China's Health Sector Ambitions and Information Needs: Implications for U.S. Health Care Cyber Defense

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Foreword and Acknowledgements

What began as a research project in the 1960s at the Advanced Research Projects Agency (ARPA), as it was then known, evolved by the end of the twentieth century into a technology revolution never anticipated. The result of new technologies connected to computers and now the Internet has been the most significant paradigm change since the invention of movable type in the 15th century. Most communications and information operations now take place on systems connected to the Internet with all major sectors including health care highly dependent on this critically important infrastructure.

Dependencies on the Internet infrastructure make health care operators and patients vulnerable to criminals and potential state adversaries such as China. Early efforts to develop what became the Internet involved only networking scientists and did not take security into account. Providing connectivity despite losses of infrastructure or malicious behavior—was a chief design consideration. Data confidentiality was seen as dependent on physical connections such as dedicated cable lines. The ARPAnet and the successor Internet were insecure and vulnerable to hostile attacks of all kinds. Together with crime, espionage and cyberwarfare, cyber attacks have become a substantial national security problem and a major threat to the health care sector.

Significant cyber threats now come from China, Russia, Iran and others. China recruits skilled personnel, develops malicious code, and prepares for hostile cyber operations. The PRC has greatly expanded its cyber capabilities in the areas of espionage, deception, and disruption. Here the vast U.S. attack surface and cybersecurity vulnerabilities in all major sectors could invite a major cyber-attack or "Digital Pearl Harbor" devastating the nation's ability to provide health care.

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Executive Summary

Cyber vulnerabilities involve risk management; perfect cybersecurity is impossible with currently deployed technologies. At present, it is therefore impossible to defend against all Chinese, state-backed or non-state-backed cyberattacks on the health care sector. China's ever-expanding arsenal of potential methods for cyberattacks is too sophisticated to be completely blocked. It also is prohibitively expensive to invest in perfect resiliency for all vulnerable sectors of the U.S. healthcare system. As with all aspects of risk management, prioritization of resources spent on resiliency and defense is crucially important to protecting the safety and privacy of U.S. citizens and the assets of the U.S. biotechnology and health care sectors.

China studies cyber security in a similarly serious and comprehensive fashion. China's concept of Military-Civil-Fusion (MCF) is an example. Military-Civil-Fusion integrates and coordinates activities of the military and intelligence arms of the PRC government in collaborations with commercial and academic entities to pursue centrally formulated goals.[1] Military-Civil-Fusion is not limited to industries that typically are associated with the military. Research projects studying topics from cancer care to trauma care are studied at PRC military hospitals.

The 2024 Change Healthcare attack demonstrated the vulnerability of U.S. citizens' personal medical data.[2] These attacks, which the Chinese government is believed to have sponsored, leaked sensitive data relating to one in every three Americans online. The attacks may directly benefit China's economic competitiveness. Biomedical data are among the most valuable pieces of intellectual property to biotechnology researchers, whether academic, commercial, or military. Attacks on third party vendors such as Change Healthcare therefore present a major national security issue for the United States. Such attacks target the two types of U.S. intellectual property at most risk in the health care sector: vaccine research and medical data.

China's stated plan is to dominate the bioeconomy by aggregating medical data.[3] At the same time China is not spending nearly as much money attaining that data through typical research efforts as its central role in industrial policy would suggest is needed. Most research spending pouring into the sector is going to applications of biomedical "big data" to relevant end goals. At the same time, attacks that are likely from PRC state-sponsored hackers acquiring enormous quantities of U.S. biomedical data are seen.

[1] See *China' Cyber Power and Military-Civil Fusion* (New York: Margin Research, 2023).

[2] Change Healthcare. (July 31, 2024). Change Healthcare HIPAA Substitute Notice. HIPAA Website Substitute Notice. https://www.changehealthcare.com/hipaa-substitute-notice

[3] "'十四五'生物经济发展规划 [The 14th Five-Year Plan for Bioeconomic Development]," *National Development and Reform Commission,* December 20, 2021. https://www.gov.cn/zhengce/zhengceku/2022-05/10/content_5689556.htm.

Hacking may be the easiest and least expensive way to obtain valuable data, and the PRC has a long history of both hacking and data theft. Successful attribution, indictment and even arrest of Chinese hackers have not deterred China.[4] A great deal of valuable medical data, especially data describing expensive medical testing or treatment, is American. Due to both privacy and national security concerns, the easiest way to obtain such sensitive U.S. data is to steal it. The PRC priority placed on medical data means that to protect the competitive position of the U.S. biomedical sector and the medical privacy of U.S. citizens requires the protection of the data of parties not directly providing care or undertaking research.

China sees developing epidemic and pandemic resilience and gaining influence in international health decisions related to infectious diseases as shorter term goals framed as directly relevant to national security.[5] Thus, the PRC likely will continue to steal data directly relevant to vaccine manufacturing.[6] Two sectors to watch for direct theft are areas upstream of biological data, such as medical devices, genetic testing, and areas with highly specialized data sets or a limited ability to be analyzed with existing computer technology.

