhand tactics to push ahead. From 2019 to 2021, China's average public sector expenditures on agricultural R&D were larger than the United States, India, and Brazil combined.[49] A number of Chinese-born scientists in the United States have been caught and prosecuted for agricultural IP theft, stealing high-value seeds such as corn, rice, and soybeans in attempts to smuggle them back to researchers in China.[50] As China's domestic research base matures, acquiring

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[45] Zhihao Xu, et al., International Approval of Chinese Pharmaceuticals: A USA-Anchored Analysis with Comparative Insights from Europe and Other Markets, eClinicalMedicine (2026).

[46] GM Approval Database, International Service for the Acquisition of Agri-biotech Applications, (2026).

[47] Intentional Genomic Alterations (IGAs) in Animals, U.S. Food and Drug Administration (2025).

[48] Biopesticide Active Ingredients, U.S. Environmental Protection Agency (2026); China Accelerates Pesticide Innovation with Wave of "Created in China" Approvals, AgroLatam Global (2026).

[49] Alejandro Plastina & Terry Townsend, World Spending on Agricultural Research and Development, Iowa State University (2023).

[50] Chris Bennett, While America Slept, China Stole the Farm, AgWeb (2021).

proprietary U.S. seed germplasm and algorithms for precision agriculture offers a shortcut to its developments.

That investment has proven successful. China now has the largest agricultural system in the world, by production value.[51] American federal investments in bioagriculture, in contrast, have declined more than 30% since the early 2000s.[52] In 2022, China commercialized its first generation of a biotech seed that improved corn yield by 10%.[53]

The competitive landscape between the United States and China differs in agricultural technology from pharmaceuticals, as agriculture is heavily state-subsidized in both countries and commands a smaller share of globally contestable commercial value. It is also less dependent on breakthrough products but rather iterative improvements over existing crops. Though the American bioagricultural landscape remains a strong and competitive player, massive state incentives from China have propelled the country forward.

In other emerging biotechnology sectors, the United States maintains a minor to moderate lead, but China is catching up rapidly.

The cutting-edge subfields in biotechnology signal where innovation is heading. The five areas below are relatively novel technology areas, where the leading edge could shift in either country's direction in the near future. Additionally, many of these subdomains act as multipliers on biotechnology innovation as a whole—for instance, biological design tools can exponentially improve the ability to conduct biological research, and synthetic biology can help create novel ingredients to improve lab self-sufficiency.

[51] Urban C. Lehner, U.S. Public Investments in Ag Research Declined as China's Boomed, Asia Times (2026).
[52] Urban C. Lehner, U.S. Public Investments in Ag Research Declined as China's Boomed, Asia Times (2026).
[53] Evelyn Cheng, CNBC's The China Connection newsletter: Inside China's Push to Feed 1.4 Billion People without U.S. Crops, CNBC (2026).

Assessment of Leadership in Biotechnology Subfields

Subfield	Leader	Trending Towards
Synthetic Biology	China	China
Cancer Therapeutics	Contested	China
Cell and Gene Therapeutics	United States	Contested
AI-Enabled Biological Design Tools	United States	Contested
RNA Therapeutics	United States	United States

- **Synthetic Biology.** This technology engineers organisms to manufacture chemicals, materials, fuels, and ingredients, contributing broadly to the industrial base. Though the United States previously led in pioneering synthetic biology research, China has overtaken the U.S. in this emerging field.[54] Chinese researchers now publish over 60% of high-impact research papers in synthetic biology.[55] China is stronger in patent volume, holding 49.1% of identified synthetic-biology patents compared to only 12.8% for the United States, and its established fermentation base supplies facilities that can more easily convert designs into commodity outputs.[56] The United States has strong laboratory and pilot capability but lacks scale-up, meaning U.S.-designed organisms may ultimately depend on foreign manufacturing.
- **Cancer Therapeutics.** Cancer therapeutics make up over 40% of priority review applications in China today.[57] The United States currently has the strongest record in globally recognized oncology approvals, with 17 novel FDA approvals in 2024, and it continues to set standards of care globally.[58] Yet Chinese-headquartered companies account for 35% of global oncology trials starting in 2023, ahead of both U.S.- and European-headquartered firms.[59] Shorter

[54] Testimony of Drew Endy before the U.S.-China Economic and Security Review Commission, Strange Competition: A Statement of Evidence Written in 2025, (2025).
[55] Critical Technology Tracker, Australian Strategic Policy Institute (2025)
[56] Literature Review of the Trends and Issues in Synthetic Biology (2012–2023), UN Environment Programme (2024).
[57] China NMPA Drug Approval Pathways: Regulatory Guide, IntuitionLabs (2026).
[58] Oncology Regulatory Review, U.S. Food and Drug Administration (2024).
[59] Benjamin Plackett, Clinical Trials by the Numbers, Nature Index (2025).

timelines around drug priority review also enable China to accelerate and approve cancer therapy applications more quickly than U.S. regulators.

- **Cell and Gene Therapies.** These therapies, also known as CGTs, are one-time treatments that modify a patient's cells or genes to correct disease at the source. They can be incredibly dangerous and highly expensive, yet also the only hope for certain fatal diseases. The FDA has approved close to 50 cell and gene therapies over the past decade and is now loosening chemistry and manufacturing requirements to accommodate small-batch and individualized production.[60] China registered 115 CGT trials in 2024, and its dual-track system of hospital-led investigator-initiated studies alongside traditional clinical trials increases its volume of research and development.[61] China's patient pools and hospital recruitment are stronger, but it also produces uneven trial quality, and its internationally recognized approvals remain scarce.

- **AI-Enabled Biodesign.** Biological design tools (BDTs) use machine learning to model, predict, and engineer proteins, antibodies, and small molecules computationally, and faster than researchers could previously. The most prominent generative protein-design work is U.S.-based, such as the new Evo 2 model.[62] U.S. companies hold access to hyperscale compute for biological data that no Chinese equivalent matches.[63] China maintains a credible position with commercial BDTs such as HelixFold and Uni-Mol, backed by an advantage in AI PCT patents in 2020 to 2023 over the United States.[64] AI-enabled biodesign sits upstream of biotechnology innovation broadly, and future influence will be shaped by genomic data collection, compute capabilities, and frontier model design.

- **RNA therapeutics.** RNA platforms instruct cells to make or silence specific proteins, which is uniquely relevant to producing necessary medicines during a pandemic response or surge capacity concern. Through July 2025 the United States accounted for 118 registered mRNA vaccine trials, 35.9% of projects

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[60] FDA Increases Flexibility on Requirements for Cell and Gene Therapies to Advance Innovation, U.S. Food and Drug Administration (2026).

[61] Jessie Xie, et al., CTGT/ATMP Clinical Trials Surge in China, as First Stem Cell Therapy Product is Conditionally Authorized - Trends in Cell, Tissue, and Gene Therapies, JD Supra (2025).

[62] Evo2: One Bio-AI Model to Rule Them All, SynBioBeta (2025).

[63] Kyle Chan, Competing AI strategies for the U.S. and China, Brookings (2026).

[64] Hanming Fang, et al., AI Patents in the United States and China: Measurement, Organization, and Knowledge Flows, National Bureau of Economic Research (2026).

among the fifteen leading countries, against 74 Chinese trials at 22.5%.[65] The United States is also the largest patent jurisdiction for RNA therapeutics applications and grants.[66] China is the clear second and is concentrating their efforts on cancer mRNA vaccine candidates.

[65] Sijia Liu, et al., Global Landscape of mRNA Vaccine Clinical Trials: A Systematic Analysis of ClinicalTrials.gov data, Frontiers in Public Health (2026).

[66] Jake Rightmyer, RNA Therapeutics: A Glance at the Patent Filing Landscape, Gill Jennings & Every LLP (2026).

Industrial Capacity: U.S. capability exists, but China controls key inputs.

Leader: China	Trending Towards: China

China maintains a slight lead in Industrial Capacity for biotechnology, measured by advantages at each point in the supply chain and whether those points can be leveraged for national purposes. Key inputs and outputs of Industrial Capacity include materials that enter the system, processing and manufacturing, and final production and distribution.

The United States retains some strengths in this category, with a long-standing lead in laboratory space, research-grade genomic data, and large-scale deployment of bioengineered crops. It also retains a larger share of biological and pharmaceutical manufacturing, but this is changing rapidly as China builds up its industrial base and maintains control over the supply chain, with substitution nearly impossible. Those supply chain chokepoints sit upstream, in the basic chemistry that begins pharmaceutical manufacturing and the commodity inputs that are needed throughout.[67]

As a result, both governments now treat biotechnology inputs as national security assets and increasingly see them as leverage points. From genomic data to clinical trial capacity, the materials and processes that shape the industrial base will determine the future of biotechnology in both countries, and both countries recognize it.

R&D capacity is shifting toward China, as laboratory construction and number of clinical trials increases.

Industrial capacity in biotechnology begins before anything is manufactured. While Innovation Leadership measures what a country discovers, discovery itself runs on physical infrastructure. Within R&D infrastructure, laboratory construction, and clinical trials capacity, the United States has built up its capabilities while China is quickly catching up.

American biotech hubs—Boston, San Diego, and San Francisco—hold the top three positions globally among cities with the most biotechnology R&D, while Shanghai and Beijing follow at fourth and seventh.[68] However, economic headwinds and a contraction in life sciences investment have pushed laboratory vacancy in Boston to roughly 25%, a

[67] Thomas J. Bollyky, et al., The Pharma Choke Point, Council on Foreign Relations (2026).

[68] Chapter 4: Laboratory/R&D Trends, CBRE (2022).

record high for that market, while Chinese facilities run at near-full utilization.[69] China also has more laboratory space under construction than any other country.[70] Measured as space in productive use rather than space in existence, the American lead is considerably narrower than the city rankings suggest, and the construction pipeline points the other way.

China also now runs more clinical trials annually than the United States. In 2024 alone, China ran over 7,000 clinical trials, compared to approximately 6,000 in the United States.[71] A large domestic patient pool and ease of patient enrollment help make China the more efficient venue for conducting trials.[72] Consequently, clinical trials in China can be 30-50% cheaper than that of the United States, and some clinical trials can be done in less than half the time, saving millions of dollars for companies.[73] Therefore, biotechnology companies of both countries increasingly begin early-phase work in China and shift later-phase trials to the United States to avoid facing regulatory delays in approval.[74] Even accounting for that constraint, China holds the stronger industrial base for conducting both animal and human trials, and trial capacity is what converts a molecule into an approvable asset.

The United States leads in genomic data quality, yet increasingly, China leads in quantity.

Genomic data is the collection of personal genetic information that makes up an organism's complete genome or DNA sequence. Scientists today use genomic databases to associate variants with disease, identify drug targets, and design trials.[75] This data holds incredible potential for training biological design tools (BDTs) – AI models that can predict protein structure, generate candidate molecules, and propose

[69] Mid-Year 2026 Boston Life Science Report, Hunneman (2026).

[70] Rapid Expansion of International Life Sciences Markets with Strong Growth in China, CBRE (2025).

[71] Yanzhong Huang, A Biopharmaceutical Superpower: China's Rise, Its Limits, and What Comes Next, CIRSD (2026).

[72] Bruce Liu, et al., China's Trial Advantage: Tracking Nation's Growth in Pharma Innovation and Global Investment, Pharmaceutical Executive (2025).

[73] Gareth Macdonald, China Leads Drug R&D with Faster Trials, BioXconomy (2026).

[74] As Early-Phase Trials Move Overseas, Experts Urge the U.S. to Act, Duke Clinical Research Institute (2026).

[75] B Chen & AJ Butte, Leveraging Big Data to Transform Target Selection and Drug Discovery, Clinical Pharmacology and Therapeutics (2016).

genetic edits.[76] As those tools mature, the country holding the deepest genomic information capacity holds the input advantage for discovery.