In general, areas that support goals that are long term and that this study has determined to be low priority such as the integration of biotechnology and information technology are less likely to be the subject of direct cyberattack. It is unlikely, for example, that China will burn zero day attacks on data related to personalized medicine or stem cell therapies, two low priority long term goals.

Why might China focus cyber-attack efforts on biomedical data rather than direct sources of biotechnology?

China currently faces simultaneous civil and economic crises related to its own health care sector. These crises include China's low fertility rate, aging labor force, lack of economically sustainable pandemic readiness, and the welcoming of non-Chinese nationals into the Chinese health care sector. China is also in the midst of a housing bubble collapse and in deep local government debt. Here China frames each of these issues in terms of national security and invokes principles of Military-Civil-Fusion while addressing them.

Immediate military and industrial policy interventions likely will not be enough to bring these economic and social crises to an end. Each of these problems involves health care, requiring a different intervention from the medical and biotechnology sectors. China itself says it is years

[4] See Abraham Wagner and Nicholas Rostow, *Cybersecurity and Cyberlaw* (Durham: Carolina Academic Press, 2021).

[5] "中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要 [Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035]," *Xinhua News Agency,* March 12, 2021. As translated by CSET, Georgetown, May 13, 2021. https://cset.georgetown.edu/publication/china-14th-five-year-plan/.

[6] "Two Chinese Hackers Working with the Ministry of State Security Charged with Global Computer Intrusion Campaign Targeting Intellectual Property and Confidential Business Information, Including COVID-19 Research," Department of Justice Office of Public Affairs, July 21, 2020. https://www.justice.gov/opa/pr/two-chinese-hackers-working-ministry-state-security-charged-global-computer-intrusion

behind the United States in these fields.[7] On the other hand, simply stealing intellectual property relevant to fertility, diseases affecting older workers, and expensive pharmaceuticals will not enable China to develop an indigenous state-of-the-art healthcare and pharmaceutical industry that is capable of producing its own state of the art health care systems and pharmaceuticals.

Despite China's formidable record in replicating foreign products and methods, even those having to do with advanced weaponry, formulae for drugs and devices are too diverse to steal in quantities that will make an impact on PRC public health. Stealing formulae may assist Chinese manufacturing over time, but theft by itself is not enough. China understands that it will need expertise in order to be dominant in biotechnology and provide solutions to fix its internal health-related issues. In an earlier era China stole U.S. nuclear weapons design information and had the expertise successfully to manufacture its own nuclear weapons based on the stolen information.[8]

According to China's official planning documents, instead of attacking the majority of downstream health-related goals head-on, the PRC will instead attempt to control their upstream access to big medical data and downstream to the medical sector. Using the leverage unique access to a diverse and integrated set of big medical data would provide, China plans to dominate the midstream and downstream expertise and manufacturing in the medical sector by using big data analysis techniques to discover new potential medical interventions. Creating that unique set may rely on a willingness to steal, a lack of privacy concerns, and an exchange of cheap services in the biomedical sector for access to medical data.

[7] "美国和中国三代试管婴儿差距在哪？两者差距主要在医疗设备 [What is the difference between the third-generation test-tube babies in the United States and China? The difference between the two is mainly in medical equipment]," *National Health Network*, December 29, 2023. https://www.qm120.com/zt/baike/8915.html

"为何中国脑梗越来越多，美国却在减少？做好这2点比补叶酸更关键 [Why are strokes increasing in China but decreasing in the United States? Doing these two things is more important than taking folic acid]," *39 Health,* January 3, 2024. https://heart.39.net/a/240103/d6lfxpa.html

[8] See the 1999 "Cox Report" of the House of Representatives Select Committee on U.S. National Security and Military/Commercial Concerns with the Peoples Republic of China, especially chapter 2. House Report 105-851. https://www.govinfo.gov/content/pkg/GPO-CRPT-105hrpt851/pdf/GPO-CRPT-105hrpt851.pdf

1. Introduction

China's proven capacity to produce and employ frequent 0-day attacks[9] means that creating resilience and targeted defense is a necessary part of defending the vulnerable health data of U.S. patients and the intellectual property of the U.S. healthcare sector. But building resilience and targeted defense is expensive and difficult. To guide spending, it is useful therefore to attempt to predict which sub-sectors of the health sector that are most likely to be hit by PRC state sponsored cyberattacks.

A recent attack on Change Healthcare, a healthcare technology company specializing in healthcare payments and revenue cycles, exposed the sensitive data of about a third of U.S. residents. It included sensitive health information such as diagnoses and medical imaging, as well as personal information like social security numbers.[10] In the immediate aftermath, hospital systems shut down before transitioning to alternate systems.

Hackers deployed ransomware on February 21st, and by April 10th, 36% of medical practices reported suspension in claim payment; 32% were unable to submit claims; and 22% were unable to verify eligibility for benefits.[11] This presented an especially serious issue for small practices with limited savings and access to IT personnel and alternate technology.