The United States leads on research-grade depth in genomic data. The All of Us program in the United States, an NIH initiative aiming to gather health data from over a million people, has enrolled more than 747,000 participants, whereas China's largest comparable cohort, the Kadoorie Biobank, holds only around 510,000 participants and is a joint venture between the University of Oxford and the Chinese Academy of Medical Sciences rather than purely a domestic asset.[77] But U.S. leadership is being eroded by a combination of Chinese initiative and self-defeating policies. All of Us has seen its budget cut by 73% since 2023, and future funding is uncertain.[78] China, propelled by lower costs and fewer restrictions, is simultaneously accelerating its own data collection. Domestic manufacturers have pushed the price of a sequenced genome down to below $100.[79] State-backed programs enable population-scale data collection, combined with global data information flows that are secured by China for potential national security or biotechnology use.[80]

Genomic data will be increasingly important to R&D in a future of AI-enabled biological discovery. Roughly 2,900 drugs have already been developed or repurposed using AI, and about 92% remain in discovery or preclinical stages.[81] Increasing collection of this training data is a bet made now that will determine which nation is able to isolate and target specific biological mechanisms three to five years from now.

Pharmaceutical inputs are controlled by China, with upstream chokepoints being the largest U.S. concern.

If R&D capacity determines what a country can attempt, input access determines what it can actually produce. Hundreds of American medicines begin with at least one

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[76] Cindy S. Groff-Vindman, et al., The Convergence of AI and Synthetic Biology: the Looming Deluge, Nature (2025).

[77] NIH's All of Us Research Program is Now the Largest Integrated Genomics and Health Database in the World, National Institutes of Health (2026); China Kadoorie Biobank: Lessons from a Visionary Cohort Study, Precision Health Research Singapore (2025).

[78] Funding and Research Partnerships, National Institutes of Health (2026).

[79] Antonio Regalado, China's BGI Says it Can Sequence a Genome for Just $100, MIT Technology Review (2020).

[80] Jessie Yeung, China's Sitting on a Goldmine of Genetic Data – and it Doesn't Want to Share, CNN World (2023).

[81] Abigail Beaney, OCT West Coast 2025: China Surpasses U.S. for Annual Number of Clinical Trials, Clinical Trials Arena (2025).

chemical most likely manufactured in China.[82] This is one of the greatest national security threats from biotechnology: a key dependence on a strategic rival that could seriously compromise military and civilian health if weaponized. Whether intentional or accidental, slowed shipments of key Chinese pharmaceutical materials would pose serious harm in weeks, creating shortages in essential medicines and panic in the healthcare system.

U.S. dependencies in biopharmaceuticals are within the inputs earliest in the supply chain, and the hardest to shift away from. The United States produces under 1% of its own key starting materials (KSMs), the compounds that are the first input for pharmaceutical manufacturing.[83] China produces an estimated 41% of the sole-sourced KSMs used in American active pharmaceutical ingredients (APIs).[84] In other words, one out of every four KSMs used in the U.S. APIs comes exclusively from China. Even India, the United States' strongest allied supplier of KSMs, could not replace everything China provides.[85]

One tier downstream, American dependency on China improves slightly regarding APIs. Direct Chinese supply of APIs to the United States sits near 17-20%, reflecting a deliberate decade-long shift towards sourcing APIs from India, which now holds a substantial share of American supply.[86] Unfortunately, between 70 to 90% of Indian API manufacturing still uses Chinese key starting materials, so U.S. diversification at the API tier has not eliminated Chinese dependency.[87] In one instance, a shortage of a single KSM in China propagated through Indian API production to American pharmacies and forced physicians to ration the supply of a cancer drug.[88]

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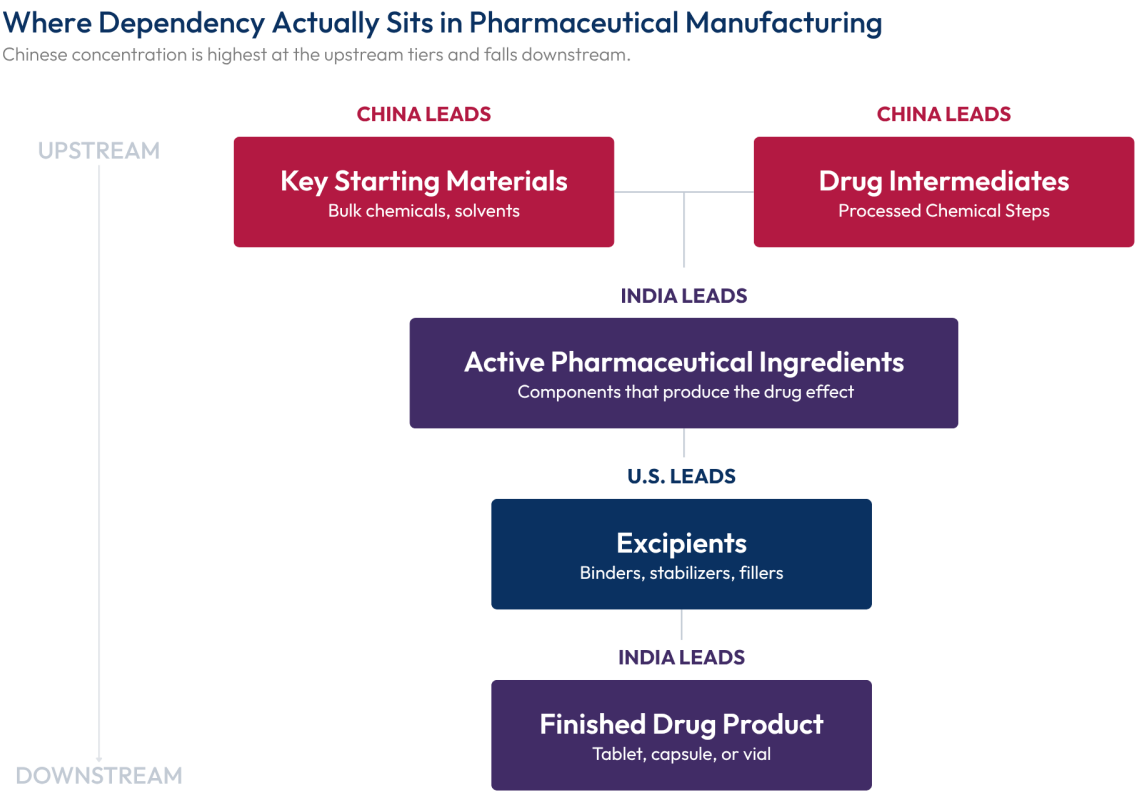
[82] Erkan Duman, USP Insights on Key Starting Materials (KSMs) for Pharmaceuticals, U.S. Pharmacopeia (2026).
[83] Erkan Duman, USP Insights on Key Starting Materials (KSMs) for Pharmaceuticals, U.S. Pharmacopeia (2026).
[84] Erkan Duman, USP Insights on Key Starting Materials (KSMs) for Pharmaceuticals, U.S. Pharmacopeia (2026).
[85] China's Irreplaceable Role in the Global Generic Drug API Supply Chain (2026 Report), DrugPatentWatch (2026).
[86] Erkan Duman, Global Active Pharmaceutical Ingredient Manufacturing Capacity Remains Concentrated Despite Shifting Production Trends, U.S. Pharmacopeia (2026).
[87] China's Irreplaceable Role in the Global Generic Drug API Supply Chain (2026 Report), DrugPatentWatch (2026).
[88] Daniel Gilbert, How Troubles at a Factory in India led to a U.S. Cancer-Drug Shortage, Washington Post (2023).



Sources: Erkan Duman, USP Insights on Key Starting Materials (KSMs) for Pharmaceuticals, U.S. Pharmacopeia (2026); China's Irreplaceable Role in the Global Generic Drug API Supply Chain (2026 Report), DrugPatentWatch (2026).

Chinese dominance is concentrated in products that are cheapest to make but difficult to do without. China supplies over 90% of antibiotics, over 70% of vitamins and antipyretics, and more than 60% of statins for the entire world.[89] These are not frontier or innovative products, but they are high-volume, low-margin commodities that Western manufacturers exited over three decades ago because the economics of production were unattractive.[90]

The United States leads in the intermediate layer, where substitution for Chinese suppliers is possible. American advantage lies in laboratory equipment, reagents, and intermediates, where the United States runs a trade surplus in the billions across these categories, while China imports substantially more than it exports.[91] Yet, unlike KPMs and APIs, laboratory instrumentation is not a strategic chokepoint. It benefits from a

[89] China's Irreplaceable Role in the Global Generic Drug API Supply Chain (2026 Report),DrugPatentWatch (2026).

[90] Andrew Rechenberg, America's Antibiotic Supply Is Hanging by a Thread, RealClearHealth (2026).

[91] SCSP analysis of UN Comtrade data. *See* UN ComTrade Database, United States (last accessed 2026).

diverse base of qualified vendors across allied nations, long equipment lifecycles, and none of the regulatory requalification hurdles found in API sourcing.[92] A rival deprived of American-made centrifuges faces costs and logistical friction, but a nation cut off from Chinese chemical inputs often faces a total production halt and medicine slowdowns within days.[93] Given China's history of weaponizing key supply chain chokepoints, such as critical minerals and foundational semiconductors, for geopolitical leverage, pharmaceutical inputs are vulnerable to becoming the next trade weapon against the United States.[94]

Manufacturing is where the countries diverge.

The final stage of a product before packaging and sale is manufacturing. Biological manufacturing involves the use of living systems like cells, bacteria, and enzymes to create commercial products, including fuels, textiles, and medicine.[95] Pharmaceutical manufacturing often involves biomanufacturing in the creation of biologics such as vaccines or mRNA therapeutics, but often drugs are chemically synthesized instead and do not require the same large-scale bioreactors.[96]

On pharmaceutical manufacturing, the United States is ahead: it manufactures roughly three times what China does by value but can supply only about 40% of its own pharmaceutical needs.[97] China manufactures less and supplies closer to 70% of its own domestic needs.[98] This is because American pharmaceutical manufacturing is oriented toward high-value products for a global market. Chinese manufacturing is instead oriented toward domestic sufficiency, a priority confirmed by China's substantially lower import share of pharmaceutical and health products.[99]

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[92] Analytical Instrumentation Market Size, Share, and Industry Analysis, Fortune Business Insights (2026).

[93] Marta E. Wosinska, When Medicine Supply Chains Become Weapons: China's Leverage and How the U.S. Should Respond, Brookings (2026).

[94] Niels Graham, Pharmaceuticals are China's Next Trade Weapon, Atlantic Council (2025).

[95] The Rise of Biomanufacturing: From Lab to Factory Floor, AIM Congress (2025).

[96] Differences Between Biopharmaceutical and Pharmaceutical Manufacturing, Radley Engineering (2026).

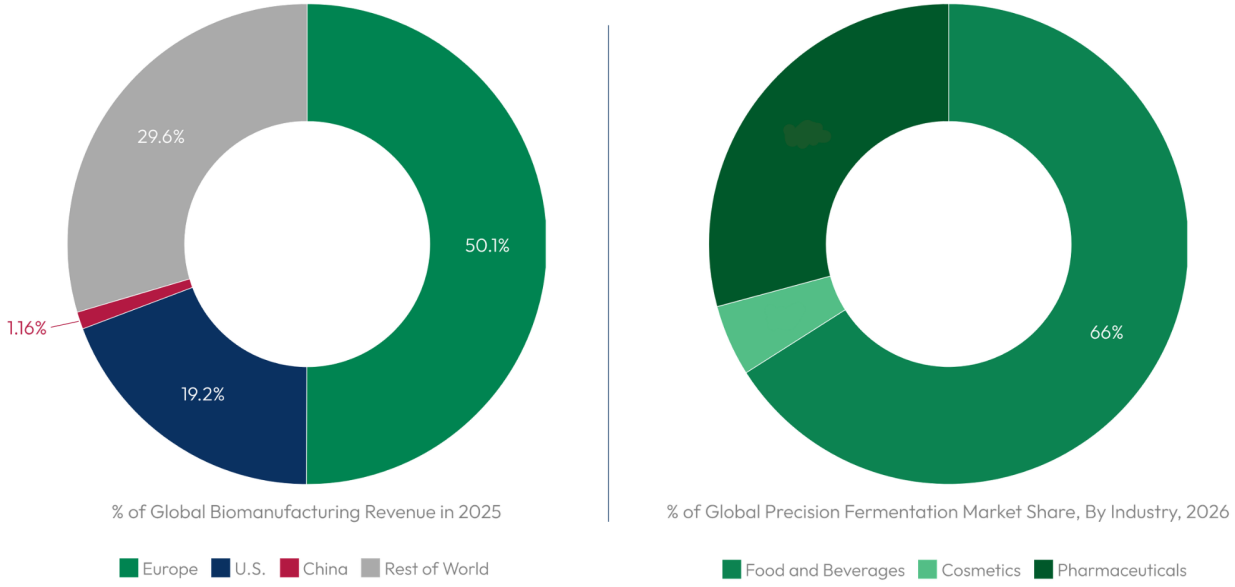
[97] Pharmaceutical Manufacturing Market Size, Share & Industry Analysis, Fortune Business Insights (2026); Andrew Rechenberg, America's Drug Shortage Isn't a Supply Problem—It's a Production Crisis, Coalition for a Prosperous America (2025).

[98] China's Pharmaceutical Industry Expected to be the World's Largest in Less Than 10 Years, Daxue Consulting (2022).

[99] China's Pharmaceutical Industry Expected to be the World's Largest in Less Than 10 Years, Daxue Consulting (2022).

Biomanufacturing is where both countries are weakest. Neither the United States nor China is the real leader in biomanufacturing; Europe leads globally across much of the field, largely because it dominates the market sector of fermentation-derived food proteins and beverages.[100] Of the two, the United States holds a larger share of global biomanufacturing by value, but China's share is growing quickly, fueled by massive state-subsidized investments.[101] China already produces the largest shares of vitamins and amino acids, commodity products that feed a range of downstream biomanufacturing applications.[102]

Europe's Lead in Biomanufacturing is Due to Food & Beverage Fermentation



Source: Precision Fermentation Market Size, Share & Industry Analysis, Fortune Business Insights (2026).

Both countries have also announced pilot-scale build-outs for biomanufacturing plants in recent years. The Department of Defense established BioMADE in 2020 with an $87 million award, matched by roughly $187 million from member companies.[103] Its pilot plant network now comprises three sites in California, Iowa, and Minnesota, using bioprocessing to create industrial and consumer goods made from organic inputs instead of relying on foreign oil or synthetic chemicals.[104] China's Ministry of Industry

[100] Precision Fermentation Market Size, Share & Industry Analysis,Fortune Business Insights (2026).
[101] Lab Leader, Market Ascender: China's Rise in Biotechnology, MERICS (2025).
[102] SCSP analysis of UN Comtrade data. See UN ComTrade Database, United States (last accessed 2026).
[103] DOD Approves $87 Million for Newest Bioindustrial Manufacturing Innovation Institute, U.S. Department of War (2020).
[104] Pilot Plant Network, BioMADE (last accessed 2026).

and Information Technology has announced more than twenty pilot-scale platforms over three years and named 43 firms to build them, though construction remains ongoing and the full scale is not yet verifiable.[105] Neither government publishes national fermentation capacity, and the global estimates in circulation are insufficient to understand the true scale. Therefore, it is difficult to determine exactly who is completely ahead in biomanufacturing today, but these moves illustrate the direction each country is headed.

In bioagriculture and bioindustrials, the United States is ahead, but the gap is narrowing. The United States plants 75.4 million hectares of genetically engineered crops, which, for reference, is slightly larger than the total land area of Texas. In comparison, China only plants 3.5 million hectares.[106] China is turning toward deploying genetically engineered crops more often and more widely: Chinese GE corn and soybean plantings in 2025 were more than four times the 2024 figure.[107] Emerging industrial applications tell the same story. In bioindustrials—which includes bio-fabricated materials like textiles and related goods produced using synthetic biology—the two countries hold comparable global shares.[108] While this market segment remains under 1% of the global textile economy, it is an indicator of future biomaterials applications.

[105] Jess Freitag and Ryan Huling, China is Bolstering Food Security with Biomanufacturing. Australia Should, Too, Australian Strategic Policy Institute (2026).
[106] Hoohui Li , et al., Global Trends in the Commercialization of Genetically Modified Crops in 2024, Journal of Integrative Agriculture (2026).
[107] Biotechnology and Other New Production Technologies Annual, U.S. Department of Agriculture Foreign Agricultural Service (2025).
[108] Bio-fabricated Materials Market Size, Trends, Share, Growth, and Opportunity Forecast, 2025-2032 Global Industry Analysis, Congruence Market Insights (2025).

Market Ecosystem: American capital and commercialization remain unmatched.

Leader: United States	Trending Towards: United States

The United States maintains a strong lead in Market Ecosystem, thanks to its ability to mobilize private capital for biotechnology over time. However, billion-dollar U.S. pharmaceutical companies are beginning to see the value in what Chinese biotech and academic spin-outs are creating, and they are paying to license Chinese intellectual property at record rates.[109] The result is an ecosystem where America still owns the market and the capital, but a growing share of what gets sold in that market originates somewhere else.

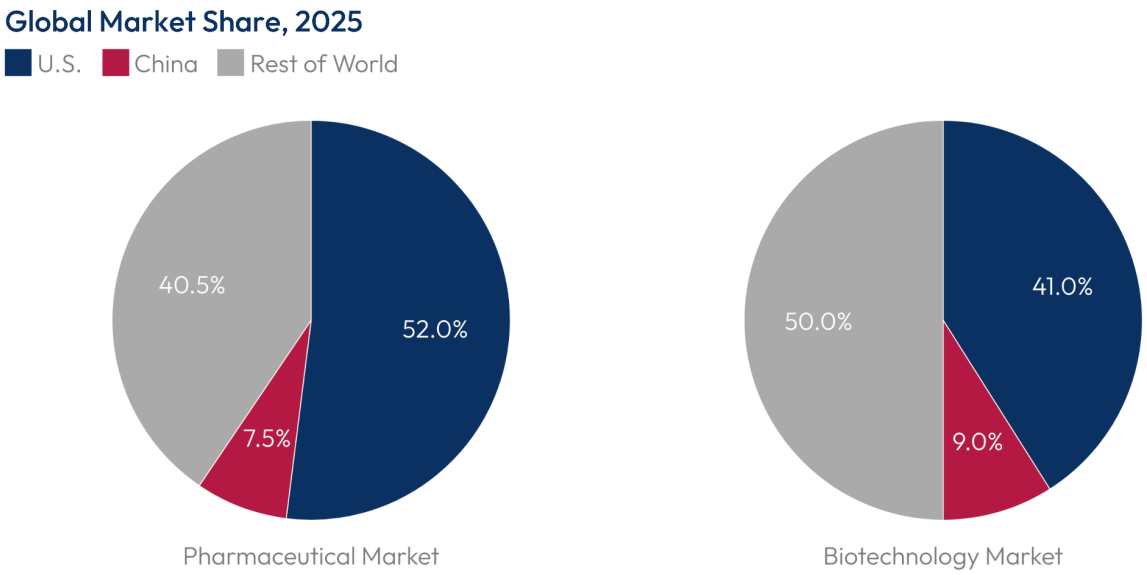
The U.S. market share leads globally, by a wide margin.

The United States maintains a considerable lead in the biotechnology and pharmaceuticals market. As of 2025, the United States held over half of the global pharmaceutical market and over 40% of the biotechnology market.[110] China holds less than a tenth of the global share for both.[111]

[109] Sriparna Roy & Sneha SK, US Pharma Bets Big on China to Snap Up Potential Blockbuster Drugs, Reuters (2025).

[110] Biotechnology Market Size, Share & Industry Analysis, Fortune Business Insights (2026); Market share of Leading 10 National Pharmaceutical Markets Worldwide in 2024, Statista (2025).

[111] Biotechnology Market Size, Share & Industry Analysis,Fortune Business Insights (2026); Market share of Leading 10 National Pharmaceutical Markets Worldwide in 2024, Statista (2025).



Source: Biotechnology Market Size, Share & Industry Analysis, Fortune Business Insights (2026); Market Share of Leading 10 National Pharmaceutical Markets Worldwide in 2024, Statista (2025).

This lead is a product of what Americans pay and what American companies make. Drug costs inside the United States are often two to four times higher than in other countries for the same medicine, which inflates the value of the market without necessarily reflecting greater output.[112] China has moved in the opposite direction: its national reimbursement list aggressively negotiates prices down as a condition of market access, compressing domestic revenues by design.[113] The U.S. market is so large partly because drugs can be expensive, and companies worldwide seek American approval to maximize revenue.[114]

Growth rates, however, reflect a changing ecosystem. Between 2024 and 2030, the United States biotech market is estimated to grow at 12%, while China's is estimated to grow by almost 20%.[115] Even at this pace, China would need well over a decade of sustained outperformance to converge with the United States. Regardless, China is becoming a larger player in the market.

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[112] Andrew W. Mulcahy, et al., International Prescription Drug Price Comparisons, RAND (2024).

[113] Chia-Feng Lu, et al., China on the Move: Lessons from China's 2024 National Negotiation of Drug Prices, Greenberg Traurig Advisory (2025).

[114] Jake Miller, The Economic Forces That Drive Prescription Drug Prices, Harvard Medical School (2025).

[115] U.S. Biotechnology Market Size and Outlook, 2024-2030, Grand View Research (2023); China Biotechnology Market Size and Outlook, 2024-2030, Grand View Research (2023).

Private investment flows largely to the United States, but is not the full story.

The United States commands a significant proportion of global private investment. Global venture funding for biotechnology reached roughly $50 billion in 2025, and U.S.-based companies captured close to two-thirds of it.[116] However, China has been making inroads: its share of private investment has quadrupled from only 4% in 2010 to 19% by 2020.[117]

Yet, private capital is not the largest driver of biotech investment in China. Instead, the Chinese Communist Party (CCP) channels significant public investment into biotechnology companies through the form of government guidance funds (GGFs), and those figures are not published in any consistent form.[118] Total Chinese biotechnology investment, public and private combined, is therefore unknown. While American capital flows overall still exceed those of China, the Chinese state is backing far more enterprises outright and shaping the direction of industry development.

Though strong government backing may be a positive sign for Chinese biotech startups, state capital allocation is often less inefficient than American private funding.[119] State funds will typically prioritize boosting employment rates or near-term growth outcomes that conflict with a risky startup environment. Therefore, where private investment flows in future years will continue to be the more promising sign of confidence in the U.S. and China biotech markets.

The United States produces more successful biotech startups.

The number of companies and their relative success describes how advanced the biotechnology sector is in each country. In 2025, the United States had roughly 7,500 biotechnology startups compared to China's almost 2,600.[120] U.S. startups are also more likely to achieve blockbuster status, with at least twenty companies worth over a billion dollars, compared to China's two.[121] The success of these "unicorns"—startups

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[116] SCSP analysis of Pitchbook data (last accessed 2026).

[117] Ge Bai, We Must Win The Race For Global Biotech Innovation, Forbes (2024)

[118] Ngor Luong, et al.,Understanding Chinese Government Guidance Funds, Center for Security and Emerging Technology (2021).