These attacks, which are believed to have been sponsored by China, took advantage of previously stolen credentials, legacy technology, and a lack of two-factor authentication. Each of these insecurities is easily fixable with enough attention and resources. But attention and resources can be hard to come by. It could also have been easily predicted that PRC hackers would target Change Healthcare. Not only does it represent U.S. critical infrastructure, Change Healthcare also holds data that is of great value to the PRC biotechnology sector.[12] That PRC sponsored cyber attackers were poking around Change Healthcare may not be a coincidence.

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[9] Cybersecurity and Infrastructure Security Agency CISA. (July 25, 2024). Chinese State-Sponsored Actors Compromise and Maintain Persistent Access to U.S. Critical Infrastructure. https://www.cisa.gov/news-events/cybersecurity-advisories/aa24-038a.

[10] Change Healthcare. (July 31, 2024). Change Healthcare HIPAA Substitute Notice. HIPAA Website Substitute Notice. https://www.changehealthcare.com/hipaa-substitute-notice

[11] "Change Healthcare Cyberattack," *American Medical Association,* May 20, 2024. https://www.ama-assn.org/practice-management/sustainability/change-healthcare-cyberattack

[12] Change Healthcare. (2024, July 31). Change Healthcare HIPPA Substitute Notice. HIPAA Website Substitute Notice. https://www.changehealthcare.com/hipaa-substitute-notice.

As noted in HC3 reports,[13] Chinese state sponsored cyberattacks frequently support its industrial policy. This is due to Military-Civil-Fusion (MCF) policies that aim to use military (and academic) resources to benefit PRC commercial sectors. Military, research, and industrial policy are each guided and funded by the same central planning, meaning that by understanding how central planning documents—which direct local governments and those in commercial sectors, and tracking how government-funded research dollars are distributed in the PRC ecosystem,[14] it is possible to understand China's industrial policy priorities, and in doing so understand which sectors industrially motivated cyberattacks are most likely to target.

Because most cyberattacks are crimes of opportunity, this method of analysis has inherent limitations. Typical cyberattacks will often occur where corrupted software is in use, regardless of motivation. Valuable 0-days are, however, used more selectively. Understanding the types of data in which Chinese actors are most interested can allow us to give special attention to software that state-sponsored hackers are most likely to selectively target and better manage the data supply chains in those sectors.

[13] "North Korean and Chinese Cyber Crime Threats to the HPH" Health Sector Cybersecurity Coordination Center, Office of Information Security, September 21, 2023. https://www.hhs.gov/sites/default/files/dprk-chinese-cyber-crime-threats-us-hph.pdf.

[14] Elsa B. Kania, Lorand Laskai, "Myths and Realities of China's Military-Civil Fusion Strategy," *Center for a New American Security*, January 28, 2021. https://www.cnas.org/publications/reports/myths-and-realities-of-chinas-military-civil-fusion-strategy.

2. Preliminary Conclusions

A major objective of the present analysis is to enable those concerned about potential vulnerabilities within their own sectors to evaluate the data provided. Examining the data available with respect to China, however, yields two immediate fields to consider carefully because of an asymmetry between their role in the PRC plans and their actual funding. These are bioinformatics and biomedical big data and vaccine development, public health, and immunity. These fields play a role in PRC planning documents that is far more prominent than their actual funding can justify, but also satisfy a crucial role in those plans and makes the use of nefarious means especially likely.

Target Tier List

Primary Targets	Infectious disease IP	Software necessary to analyze big biomedical data	Easily formatted biomedical data	Technology upstream of medical data
Secondary Targets	IP in areas that require more specific biomedical data e.g. neuroscience	Reproductive Medicine (Fertility)	Trauma Care (War)	Cheap care for older adults (Aging Workforce)
Less Likely Targets	Personalized Medicine	Stem Cell Therapy	Expensive Cancer Care	Hard to produce pharmaceuticals

Bioinformatics and Biomedical Big Data

Although bioinformatics and biomedical big data is the only upstream subfield of medical biotechnology to receive its own section in China's 14th Five Year Plan for Development of the Bioeconomy, it has few dedicated projects and laboratories contributing to its success. This makes any biomedical data that can be easily integrated into large datasets and biomedical models a highly valuable target for Chinese hackers.

Vaccine Development, Public Health, and Immunity

Similarly, data and biotechnology IP related to vaccine development, viral disease testing, public health and immunity are not especially well-funded in projects even though these subfields are highly prioritized in planning documents and have several labs devoted to their research. Their subfields are upstream of major national security goals such as influence in creating international health standards and resilience in the face of future epidemics and pandemics that receive their own sections in the *Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035*, China's main planning document for the five-year period.

Other areas such as neuroscience, pharmaceuticals, genetics, and oncology receive an extraordinary amount of funding in the PRC system along with many devoted laboratories and therefore don't present the same asymmetry. In China, projects and laboratories in these fields are also frequently supported by the expertise of scientists who have left their home countries or scientists who grew up in the PRC but have extensively studied abroad.[15]

Scientists in these fields, and especially those with connections to the PRC, are more likely to be targeted by the Chinese government in attacks involving blackmail. Institutions should help safeguard their scientists against these attacks.

[15] For a detailed breakdown of biotechnology funding in China, please see Section Six. For the complete dataset used, please see the appendix.

3. The Health Sector in Chinese Industrial Policy

Military-Civil-Fusion (MCF) is China's overall policy for integrating the nation's military, commercial, and academic sectors.[16] This kind of integration is not unique to China, in fact, Military-Civil-Fusion was designed to emulate the U.S. military's success, but two key distinguishing factors between PRC MCF and the U.S. military industrial complex are scope and mandate.[17] Recent Chinese policy leverages military tools to give direct support to commercial entities only tangentially related to defense.

In return, it expects those entities to support national security goals. Through the lens of MCF, the CCP views every major entity in China as part of one unified national plan. Entities that fail to aid the PRC national project when called upon swiftly lose favor, and soon after may lose their funding as well. At times even their leaders have been arrested on trumped up charges or are simply no longer shielded from legitimate law enforcement.

In practice, in biotechnology, the policy of Military-Civil-Fusion drives the use of PRC cyberattacks to contribute to China's health and biotechnology sectors, both of which are viewed as national security concerns.[18] Many analysts[19] have noted that the PRC prioritizes genetic testing technology, exporting genetic testing, and controlling genetic data. China plans to use this data,

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[16] See *China's Cyber Power and Military-Civil-Fusion, op. cit.*

[17] Elsa B. Kania, "In Military-Civil Fusion, China is Learning Lessons from the United States and Starting to Innovate," *The Strategy Bridge*, August 27, 2019. https://thestrategybridge.org/the-bridge/2019/8/27/in-military-civil-fusion-china-is-learning-lessons-from-the-united-states-and-starting-to-innovate.

[18] Kelli Vanderlee, written testimony for the U.S.-China Economic and Security Review Commission, Hearing on China's Cyber Capabilities: Warfare, Espionage, and Implications for the United States, (February 17, 2022), p. 6.

[19] Julian E. Barnes, "U.S. Warns of Efforts by China to Collect Genetic Data: The National Counterintelligence and Security Center said American companies needed to better secure critical technologies as Beijing seeks to dominate the so-called bioeconomy," *The New York Times*, (October 22, 2021). https://www.nytimes.com/2021/10/22/us/politics/china-genetic-data-collection.html.

"China's Collection of Genomic and Other Healthcare Data from America: Risks to Privacy and U.S. Economic and National Security," *National Counterintelligence and Security Center,* February 2021. https://www.dni.gov/files/NCSC/documents/SafeguardingOurFuture/NCSC_China_Genomics_Fact_Sheet_2021revision20210203.pdf.

as expressed in national planning documents,[20] to train AI and use big data to break new ground in biotechnology.[21]

Here it is possible to show that China's interest in U.S. genetic data is just one side of its general interest in U.S. medical data. As a whole, the PRC plan to dominate the bioeconomy is reliant on controlling big medical data (including genetic data) by dominating the upstream bottleneck that is biological data collection. This strategy is stated in Chinese state rhetoric and mimics the successful strategy to gain a foothold in the Electric Vehicle (EV) sector by dominating the rare earth minerals sector.

Understanding the Medical Data Supply Chain:
A Brief Comparison to Rare Earth Minerals

Electric vehicles are reliant on batteries, which in turn are reliant on rare earth minerals. In the EV sector, the PRC used a combination of industrial policy and deregulation, and mineral reserves in China to capture the rare earth mineral market, driving other sources of rare earth minerals out of business. This monopoly on the upstream helped the PRC develop a monopoly on the midstream business of refining rare earth minerals into batteries. Batteries have many applications, but the capacity and reliability of a large battery is essential to the value of an electric vehicle.

Currently, China's grip on the rare earth mineral sector, industrial policy, and investment in battery production has allowed them to create the cheapest, best batteries available for purchase,[22] drawing in U.S. automakers like Tesla, and allowing companies like BYD to access their designs.[23] This is the model that China hopes to replicate for its biotechnology and health sectors.

Here, controlling sources of medical data runs parallel to controlling sources of rare earth minerals. These sources of data must be aggregated and processed into compatible formats and analyzed with AI and other big data analysis tools to create original biotechnology solutions. Genetic data is a key component of medical data, but it is not sufficient to capture all the PRCs health and biotechnology goals, nor is it necessary for many of them.