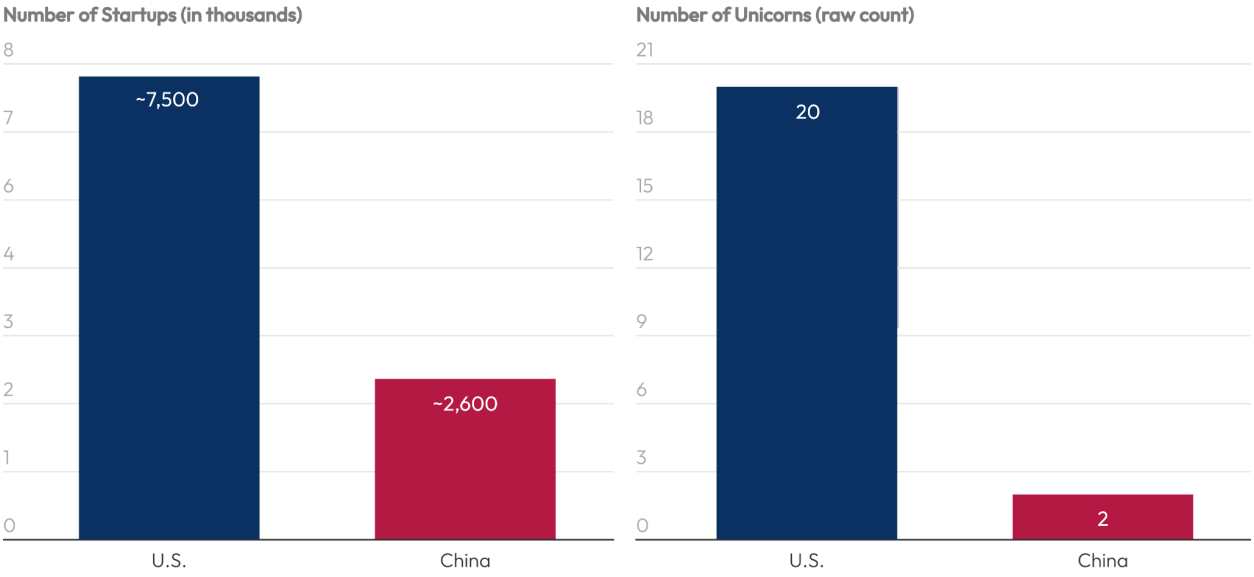
[119] Liza Lin & Rebecca Feng, For Chinese Tech Startups, Beijing Fills a Funding Void Left by VCs, Wall Street Journal (2024)

[120] SCSP analysis of Pitchbook data (last accessed 2026).

[121] SCSP analysis of Pitchbook data (last accessed 2026).

with valuations over $1 billion—is a defining feature of the U.S. biotech environment and reflects the strength of U.S. capital markets.[122] The United States also consistently produces more new biotech startups per year, signaling a more risk-tolerant business environment.[123] Thus, the United States remains ahead in both the number and the success of its startups, the product of a market ecosystem that has flourished for decades and built an environment where companies can succeed.

The U.S. Startup Base is Both Larger and More Successful



Source: SCSP Analysis of Pitchbook Data.

Initial public offerings (IPO) is another signal of a strong market ecosystem, as startups mature into revenue-generating companies. IPO proceeds hit a ten-year low in 2025 across the sector, but China listed slightly more biotech IPOs than the United States that year.[124] The American market has rebounded in the first half of 2026, with thirteen firms raising a combined $4.5 billion.[125] Here, while the market waxes and wanes for both countries, the American public market has traditionally remained the strongest.

Another measure of market prosperity is how well companies commercialize the patents they file. Often, biotechnology patents emerge from universities where the

[122] How do Biotech Startups Become Unicorns?, Excedr (2025).

[123] SCSP analysis of Pitchbook data (last accessed 2026).

[124] Mandy Jackson, Asian Offerings Again Outpace Western Biopharma IPOs In Q4, Citeline (2026).

[125] Gwendolyn Wu, Biotech Startup Funding Gap Widens Despite Rebound in VC investment BioPharma Dive (2026).

initial discovery occurred and spin out into smaller biotechnology companies.[126] Of valid patents arising from university inventions in the United States, approximately 37% were eventually commercialized.[127] In comparison, only about 4% of valid university patents are commercialized in China.[128] This gap could reflect the low quality of the patents themselves in both countries, as many may be filed for grant or evaluation purposes with no commercial intent. But it more likely reflects weaker links between academia and industry in China.[129] Discoveries and publications in China are plentiful, but the market ecosystem that would absorb them is still expanding, and technology transfer does not happen as easily. Beijing has recognized the problem and intervened directly by reallocating university-held patents to companies in an effort to force commercialization rather than let the rights sit unused.[130] In contrast, U.S. universities operate dedicated Technology Transfer Offices that make the connection routine, bridging the gap more easily.[131]

China attracts billion-dollar out-licensing deals for biotech.

Out-licensing deals occur when a business licenses their technology or IP to another, typically larger company in exchange for upfront payments or royalties, and in-licensing consists of paying for the rights to develop another company's drug candidate.[132] There's been a surge in American companies both out- and in-licensing to China. The largest Western pharmaceutical companies are approaching a patent cliff worth more than $200 billion and blockbusters that generate billions annually lose exclusivity as generics flood in.[133] Facing this revenue hole, and with internal R&D slow and failure-prone, companies like Merck and Pfizer have expanded the practice of

[126] Caroline Hroncich, How Universities Became the Engine of the Biotech Industry, Cure (2026).

[127] Federico Caviggioli, et al., The Licensing and Selling of Inventions by U.S. Universities, Technological Forecasting and Social Change (2020).

[128] Yiling Guo, et al., Intellectual Property Services and the Commercialization of Patents: Insights from Chinese Scientists, China Economic Review (2026).

[129] Fulong Wu, et al., State-Sponsored Research and Development: A Case Study of China's Biotechnology, Regional Studies (2010).

[130] China Completes Patent Screening at Universities, Research Institutions to Enhance Commercialization, Xinhua (2026).

[131] Caroline Hroncich, How Universities Became the Engine of the Biotech Industry, Cure (2026).

[132] In-Licensing vs Out-Licensing in the Pharmaceutical Industry, PharmaVenue (2023).

[133] The Impact of Patent Cliff on the Pharmaceutical Industry, Bailey Walsh & Co (2025).

sourcing early-stage assets externally or in-licensing.[134] Entire teams are now dedicated to finding those candidates, and increasingly they are finding them in China.

As a result, Chinese out-licensing deal value reached a record in 2025, with roughly $137 billion across about 157 transactions, nearly ten times the 2021 figure.[135] China's share of global licensing deal value rose from less than 10% in 2019 to 48% in 2025, while the American share fell from 55% to 29% over the same period.[136] This pace has not slowed: Chinese biotech companies signed roughly $60 billion in cross-border out-licensing in the first quarter of 2026 alone.[137] The value cited in these headline figures, however, represents total potential deal value, including development, regulatory, and sales milestones that may never be triggered. These deals are typically struck early in the drug development pipeline, so there is no guarantee they will pan out and become revenue-generating.[138] Actual upfront payments to Chinese companies were only around $5.6-7 billion, which is what measures initial Western willingness to pay.[139] Upfront deal value is climbing, however, signaling to investors that large pharmaceutical companies increasingly see China as a source of innovative mechanisms worth exploring.[140] This feedback loop is entirely positive for China – the more billions of dollars companies receive from licensing deals, the more funding that can be reinvested into R&D. Even if Western companies do profit off of Chinese small-molecule drugs, investments are simply circulated back into the Chinese research pipeline rather than the American one.

Chinese companies have every incentive to keep feeding this cycle. Winning a large deal is lower-risk than refusing and attempting to build out the entire drug pipeline alone. For now, wanting a return on investment and some visible payoff on innovation, Chinese companies will keep pursuing Western financing even at the cost of surrendering IP

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[134] Arnav Khanna, Buying the Future: How Patent Cliffs are Driving Biotech, Cureus Journal of Medical Science (2026).

[135] China is Increasing Its Share of Global Drug Development, Goldman Sachs (2025).

[136] Aaron Blotnick, The Year China Surpassed the USA in Biotech Innovation, Deal Value, and Clinical Output, SynBioBeta (2026) .

[137] The Sourcing Channel Moved East, Life Science Daily News (2026).

[138] Licensing out: Try not to get benched, Taylor Wessing (2020).

[139] Will Maddox, After 230% Deal Size Explosion, China is No Longer the 'Bargain Basement' for Biopharma Licensing: Analyst,Fierce Biotech (2026).

[140] Will Maddox, After 230% Deal Size Explosion, China is No Longer the 'Bargain Basement' for Biopharma Licensing: Analyst,Fierce Biotech (2026).

rights. But in the long term, it could be major Chinese pharmaceutical giants doing the out-licensing and financing Western innovation.

Talent Pipeline: The United States leads in quality, China on scale.

Leader: United States	Trending Towards: Contested

Talent is one of the most critical inputs for biotechnology. Whether it be academics spinning out a university lab discovery into an early-stage startup, a seasoned biotech executive hiring top scientists, or biotech professionals filing the patents on inventions that eventually turn into billion-dollar discoveries, people are the ones who work for years, if not decades, on niche biological mechanisms that could translate into a breakthrough drug. Talent is also a long-horizon investment. Biotechnology scientists often require a PhD in a related discipline like bioengineering, microbiology, or biochemistry, followed by postdoctoral training.[141] That means the individuals who will make up the talent pipeline ten to fifteen years from now may have just entered university. Today's talent metrics describe decisions made a decade ago, while today's policy decisions will not show results until the 2040s.

Biotechnology talent can be tracked by education, recruitment, retention, and research performance. What determines the talent pipeline is not only how many people are born in a country who will eventually work in biotechnology, but also how each country welcomes and supports foreign talent, and whether it can encourage those individuals to remain and keep contributing to their biotechnology research ecosystem.

The United States leads in Talent Pipeline partly because of domestic talent, but mainly because it has succeeded in attracting the top foreign talent into the American research ecosystem. Immigrants made up 30% of U.S. life scientists with a bachelor's degree or higher, yet they have contributed to 79% of pharmaceutical patents at the country's leading research universities, and founded or co-founded a fifth of U.S. bioscience firms.[142] Talented professionals seek out U.S. academia and industry for the mission, funding, prestige, and benefits that come by association.[143] However, this lead has shrunk in recent years. China has harnessed its domestic talent pool and fed a biotechnology pipeline that only now, after a decade or more, is showing results. It is easily competitive on pure numbers alone: China has more than four times the

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[141] Ryan Helwig and Dylan Yetter, 2025 Life Sciences Workforce Trends, TEConomy Partners, LLC (2025).

[142] STEM Talent: Education, Training, and Workforce, U.S. National Science Foundation (2026); Press Release: New Study Reveals Immigrants Are Behind More Than Three-Quarters of Patents From Top Ten Patent-Producing American Universities, American Immigration Council (2012); Vivek Wadhwa, et al., America's New Immigrant Entrepreneurs, Duke University and UC Berkeley (2007).

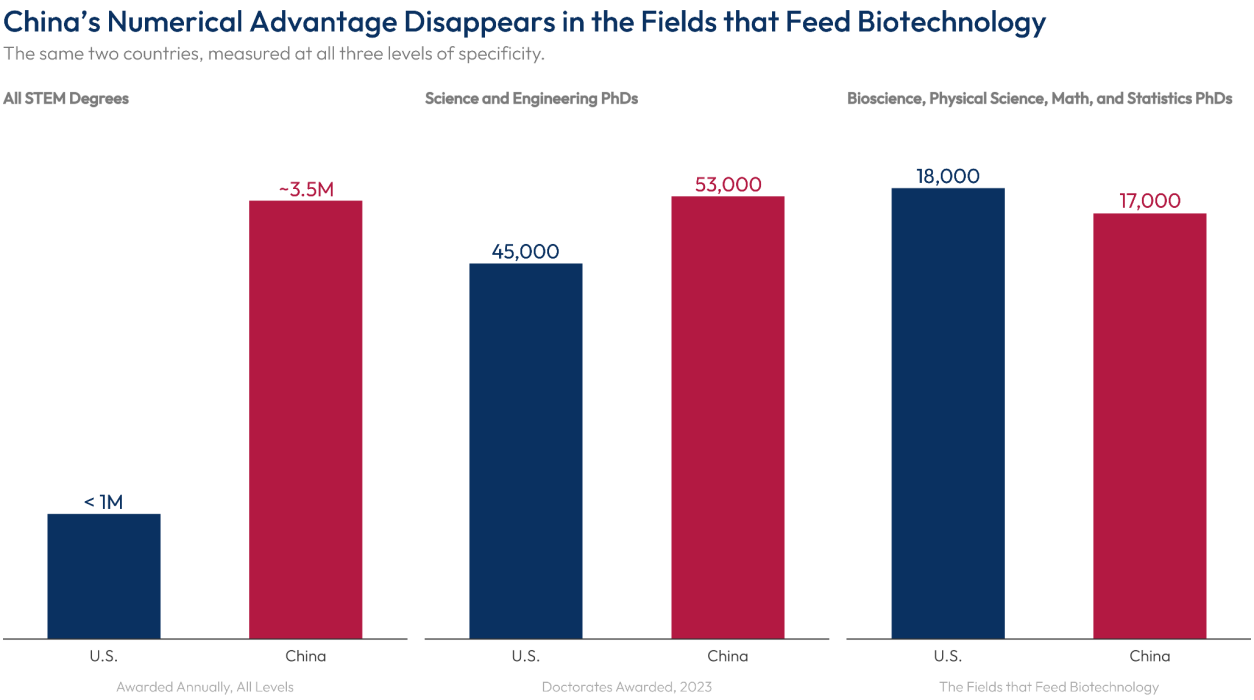
[143] Matthew Murray, New Research Shows that Powerhouse Institutions Play an Outsized Role in Scientific Innovation and Discovery, Harvard Kennedy School (2025).

population of the United States and can produce gifted academics from its highly ranked science institutions at scale.[144] More and more Chinese scientists are staying home to build domestic careers in biotechnology.[145] The United States is still at an advantage, as lucrative opportunities and intellectual freedom encourage foreign nationals who study in the United States to stay. However, this advantage is not large.

China produces more graduates, but the United States matches it in the life sciences.

China has long surpassed the United States in the number of STEM degrees it produces each year. The United States awards less than a million STEM degrees compared to China's roughly 3.5 million.[146] That gap shrinks substantially at the doctoral level: China awarded 53,000 science and engineering PhDs against the American estimate of 45,000 in 2023.[147] This difference between undergraduate and graduate degrees reflects the broader upstream research talent supply, as scholars go on to find jobs in academia and industry, many of them dedicating their careers to biotechnology. But zoom in on the relevant subfields and the picture changes. The United States has less than a quarter of China's population yet produces the same number of PhDs in science-related subjects. Within math and sciences specifically, the United States matched China's doctoral output in 2023.

[144] Dannie Peng, China Surpasses U.S. in Tally of Top Scientists for the First Time: Report, South China Morning Post (2025).
[145] Laurie Udesky, The Number of China's Elite Scientists who Have been Trained Abroad is Falling, Career News (2026); Why Ever Fewer Young Chinese Study Abroad, The Economist (2026).
[146] Shane D. Shook, America is losing the AI productivity war to 3.5 million Chinese STEM graduates, Market Watch (2026).
[147] STEM Talent: Education, Training, and Workforce, U.S. National Science Foundation (2026).



Source: Shane D. Shook, America is Losing the AI Productivity War to 3.5 million Chinese STEM Graduates, Market Watch (2026); STEM Talent: Education, Training, and Workforce, U.S. National Science Foundation (2026).

While China's numerical advantage in STEM is real, it is concentrated in disciplines that feed manufacturing and infrastructure rather than the life sciences, as China's doctoral output overwhelmingly favors engineering.

Foreign talent remains a U.S. advantage, but it can no longer be taken for granted.

The more meaningful difference is where the talent comes from. Chinese doctoral candidates are overwhelmingly Chinese citizens, while nearly half of U.S. STEM PhD graduates are foreign nationals.[148] The United States has historically benefited from both attracting these students and retaining them after graduation. Among temporary-visa recipients earning biological and biomedical science doctorates between 2020 and 2023, 81% planned to remain in the United States and 60% had made definite commitments to U.S.-based employment or postdoctoral positions—both

[148] STEM Talent: Education, Training, and Workforce, U.S. National Science Foundation (2026).

higher than for earlier cohorts.[149] These figures confirm that the United States remains capable of converting international education into domestic scientific capacity.

The more immediate concern is whether the United States will continue attracting talent at the same scale. In the Fall of 2025, new international enrollment at U.S. institutions fell 17%, while international graduate enrollment declined 12%.[150] Data collected in 2026 also show declining international applications and admissions offers at both the master's and doctoral levels, with institutions reporting visa delays, immigration uncertainty, research-funding constraints, and the cost of graduate education are influencing student decisions.[151] These figures cover international students broadly rather than biotechnology alone, but they are important leading indicators for a sector that depends heavily on foreign graduate talent.

But changing conditions in China are also affecting the flow of talent. In 2008, China launched its Thousand Talents Program to lure Chinese-born researchers back home, and thousands have returned since.[152] Departures of Chinese-descent scientists from the United States have risen steadily since then, with the life sciences seeing the largest exodus of any field.[153] Chinese talent programs have poached at least 100 top scientists from the United States in recent years, typically by offering lucrative salaries and steady research funding.[154] Increased basic research funding in the life sciences has also incentivized Chinese-born scientists to move back to China for career success. While the United States remains a top destination for talent, a combination of push and pull factors may cause Chinese STEM talent to stay at home rather than pursue study and work abroad.

Biotechnology talent starts early, and China knows that.

The talent pipeline for the next decade of biotechnology is determined by inputs to the sector today, particularly in secondary and collegiate education.

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[149] STEM Talent: Education, Training, and Workforce, U.S. National Science Foundation (2026).

[150] Four Things to Know About the Fall 2025 Snapshot, Institute of International Education (2025).

[151] Status of International Graduate Students in the United States: Data from 2026 CGS Survey of Graduate Institutions, Council of Graduate Schools (2026).

[152] Dongbo Shi, et al., Has China's Young Thousand Talents program been successful in recruiting and nurturing top-caliber scientists?, Science (2023); Why Ever Fewer Young Chinese Study Abroad, The Economist (2026).

[153] Yu Xie, et al., Caught in the Crossfire: Fears of Chinese–American Scientists, PNAS (2023).

[154] Gabrielle Fahmy, China Lures Away 105 Top American Minds in Bid to Dominate Med, Tech Fields, NY Post (2026).

In global student competitions, China has climbed to the top of the ladder in biology and biotechnology, though the United States remains closely behind. In the International Biology Olympiad, a prestigious competition for high school students, China took the top three individual places and placed five teams in the top thirty. The United States placed three.[155] At the undergraduate level, the picture is similar: in the International Genetically Engineered Machine competition, China collected roughly 100 gold medals in 2025 against about 27 for the United States, which finished second.[156] This is notable as iGEM originated in the United States, and American teams led the competition for years.

These are minor wins in the grand scheme of biotechnology talent. But they demonstrate the seriousness with which China treats this competition, and they are a leading indicator rather than a lagging one. China is training its young citizens to build a domestic model of scientific talent, betting that today's high schoolers and undergraduates will become tomorrow's leading researchers.

[155] Results of IBO 2026, International Biology Olympiad (2026).

[156] Competition Results, iGem Foundation (2025).

National Leverage: China's coordinated state strategy outpaces American fragmentation.

Leader: China	Trending Towards: China

China leads in the deliberate use of state power to build a biotechnology industry. Over the past decade, Beijing has combined sustained state investment in basic research and STEM training, direct government support for commercialization, and structural reform of its drug approval system into a coordinated effort with defined national objectives. In contrast, the United States lacks a cohesive national strategy, but can rely on a strong base of scientific and regulatory institutions and world-leading government funding for basic research in biotechnology.

China's leadership treats biotechnology as a strategic national priority, while U.S. policymakers focus on creating conditions for private-sector success.

The key difference between the United States and China in their industrial policies towards biotech is that American efforts are fragmented and disparate. America lacks a coordinated national strategy that brings the full weight of state power to bear and provides support at all stages of industrial development. Its research institutions have increasingly ceded biotech funding responsibilities to the private sector, creating insufficient incentives to bolster domestic capacity. This stems from the United States and China assigning different strategic value to the sector, as evidenced in their strategic approaches to biotech or lack thereof. The way they respectively leverage state power over biotechnology reflects this philosophical asymmetry.

American government support for biotech has historically been anchored to the funding of basic research, as NSF academic grants enabled innovations like DNA cloning in the 1970s and R&D funding ramped up heavily in the 1980s and 1990s.[157] It is also intertwined with a number of legal and regulatory reforms that allowed the private sector to more easily commercialize federally funded research and make significant private investments.[158] Yet, as debates in the 1980s made clear, a sustained, whole-of-government industrial policy had few supporters because biotechnology was not

[157] Fred Block & Matthew Keller, State of Innovation: The U.S. Government's Role in Technology Development, Paradigm Publishers (2011).
[158] Amanda Mayoral, We Need to be Better at Industrial Policy, Prosperous America (2022).

concentrated in a single industry, difficult to understand, and more removed from the manufacturing process than most industrial R&D.[159]

The United States has shown that it can implement successful industrial policy towards the industry when it is seen as a strategic necessity, most notably during Operation Warp Speed (OWS). Through OWS, a combination of extensive financial derisking, significantly accelerated approval timelines, and public-private supply chain partnerships delivered a vaccine in nine months.[160] In 2022, the federal government even released an Executive Order articulating a "whole-of-government" approach to biotechnology that sought to expand domestic biomanufacturing capacity, loosen regulations to fast-track biotech commercialization, and apply biotechnology cross-sectorally.[161] However, this policy was rescinded in 2025, and the United States now once again lacks an articulated national strategy for biotechnology. Though the current Trump Administration and Congress have since released a patchwork of policies, the structural incentives across the federal government to leverage state power in support of the U.S. biotech industry remain unchanged.

Despite this, U.S. biotechnology policy has improved. The congressionally-mandated National Security Commission on Emerging Biotechnology outlined 49 recommendations to improve U.S. biotech competitiveness.[162] To date, 28 statutory or executive provisions have partially or fully implemented elements of 25 of those recommendations.[163] . Despite this progress and declarations of biotechnology's importance by certain government bodies, there is a noticeable lack of urgency to expand the mechanisms of government support outside of its traditional role in funding basic research and maintaining strong legal and regulatory standards. Until the government reweights the strategic value of biotechnology, this is unlikely to change.

In China, state support began fostering a competitive biotechnology industry as early as 1978 through investments in bioagriculture and improved seed qualities.[164] This support

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[159] Christopher Edwards, Industrial Policy: Where is Biotech?, Nature Biotechnology (1983).

[160] Operation Warp Speed: Accelerated COVID-19 Vaccine Development Status and Efforts to Address Manufacturing Challenges, U.S. Government Accountability Office (2021).

[161] E.O. 14081, Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy, The White House (2022).

[162] Shaping the Future of Biotechnology, National Security Commission on Emerging Biotechnology (2026).

[163] Some of NSCEB's recommendations contain multiple proposed actions, therefore, provisions and recommendations cannot be counted interchangeably.