It is possible to think of genetic data within the medical data supply chain similarly to the role of nickel as a part of the rare earth minerals supply chain. It is necessary for quite a few key

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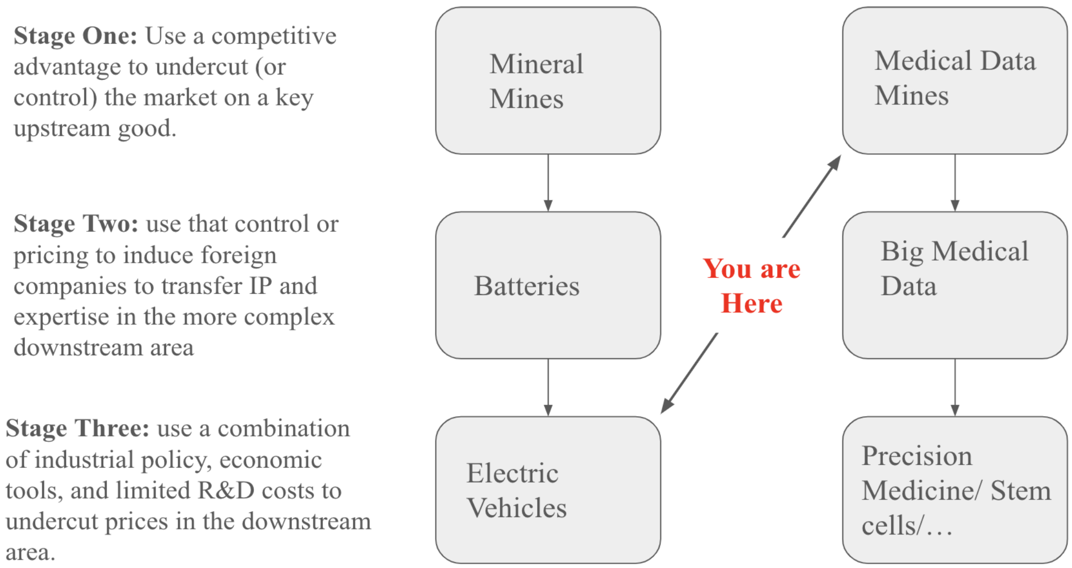
[20] "'十四五'生物经济发展规划 [The 14th Five-Year Plan for Bioeconomic Development]," *National Development and Reform Commission,* December 20, 2021. https://www.gov.cn/zhengce/zhengceku/2022-05/10/content_5689556.htm.

[21] "中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要 [Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035]," *Xinhua News Agency,* March 12, 2021. As translated by CSET, Georgetown, May 13, 2021. https://cset.georgetown.edu/publication/china-14th-five-year-plan/.

[22] "CCP Industrial Policy for the Auto Sector," *Horizon Advisory,* June 2021.

[23] James Ochoa, "Feds accuse enterprising duo of stealing and selling valuable Tesla IP," *TheStreet,* March 20, 2024.

projects, but not all of them, and it is important to focus on other minable commodities, whether minerals or medical data, as well.



In response to PRC plans for genetic information, proposed U.S. legislation would bar many Chinese biotechnology firms from extracting medical data from the United States,[24] and agencies like CFIUS prevent the sale of large tracts of U.S. biotechnology data to Chinese commercial entities.[25] Although this regulatory regime will likely remain imperfect, if enforced well enough, it may cause PRC state affiliated commercial entities to pursue the same information through less legitimate means.

Because of the nature of the PRC commercial system and its often intimate connections with the PLA, along with a history of PRC cyberattacks supporting state policy, it is more than likely that biological data collection goals will be supported by PRC state sponsored hackers.[26] This makes the likelihood of cyberattacks the highest in sectors that are both the most desired by PRC actors and the most well protected by U.S. regulatory entities.

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[24] United States Congress, House Committee on the CCP, "To Prohibit Contracting with Certain Biotechnology Providers, and for other Purposes," January 25, 2024. https://selectcommitteeontheccp.house.gov/sites/evo-subsites/selectcommitteeontheccp.house.gov/files/evo-media-document/text-biosecure-act.pdf 118th Congress 2nd Session, accessed July 15, 2024.

[25] United States Department of Defense "2023 Biodefense Posture Review," 2023. https://media.defense.gov/2023/Aug/17/2003282337/-1/-1/1/2023_BIODEFENSE_POSTURE_REVIEW.PDF

[26] "North Korean and Chinese Cyber Crime Threats to the HPH," *Health Sector Cybersecurity Coordination Center, Office of Information Security,* September 21, 2023. https://www.hhs.gov/sites/default/files/dprk-chinese-cyber-crime-threats-us-hph.pdf

Genetic testing data does not constitute all biological data that China is seeking. In order to understand their data sets' levels of vulnerability, U.S. companies should understand PRC development priorities, and the role their data might have in them. Analyzing which data is most at risk is therefore a two-fold process. First, it is necessary to decide which areas are most desired by PRC actors, and then we must decide which datasets are best protected. The ability of biological data to be used in big data or AI settings in order to accomplish specific PRC goals is, however, more specific to individual datasets than it is to sectors.

Similarly, how difficult it is to access that data by means other than theft is highly dataset specific. Here it is important to focus on the goals that China is pursuing in biotechnology that can best be supported with data theft in order to best allow those protecting data at individual companies holding U.S. medical data to assess their own specific security needs.