[164] Zhihua Xiao, et al., Biotechnology in China – Regulation, Investment, and Delayed Commercialization, GM Crops and Food (2022).

was formalized through industrial policies seeking to repair China's scientific institutions and basic research capacity after the Cultural Revolution.[165] As the field grew in importance, biotech was labeled a "frontier" technology in guidance documents and industrial plans, representing an expansion in government focus from R&D-focused to include commercialization.[166] State support reached new heights in the late 2010s, with the Made in China 2025 policy directing government funding to indigenize the production of critical technologies and the State Council streamlining Chinese drug approval regulations to align them with international standards.[167] These policies encouraged a dual circulation strategy where Chinese firms built capacity domestically while also pushing them to become globally competitive in international markets. China's strategic vision is exemplified in a 2015 speech by Xi Jinping imploring policymakers to seize "the commanding heights" of biotech and prevent foreign domination of China's markets, pushing for accelerated indigenization due to biotechnology's strategic value.[168]

In recent years, biotechnology has become increasingly identified as a "top priority sector" for the Chinese government.[169] The 14th Five Year Plan included an industry-specific "Plan for the Bioeconomy" that outlined broad sectoral and explicitly targeted bottlenecks for China to overcome to build an indigenous biotechnology stack. No analogous large-scale plan for the bioeconomy exists in the United States. China's newest 15th Five Year Plan explicitly seeks to make biotechnology a source of Chinese technological and industrial power by taking "extraordinary measures" to achieve "decisive breakthroughs" while shifting the focus even further towards commercialization and creating pilot programs that can bring novel products to market.[170] It identifies specific enabling technologies like industrial enzymes or intelligent fermentation as well as industrial applications to target. It even goes as far as to assign biomanufacturing the distinction of being the only technology sector categorized as both a "core technology" and "future industry," demonstrating the level of present and

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[165] Zhihua Xiao, et al., Biotechnology in China – Regulation, Investment, and Delayed Commercialization, GM Crops and Food (2022).

[166] Cong Cao, et al., China's 15 Year Science and Technology Plan, Physics Today (2006).

[167] Adolfo Arranz, Betting Big on Biotech, South China Morning Post (2018); Katherine Wang, China's State Council Announces Reform on the Drug and Device Approval System, Ropes and Gray (2015).

[168] Gene Kim, China Moving Towards Commercialization of Its Own Biotechnology Crops, USDA Global Agricultural Information Network (2016).

[169] Lucas Fluegel, A Competitive Analysis of the Biomanufacturing Strategic Landscape and Technology Stack, Carnegie Endowment for International Peace (2026).

[170] Chen Xiangming, et al., Why China's Biotech Rise is Harder to Contain than AI, ThinkChina (2026).

future strategic value assigned by the state to rapidly expanding domestic innovation and industrial capacity.[171]

Chinese government funding spans basic research to commercialization.

Ultimately, a policy strategy is only as good as its implementation. Both countries invest heavily in basic research, where the United States maintains an edge, but China more actively supports its biotech startups as they bridge the "valley of death" stage. This is when a firm needs capital to build pilot capacity, scale-up, and reach the market without a definitive return on investment.[172] Commercialization is ultimately the most important step in capturing value from biotechnology and creating real applications from basic research. Chinese policy addresses this challenge directly through equity investments, preferential taxation, below-market lending, direct subsidies, and procurement to provide firms with sufficiently "patient capital" during development cycles that can take decades. The United States largely leaves the challenge to private capital, giving the state fewer levers to strategically influence sectoral outcomes.

In the United States, the bulk of government funding for biotechnology flows into basic research. The federal government spent an estimated $16 billion on biotechnology R&D in 2025, compared to an estimated $2.9 billion by China in 2023.[173] This spending is primarily disbursed by agencies like the National Science Foundation (NSF) and National Institute of Health (NIH), which direct 85% of funding associated with new drug approvals to basic research, but also supports independent labs and smaller biotech startups through programs like the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR).[174] Agencies and programs like the Advanced Research Projects Agency for Health (ARPA-H), the Biomedical Advanced Research and Development Authority (BARDA), as well as programs by the Department of War on biomanufacturing similarly incentivize the commercialization of specific biotech

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[171] Lucas Fluegel, A Competitive Analysis of the Biomanufacturing Strategic Landscape and Technology Stack, Carnegie Endowment for International Peace (2026).

[172] Abigail Coplin, Getting Biotechnology Right: Managing Risk and Reward Between the U.S. and China in the Life Sciences, Penn Project on the Future of U.S.-China Relations (2026).

[173] Estimate based on U.S. government funding towards biotechnology R&D data from USAspending. See USAspending, USAspending.gov (last accessed 2026); Lab Leader, Market Ascender: China's Rise in Biotechnology, MERICS (2025).

[174] Fred D. Ledley, et al., NIH Funding for Patents that Contribute to Market Exclusivity of Drugs Approved 2010–2019 and the Public Interest Protections of Bayh-Dole, PLOS ONE (2023).

outcomes beyond basic research.[175] However, these programs typically either fund health technology broadly, like ARPA-H, or focus on very specific issues such as nuclear or radiological countermeasures, like BARDA, rather than scaling up biotechnology broadly.

In contrast, China's government has invested significantly more state resources than the United States towards helping firms commercialize biotech products. Perhaps the greatest disparity is in equity investments by the government. Chinese government guidance funds such as the State Development and Investment Corporation (SDIC), who act as state-funded venture capital firms, have played an anchoring role in supporting China's biotechnology ecosystem by investing an estimated $56 to $90 billion in the life sciences from 2000 to 2023.[176]

Yet government equity funding, despite supposedly incentivizing patient capital, also falls prey to pressures for short-term progress and returns. State leadership of investment vehicles often leads to politically-guided decisionmaking that can force firms to invest in certain localities or maintain employment instead of being guided by market efficiency. In biotech, the longer payout and exit timeline for VCs generates enormous pressure from both private and state investors to make returns on investments. This in turn pushes Chinese firms to be risk-averse and crowd into tested and proven molecules that they know are viable.[177] While this may play to China's strength in catch-up scenarios, it ultimately suppresses the incentives for firms to pursue truly novel innovations. Chinese biotech firms benefit from numerous government-funded economic incentives, such as generous tax credits. Eligible firms receive the High and New Technology Enterprise's 15% corporate income tax (CIT) rate compared to the standard 25% rate, as well as a 200% R&D super deduction.[178] Direct monetary subsidies, typically disbursed by provincial or municipal governments, also provide support across key points of the commercialization process that can be stacked together to compound the total subsidies a firm receives.[179] For instance, the Beijing municipal government's subsidies for biotechnology firms specifically support everything from pilot-scale

[175] Defense Industrial Base: DOD Efforts to Develop Domestic Biomanufacturing, U.S. Government Accountability Office (2026).

[176] Estimate based on government VC spending figures in Martin Beraja, et al, Government as Venture Capitalists in AI, National Bureau of Economic Research (2024).

[177] Liza Lin & Rebecca Feng. For Chinese Tech Startups, Beijing Fills a Funding Void Left by VCs, Wall Street Journal (2024)

[178] Tax Incentives for Foreign Invested Enterprises, China Briefing (2026).

[179] Dirk van der Kley, What Do Chinese Biotech Subsidies Cover?, Bio Brawl (2026).

facilities, fixed asset investment to kickstart industrialization, R&D and technology transfer from foreign countries, and product commercialization.[180] The integrated and coordinated nature of these subsidies works to support Chinese biotech firms at all stages of the process of bringing a new product to market, providing funding, access, and facilities that can even be expanded to upstream supplier networks.

State and local governments in the United States play a smaller role than in China, but economic incentives for the life sciences still exist. North Carolina's Biotechnology Center helps seed small biotech firms while investing into workforce training and development.[181] Massachusetts has invested over $638 million to the Massachusetts Life Sciences Center since 2020, funding biotech more than any other individual U.S. state.[182] Yet the majority of U.S. government biotech investment still largely flows from the federal government, with states such as California and Texas financing specific initiatives focused on cancer or neurodegenerative disease, rather than biotech-specific funding.[183]

All in all, Chinese state funding for commercialization dwarfs that of the U.S. , largely because the U.S. government model invests far more heavily in basic research while leaving commercialization up to the market. The American government's inability to play the role of capital provider, however, gives it far less ability to strategically influence the sector towards its desired outcomes or guarantee capacity in times of crisis.

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[180] 北京市科学技术委员会、中关村科技园区管理委员会等部门关于印发《北京市加快合成生物制造产业创新发展行动计划（2024-2026年）》[Beijing Action Plan for Accelerating the Innovative Development of the Synthetic Biology Manufacturing Industry (2024–2026)], Beijing Municipal People's Government (2024).

[181] North Carolina Biotechnology Center, NCBiotech (2026).

[182] Research Infrastructure, Massachusetts Life Sciences Center (2026).

[183] Our Programs, Cancer Prevention & Research Institute of Texas (last accessed 2026); Funding Opportunities, California Institute for Regenerative Medicine (last accessed 2026).

Comparison of U.S. and Chinese Government Entities with Authority over Biotechnology

Function	U.S. Entity	Chinese Entity
Basic Research Funding	National Institutes of Health (NIH); U.S. National Science Foundation's (NSF) Directorate for Biological Sciences	National Natural Science Foundation of China (NSFC); Chinese Academy of Sciences (CAS)
Drug/Biologic Regulation	FDA's Center for Drug Evaluation and Research (CDER) & Center for Biologics Evaluation and Research (CBER)	NMPA's Center for Drug Evaluation (CDE)
Mission and Applied Research	Department of Energy's (DOE) National Laboratories	Ministry of Science and Technology (MOST)
Agricultural Biotechnology Regulation	U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS); U.S. Environmental Protection Agency (EPA); FDA	Ministry of Agriculture and Rural Affairs (MARA)
High-Risk and Advanced Development	DARPA; ARPA-H; BARDA	*Comparable institutions exist in the People's Liberation Army (PLA), but are focused on military applications*
Industrial Policy	Deptartment of Commerce	National Development and Reform Commission (NDRC); Ministry for Industry and Information Technology (MIIT)
Advisory Bodies	Office of Science and Technology Policy; White House	The State Council of China
Genomic Data Governance	Health Insurance Portability and Accountability Act of 1996 (HIPPA); NIH	MOST

On biopharma approvals, China matches pace, but the United States remains the gold standard.

Within the biopharmaceuticals sector of biotechnology, a core measure of National Leverage is whether the regulatory system can deliver credible, timely, and predictable decisions while maintaining rigorous standards for safety and efficacy. Approval timelines for drugs entering clinical trials and going to domestic markets are driven by government policy, and can help accelerate, or slow down, the pipeline of innovation.

In China, the National Medical Products Administration (NMPA) is the administrative body with direct regulatory authority over drugs and medical devices, most analogous to the FDA. Reforms by the NMPA of Chinese regulatory standards in the mid-2010s are one of the largest factors in the nation's rise to biotech prominence. These regulatory reforms pushed Chinese biotech firms to align with international regulatory standards, allowing overseas clinical trial data, and accelerating their ability to receive drug approvals.[184] Since then, the number of new biologics and domestically produced

[184] Sen Liu, et al., The Rise of China's Pharmaceutical Industry from 2015–2024: A Decade of Innovation, Nature Reviews Drug Discovery (2025).

innovative drugs has more than doubled, rising from 17 and 10 respectively in 2019 to 50 and 59 in 2025.[185]

Currently, NMPA drug approval timelines are in line with those of the FDA.[186] In fact, certain regulatory mechanisms implemented by the NMPA have allowed clinical trials to be initiated even faster in China. The use of investigator-initiated trials (IIT) allows clinical trials on patients under the supervision of local scientific committees without needing to receive approval from the central government. By decentralizing approvals, physicians can stand up trials and quickly iterate instead of having to seek approval from federal regulators and go through private companies such as in the United States.