4. Methodology

According to a report by the Health Sector Cybersecurity Coordination Center, Chinese state-sponsored cyber-attacks often focus on sectors identified as priorities in five-year planning documents such as the Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035.[27] Planning documents have long represented the public aspirations of the CCP, but in more recent years China has come increasingly close to meeting those aspirations.

Still, these planning documents do not perfectly reflect PRC government spending or achievement. By observing the differences and similarities between China's long term aspirations, as reflected in their planning documents, and achievable goals, such as actual government spending on research and development, it then becomes possible to identify where China is falling behind its own goals, and where therefore, it could most use the boost that the major resource of a sophisticated cyberattack can provide.

In order to assess priorities in the PRC ecosystem, the research then diagrams sub-areas that are noted as areas for special prioritization in planning documents. These areas will be taken as our categories. Then the discussion below tags each biology or health-related government funding source with one of these tags or "Medical/Other." Once these funding sources have been tagged, it becomes possible to interpret differences between planning prioritization and actual funding.

Chinese Funding Sources Assessed

- National Level Research Institutions
  - National Laboratories
  - National and State Key Laboratories
  - Chinese Academy of Sciences Institutes
  - Chinese Academy of Sciences Centers for Excellence
  - Chinese Academy of Sciences Key Laboratories
  - Chinese Academy of Engineering Key Laboratories
- NNSFC Project Funding
  - National Key Research and Development Projects
  - General Projects
  - Youth Science Fund Projects
  - Regional Science Fund Projects
- Key International Cooperative Research Projects

[27] Health Sector Cybersecurity Coordination Center, Office of Information Security, *North Korean and Chinese Cyber Crime Threats to the HPH*, (September 21, 2023), https://www.hhs.gov/sites/default/files/dprk-chinese-cyber-crime-threats-us-hph.pdf

- The 8th batch of Single Champions, 2023
- Eastmoney.com Concept Stock Data, July 2024

Limitations

Biology and biotechnology are highly interdisciplinary fields. This makes reducing the work of any laboratory to a single subfield especially difficult. Since some subfields are more interdisciplinary than others, however, assigning more than one subfield per laboratory then overweighs those fields. For example, integration of biotechnology and IT (BT+IT) takes place in almost all other subfields, and it is often listed as a key component of lab's research that study genetics, neurosciences, medical devices, and pharmaceuticals, but it is rarely the primary subject of study.

This creates systemic error that undervalues BT+IT. On the other hand, if we were to include BI+IT everywhere that it was used even in passing, this would systemically overrate BT+IT and also overvalue the laboratories that use it. In addition, some subfields are more general than others. For example, "Biochemistry, Bioengineering, and Microbiology" is much broader as a category than Animal and Human Genetics.

Because of this, although there are 16 National Level Research Institutes studying "Biochemistry, Bioengineering, and Microbiology" and 11 studying Animal and Human Genetics, the number studying Animal and Human Genetics may be more relevant. As a result, the categorization above should be taken as an estimate of a breakdown of the field rather than an exact breakdown.

This is not to argue that datasets that China does not have an especial interest in are guaranteed safety and should not be protected. It is also not arguing that all PRC cyberattacks on the healthcare sector are motivated by data collection in support of a long-term plan. Even among state sponsored cyberattacks, crimes of opportunity are extremely common. Moreover, many politically motivated state sponsored attacks are not motivated simply by an interest in the information.

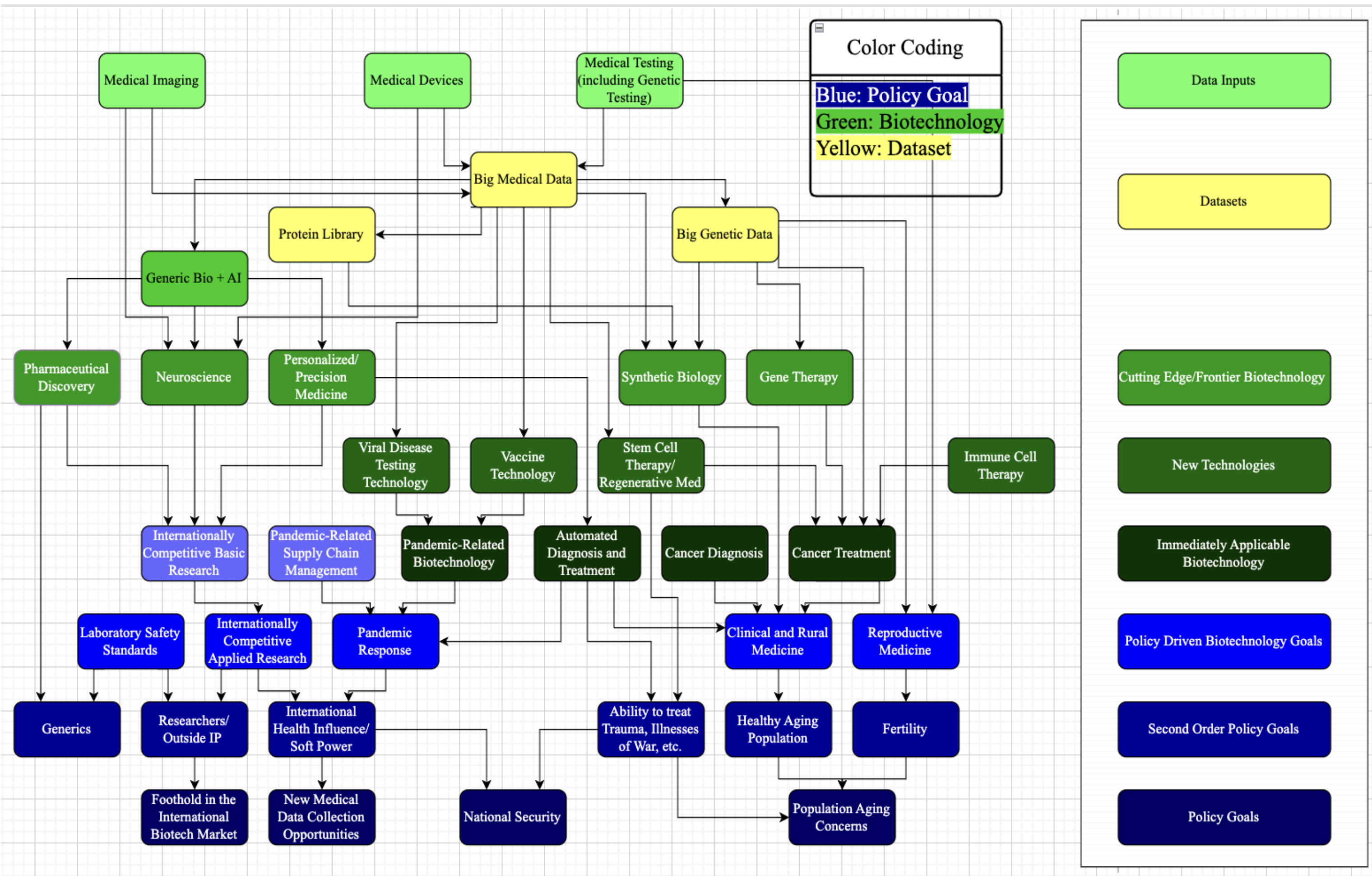
At times, adversarial nations estimate that the destabilization alone that a cyberattack causes can be used as deterrence against undesirable U.S. actions.[28] But understanding China's motivations can help prioritize spending on cybersecurity, alert biotechnology companies that they are at special risk, and aid in attribution efforts.

[28] See: the 2014 Sony Pictures Hack. Office of Public Affairs | North Korean Regime-Backed Programmer Charged With Conspiracy to Conduct Multiple Cyber Attacks and Intrusions | United States Department of Justice.

5. Planning Documents

China has four planning documents that are immediately relevant to its healthcare sector. These are the 14th Five Year Plan for the Bioeconomy, the 14th Five Year Plan for Pharmaceuticals, the Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035, and Healthy China 2030.

In the "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035" which serves as the overall planning document for the PRC, there is an emphasis on biosafety, the integration of biotechnology and big data, brain science, clinical medicine, rural medicine, medical supply chain management, and the application of genomic research to other fields. It also contains goals for healthcare such as treating an aging population, fertility treatment, scoping out a central role in international biosafety decision making, and public health self-reliance.



Above is a detailed diagram of the research and development supply chain outlined in the *Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035* and the *14th Five Year Plan for the Bioeconomy*, as well as goals laid out in *Healthy China 2030*, a pre-pandemic document that focuses on domestic health issues such as elder care. This chart is arranged from basic research in the upstream to policy applications in the downstream.

This diagram does not include priorities that are relevant to every sector such as quality control, and it excludes all priorities that are irrelevant to the health sector such as "bio agriculture," bioecology," and "biomass engineering." Here it is possible to see a much more serious priority placed on quality control and supply chains in the 14th Five Year Plan for pharmaceuticals. Notably, one end goal, "New Medical Data Collection Opportunities" makes this chart into a large cycle once it is successfully running.

Some areas of this chart are mentioned more frequently than others. Those are expressed in this secondarily color-coded chart which shows both sourcing and the level of prioritization in planning documents. Bubbles in green are sourced from the *Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035,* meaning that they contribute to policy objectives that are broader than subareas of biotechnology or health.