But while China has made elements of its drug approval and testing regime more predictable, multi-national firms still face substantial risk from an often-ambiguous regulatory landscape where rule of law is not guaranteed. Targeted actions against foreign firms—such as the singling out of GlaxoSmithKline in 2014 for bribery—or even persecution of individual foreign executives from firms like AstraZeneca and Astellas Pharma highlight the regulatory risks faced by firms operating in China.[187]

The FDA still remains the gold standard in pharmaceutical regulators and retains the trust of most other regulators and governments worldwide. Its power is such that approval essentially guarantees a drug the largest global consumer pharmaceutical market. However, speed has always been a complaint of the FDA's process, and the speed enabled by Chinese regulatory innovations prompted the FDA to announce Operation Trailblazer in June 2026. This slate of reforms would shorten IND timelines, simplify application materials and requirements, and revise statutory standards for "substantial evidence" of effectiveness; a much-needed effort that will require careful implementation.[188]

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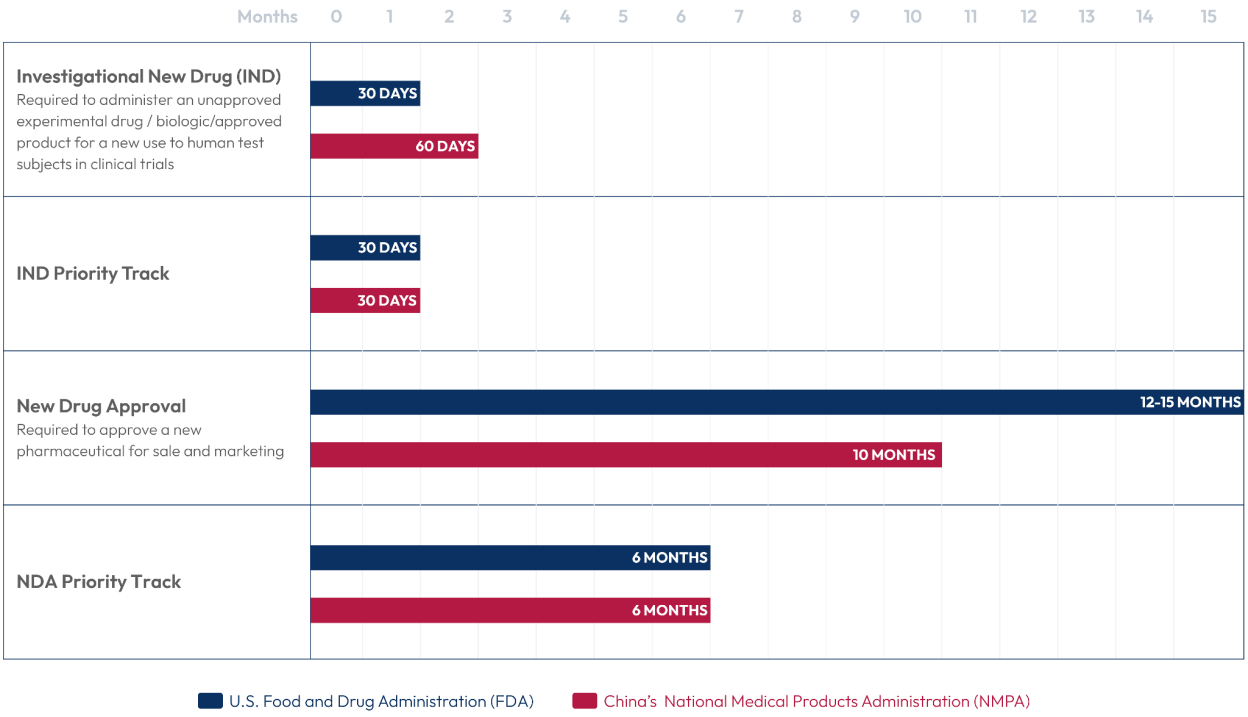
[185] Lab Leader, Market Ascender: China's Rise in Biotechnology, MERICS (2025); Ran Jing, et al., Approvals by the China NMPA in 2025, Nature (2026).

[186] 2026 China Life Sciences Sector Overview and Outlook, KPMG China (2026)

[187] Dereck Lowe, China's GlaxoSmithKline Crackdown, Science.org (2014). China charges former AstraZeneca regional head Leon Wang, Reuters (2026). Austin Ramzy, China Convicts Employee of Japanese Drugmaker of Spying, Wall Street Journal (2025).

[188] Eva Temkin, et al., FDA Proposes Expedited Investigational New Drug Pilot Program to Drive Early Phase Clinical Research in the United States, Arnold and Porter (2026).

Drug Approval Timelines in China vs. the U.S.



The key distinction between China's regulatory framework and that of the United States' lies in their broader policy objectives surrounding regulation. The NMPA's regulatory system is clearly shaped by China's broader industrial policy objectives, calling for a regulatory system "fit for industrial development" with the explicit goal of making China's pharmaceutical industry globally competitive.[189] Meanwhile, the FDA's framework remains institutionally oriented more towards general product safety, efficacy, and clinical need as opposed to boosting the industrial development of pharmaceuticals domestically.[190] While these high standards are a strength, the United States will need to play a balancing act and develop faster, more predictable, and better resourced pathways for novel products and innovations.

At the regulatory level, China's whole-of-government approach to industrial policy creates a coordinated system working in tandem to boost industrial development as quickly as possible, even when at the expense of foreign firms. In contrast, America's

[189] Opinions of the General Office of the State Council on Comprehensively Deepening the Reform of Regulation of Drugs and Medical Devices to Promote the High-Quality Development of the Pharmaceutical Industry, National Medical Products Administration (2025).
[190] FDA 101: Overview of FDA's Regulatory Review and Research Activities, U.S. Food and Drug Administration (2024).

more siloed institutions have narrower responsibilities and do not yet see themselves as front-line actors in strategic competition.

China lists bioagriculture as a strategic national priority.

Bioagriculture remains a strategically significant field of biotechnology due to its role in food security and safety, but Chinese state prioritization surpasses that of the United States resulting in greater direct state intervention. Due to long-standing food security fears stemming from China's large population and historical experiences with famine, the Chinese state has treated bioagriculture as a "priority scientific field" in industrial policy since 1986.[191] After China became a net food-importer in 2004, fears of political instability have been heightened by the possibility that dependence could be weaponized in the future.[192] Thus, the CCP has made it a national priority to boost domestic agricultural efficiency and production in order to reduce reliance on foreign agricultural trade, something it sees as instrumental to both national and regime security.

However, bioagriculture and genetically modified (GM) crops have suffered previous backlashes in China over fears of potential health risks, which prevented their earlier large-scale commercialization despite successful Chinese development of GM crops.[193] This contrasted sharply with initial American attitudes; while controversial, the legalization of patents on bioengineered life led to rapid wide-spread adoption of GM crops throughout the 1990s and positive consumer reception.[194] While public opinion turned in favor of greater regulation and labeling of GM products, there remained greater consumer acceptance in the United States than, for example, Europe.

Since 2022, the dynamic in China has completely reversed. The 14th Five-Year Plan for Bioeconomy Development released that year made bioagriculture modernization a key pillar of China's biotechnology policy, with an emphasis on biotechnology-enabled productivity.[195] The 2022 approval of GM corn and soybeans by the Ministry of

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[191] 高技术研究发展计划 (863计划) 纲要) [National High Technology Research and Development Program (863 Program) Outline], Central Committee of the Chinese Communist Party and State Council of the People's Republic of China (2012).

[192] China's Genetically Modified Dilemma, Asia Society Policy Institute (2024).

[193] Zhihua Xiao, et al., Biotechnology in China – Regulation, Investment, and Delayed Commercialization, GM Crops & Food (2022).

[194] Jan Lucht, Public Acceptance of Plant Biotechnology and GM Crops, Viruses (2015).

[195] Bioeconomy Prominent on Growth Agenda, The State Council of the People's Republic of China (2022).

Agriculture and Rural Affairs (MARA) paved the way for broader adoption in China and growing comfort from the public.[196] The 15th Five Year Plan emphasizes movement from basic research and controlled pilots towards large-scale commercialization of agricultural biomanufacturing, with accompanying reforms to IP law.[197]

The U.S. bioagriculture industry, being more mature than China's, benefits from more consistent statutory regulations. Responsibility for agricultural biotechnology is split between the U.S Department of Agriculture (USDA), U.S. Environmental Protection Agency (EPA), and the FDA, who perform both regulatory oversight and support for research and commercialization. The U.S. regulatory framework typically takes a risk-based approach for genome-edited plants specifically, as the FDA and EPA recommend firms engage the government preemptively on safety issues.[198] On intellectual property, the NMPA began mirroring U.S. policies like pharmaceutical patent linkages, patent term extensions (PTE), patent term adjustments (PTA), and greater IP enforcement and arbitration; a sign of respect for America's regulatory dominance.

Yet despite America's strength in regulation and intellectual property rights, there remains no central strategy for government-wide investment in bioagriculture development akin to the PRC. China has chosen to ramp up support across a span of biotechnology fields while the United States has treated these other subdomains with little urgency in terms of direct government support or funding.

The United States and China are beginning to securitize biotechnology.

As with many dual-use emerging technologies, the strategic value of biotechnology has led both sides to consider increasing securitization of the industry. But as of now, the biotech industry is still highly globalized and dependent on a web of international partnerships that make defensive statecraft and intense securitization difficult to impose on firms with close ties to foreign partners.

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[196] China MARA Issues Final Registration Data Requirements for Herbicides on GM Crops, CIRS Group (2022).

[197] Translation: Proposal of the Central Committee of the Chinese Communist Party on Drawing Up the 15th Five-Year Plan for National Economic and Social Development, Center for Security and Emerging Technology (2026).

[198] Statement of Policy: Foods Derived from New Plant Varieties, U.S. Food and Drug Administration (1992).

Despite this, the United States has advanced a number of defensive measures to protect its own biotech industry. The BIOSECURE Act, passed in 2025, bars U.S. federal agencies or federal funds recipients (with few exceptions) from purchasing biotechnology equipment or service from a "biotechnology company of concern" (BCC), relying on the Pentagon's 1260H list of Chinese firms with military ties.[199] This list continues to expand today. The Bureau of Industry and Security (BIS) also placed export control restrictions in 2025 on specific dual-use laboratory hardware such as flow cytometers and liquid chromatography-mass spectrometers that are used to produce high-quality datasets for AI systems that build biological products.[200] But data security remains inconsistent and outdated across the American government's biological data resources, and will require a whole-of-government effort to upgrade.

China has itself built up defensive state capacities in biotech, most notably towards genomic data.[201] The Chinese government has identified genomic data as a key risk for foreign exfiltration of sensitive "national" data since 1998, when the state started to require approval for the collection and outbound dissemination of human genetic resources (HGR) during international cooperation.[202] This fear was heightened after a 2018 scandal over gene-edited infants showcased the weakness of the regulatory system and the central government's lack of control over the field, spawning tighter regulation and increasingly centralized oversight of all human genetic data through the 2020 Biosecurity Law.[203] Beijing has since established a far-reaching regulatory regime focused on biosecurity, data exfiltration, and cross-border data flows while standing up national-level gene banks that act as a central repository for state collection of all HGR in China.[204] As a result, China's national efforts to both collect and securitize genomic data have surpassed any other country in scope and intensity and deserve greater scrutiny from countries and firms that share genomic data with China.

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[199] Public Law 119-60, National Defense Authorization Act for Fiscal Year 2026, (2025).

[200] Jack Burnham, et al., New U.S. Export Controls Seek to Prevent China From Weaponizing Biotech, Foundation for Defense of Democracies (2025).

[201] China Tightens Exit Rules Over Tech Security Risks, Reuters (2026).

[202] 人类遗传资源管理暂行办法 [Interim Measures for the Administration of Human Genetic Resources], Ministry of Science and Technology and Ministry of Health of the People's Republic of China (1998).

[203] China Unveils New Rules on Biotech After Gene-editing Scandal, STAT News (2019).

[204] Christopher Nye, et al., Beijing's Asymmetric Securitization of Genomic Data, The Jamestown Foundation (2026).

Outlook: Wildcards and What to Watch

Each nation's trajectory is far from fixed. The biotechnology competition is unfolding across subfields with different timelines, different capital requirements, and different sensitivities,which means the balance can quickly shift some places and can shift in either direction. For instance, bioagriculture is a field shaped by a few commercial giants and heavy state-backed investment, whereas biopharmaceuticals are driven in large part by the market ecosystem and input flows. The incentives for each biotech subdomain differ, and certain variables could materially affect future leadership.

How will AI-assisted biology change the pace of innovation?

A core question in biotechnology today is how quickly AI will collapse the gap between hypothesis and validated candidate. Historically, identifying a promising molecule meant testing enormous numbers of candidates empirically, because the underlying biology was too complex to predict.[205] That constraint is eroding with new biological design tools. Protein structure prediction that once took months or years now takes days, and hundreds of millions of structures have been characterized computationally.[206] As models improve at predicting how a molecule will behave before it is synthesized, the expensive early stage of discovery shrinks, and the number of candidates a given laboratory can generate rises sharply.

This is usually framed as an American advantage, and in the near term it is. The leading foundation models are American, and the deepest basic research base is American.[207] But the advantage is not automatic. AI shifts the binding constraint from insight to data, and the country with the largest and most legally accessible biological datasets is positioned to benefit disproportionately as models scale.[208] China is gaining ground in that respect. Compressing discovery also raises the relative value of everything downstream. If generating a promising candidate becomes cheap and fast, competitive advantage migrates toward the ability to test, manufacture, and commercialize candidates at speed.

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[205] Monica Schenone, et al., Target Identification and Mechanism of Action in Chemical Biology and Drug Discovery, Nature Chemical Biology (2013).

[206] Sarah Manoj, How AlphaFold Revolutionized Protein Structure Prediction, BioInnovation Group at UC Davis (2026).

[207] Research and Development, Stanford Human-Centered Artificial Intelligence (2025).

[208] Michelle Holko, et al., AI-Ready Biodata Is America's Next Strategic Infrastructure, War on the Rocks (2026).

The U.S. advantage in biotech has thrived from a head start in R&D, but AI could help China make up for decades of lost time. The combination of AI-enabled design and industrialized production could enable China to convert a research position into a commercial one quickly. Whether the United States retains its edge depends both on model quality and how quickly it can move a computationally generated candidate through trials, approval, and manufacture before a competitor improves on it.

Can the United States meaningfully reduce its pharmaceutical supply chain exposure?

American dependence on Chinese key starting materials and APIs is the most acute vulnerability. Full reshoring is unlikely, largely because the production of key starting materials generates hazardous waste at volumes that violate U.S. environmental regulations.[209] Reshoring is a possible solution for a narrow set of critical molecules, but not a general standard.

Diversifying into allied manufacturing capacity offers a path to mitigate this dependence. By leveraging existing biologics and generic production in nations like India, Japan, and various European partners, the United States may be able to dilute this single-source exposure and improve supply-chain resilience.[210]

Another path is technological substitution. Biomanufacturing can produce through fermentation what traditional synthesis produces through multi-step chemistry, and doing so avoids many of the toxic intermediates that made the original offshoring attractive.[211] As many as half the drugs on the FDA's essential medicines list could in principle be produced this way.[212] This path would require sustained capital for pilot and commercial-scale fermentation capacity, and whether it materializes would be dependent on American investment.

What happens if the next blockbuster drug originates in China?

A single therapeutic class can reorder an industry's economics. GLP-1 receptor agonists demonstrated this within a few years, generating revenues large enough to reshape

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[209] Jack Leimann, Onshoring Pharmaceutical Manufacturing: Ambiguity Complicates Potential Success, American Action Forum (2026).

[210] Thomas J. Bollyky, et al., The Pharma Choke Point, Council on Foreign Relations (2026).

[211] Sarah Houlton, Biomanufacturing Proliferates in Chemicals, Royal Society of Chemistry (2025).

[212] Charting the Future of Biotechnology, National Security Commission on Emerging Biotechnology (2025).

corporate valuations, capital allocation, and national trade balances.[213] That dynamic is not intrinsically American, and could be replicated if China produced a similarly blockbuster-sized drug. The wildcard could be the next one, whether it be an effective Alzheimer's therapy, a breakthrough oncology platform, or another–originating in a Chinese laboratory and commercialized by a Chinese firm.

While a blockbuster drug commands tens of billions in yearly revenue, the strategic concern lies in the subsequent reinvestment of those profits. The revenue from that drug would fund the next decade of Chinese research, draw in senior researchers who follow resources and prestige, and supply the one thing Chinese biotechnology currently lacks: demonstrated ability to carry an asset from discovery to approval and commercialization without a Western partner. That capability is the difference between a research power and a biopharmaceutical power.

The other concern is the American response to such an innovation. If a vital therapy emerges that becomes essential to the U.S. patient population, the pricing and supply terms are set by a firm operating under a government with a history of restricting access to strategically important goods when it suits them.[214] This vulnerability mirrors the active pharmaceutical ingredient (API) dependencies, but now it refers to an essential, high-value product.

Currently, out-licensing agreements serve as the bridge for Chinese innovations to enter the U.S. market, but the structure of these contracts is evolving.[215] A transition away from offloading early-stage candidates toward retaining late-stage assets through final approval would signal that the evolution from discovery partner to comprehensive global competitor is nearly complete.

[213] Obesity Drugs Are Scaling Fast, Morgan Stanley (2026).

[214] Thomas J. Bollyky, et al.,The Pharma Choke Point, Council on Foreign Relations (2026).

[215] Kelly Bilodeau, Amid a Flurry of Biotech Deals, China Looks to Keep Innovation at Home, PharmaVoice (2026).

Conclusion

Leadership in biotechnology spans many categories and metrics, yet the nature of the competition remains critical. The United States enters this race with key advantages. Its lead in innovation emerges from a thriving academia-industry research ecosystem, a strong commercial marketplace, and a robust talent pipeline. But China's decades of strategic planning have paid off, and the results of that investment are only starting to show. China's edge in manufacturing and industrial capacity is an advantage difficult to match, and it is advancing quickly on talent recruitment, market buy-in, and novel discovery. The U.S. lead in biotechnology is not inevitable. Based on current trajectory, China will inch ahead by the end of the decade.

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Appendix I: Tech Scorecard Matrix

The Tech Competition Scorecard relied on expert scoring of quantitative and qualitative data across many technology-specific metrics relevant to each category of positional advantage in biotechnology. Final scores were determined by a weighted average of the metric scores below. The 1-to-5 ranking corresponds to the following rubric:

1) Negligible / Nascent: The country has minimal presence or capability in this metric. The data point is insignificant on a global scale.
2) Emerging / Minor: The country is active but below the global average or industry standard. They are followers or niche players. Performance is functional but clearly inferior to top-tier competitors.
3) Competitive / Mainstream: The country operates at the global industry standard. The metric represents a healthy, functioning ecosystem that meets current market needs but does not differentiate itself as superior.
4) Advanced / Leading: The country is among the top tier globally. The metric shows performance, scale, or quality that exceeds the average and rivals the best.
5) State-of-the-Art / Dominant: The country sets the global benchmark. This metric represents the absolute peak of what is currently possible.

	Metric	Source(s)	Weight	U.S. Score	China Score
Innovation Leadership	Share of highly cited publications in biotechnology	OpenAlex; ITIF	Medium	4	5
	Citation rate of biotechnology publications	OpenAlex	Low	4	5
	Institutional ranking for biological sciences	Nature	Medium	4	5
	Biotechnology and pharmaceutical patent applications filed annually	WIPO IP Statistics Data Center	Low	4	4

	International PCT biotechnology and pharmaceutical patent applications filed	WIPO IP Statistics Data Center	Medium	5	4
	Total patents granted in biotechnology and pharmaceuticals annually	Lens	Low	4	4
	Private R&D biotechnology investment	ITIF	Medium	5	3
	Share of early-stage drug development programs	JAMA	Medium	5	5
	First-in-human drugs introduced to clinical trials	ScienceDirect	Medium	5	5
	Share of global drug pipeline	GlobalData	Medium	5	4
	First-in-class domestic drug approvals yearly	CDER; NMPA	Medium	5	2
	Total drug approvals yearly	CDER; NMPA	Low	5	5
	Animal species approved for genetically modified food production	SCSP Analysis	Low	4	1
	International genetically modified crops approved	ISAAA GM Approval Database	Medium	5	3
	Novel biopesticide active ingredient approvals	EPA; ICAMA	Low	4	3
Industrial Capacity	Share of domestic pharmaceutical production	Bureau of Labor Statistics; ChemLinked	Low	3	5
	Share of global biomanufacturing market	MERICS	Medium	4	2
	Share of global pharmaceutical production	Fortune; Mordor	Medium	4	3
	DNA sequencing and synthesis equipment capacity	Carnegie Endowment; Grandview	Low	4	4
	Genetic database capacity	Carnegie Endowment	Low	4	4

	Feedstock capacity	Carnegie Endowment	Low	3	3
	Share of active pharmaceutical ingredients (APIs) for the U.S. market	DrugPatentWatch	Medium	2	4
	Cost of clinical trials	Clinical Trials Arena	Low	3	5
	Number of clinical trials	WHO International Clinical Trials Registry Platform	Low	5	5
	Speed of clinical trials	Clinical Trials Arena	Low	3	5
	Life sciences lab capacity	CBRE Research	Medium	5	4
	Trade balance in antibiotics	UN ComTrade	Low	3	5
	Trade balance in vitamins	UN ComTrade	Low	1	5
	Trade balance of lab intermediates and materials	ScienceDirect	Low	4	2
	Trade balance of amino acids	UN ComTrade	Low	2	5
	Land area production of genetically engineered crops	UN ComTrade	Medium	5	3
Market Ecosystem	Global private investment into biotechnology	PitchBook	High	5	3
	Share of out-licensing deal value	SynBioBeta	High	4	5
	Blockbuster deals	SynBioBeta	High	5	5
	Share of global pharmaceutical exports	UN ComTrade	Low	3	1
	Domestic private investment into biotechnology	CrunchBase	Low	5	2

	Biotechnology companies in the Global 2000	Forbes	Low	5	4
	Number of unicorns	PitchBook	Medium	5	3
	Number of startups	Pitchbook	Low	5	3
	Number of IPOs	Citeline	Medium	5	5
	Average biotech company valuation	Pitchbook	Low	4	5
	Market growth rate	Grandview	Low	4	5
	Share of global market in biotechnology and pharmaceuticals	Fortune; IQVIA	Medium	5	2
	Share of university patents which are commercialized	ScienceDirect; China Patent Survey Report	Low	4	2
Talent Pipeline	Share of highly cited researchers in biotechnology relevant fields	Clarivate	Medium	5	3
	Annual doctoral degrees awarded in math and science	NSF	Medium	4	4
	Stay rates of U.S.-trained doctoral scientists and engineers	NSF	High	4	3
	Collegiate iGem gold medals	iGem	Low	4	5
	Performance in the International Biology Olympiad	IBO	Low	4	4
	Median total compensation for the field	Glassdoor	Low	5	4
National Leverage	Strength of national government strategy	SCSP Analysis	High	3	5

	Government spending on biotechnology R&D	USASpending; MERICS	Medium	5	4
	Investigational New Drug (IND) approval timelines	FDA; KPMG	Low	5	5
	New Drug Approval (NDA) approval timelines	KPMG: NMPA	Low	4	4
	Government-backed investment into biotechnology	ASPR; NBER	Medium	3	5
	Global clinical trial and evaluation standards	SCSP Analysis	High	5	4
	Influence on international standards	ISO; ICH; WHO; CODEX	Low	4	4