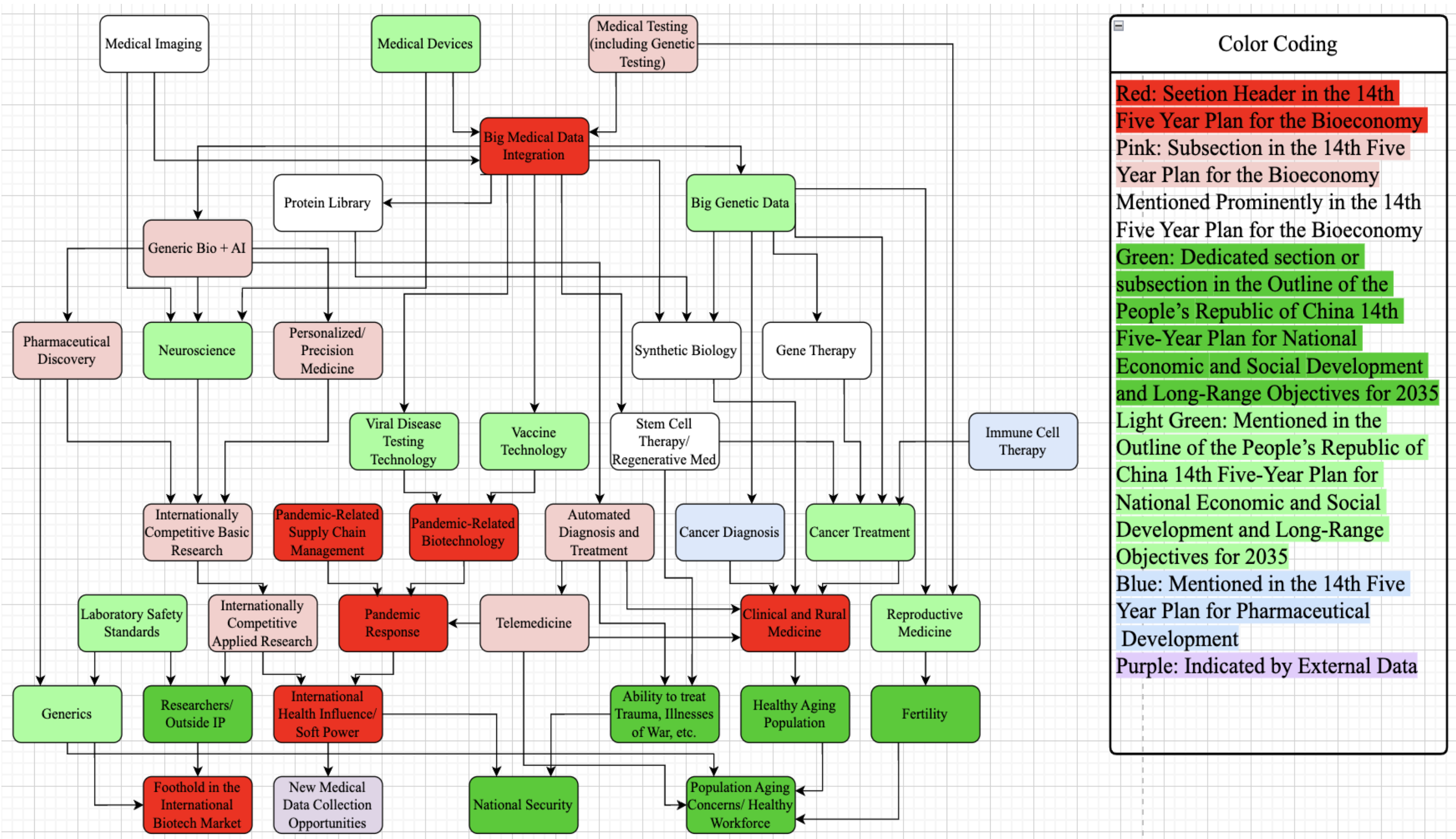
Those in red and white are more focused on biotechnology specifically, while goals in blue are more interested in pharmaceuticals. Finally, creating international Medical Data Collection Opportunities, while never explicitly mentioned in the 14th Five Year Plan for the Bioeconomy, is frequently alluded to.

In the sentence, "Promote the export of innovative drugs, **high-end medical devices**, **genetic testing**, **pharmaceutical R&D services**, traditional Chinese medicine, **internet diagnosis and treatment** and other products and services, and **encourage bio-enterprises to accelerate their integration into the international market by establishing overseas R&D centers, production bases, sales networks and service systems**," each of the bolded phrases would contribute to international collection.

It also appears to be a goal of "China's National Standard "Information Security Technology—Guide for Health Data Security 2020" as well as BGI's recent activity.[29]

[29] "Shenzhen-based BGI shot to global prominence last year after selling or donating millions of COVID-19 test kits and gene-sequencing labs outside China. U.S. security agencies warned this was part of an effort to collect large amounts of foreign genetic material. BGI said this year it has built 80 COVID-19 labs in 30 countries, which it plans to repurpose for reproductive health screening. It says its COVID-19 tests do not collect patient DNA. But its prenatal tests do." Clare Baldwin and Kirsty Needham, "China's gene giant harvests data from millions of women" *Reuters*, July 7, 2021. "China's National Standard "Information Security Technology—Guide for Health Data Security 2020" (GHDS) introduced the concept of a "limited data set," which stipulates that de-identified data could be used or disclosed without the PI subject's consent when used for scientific research, medical/health education, and public health purposes." Yao Y., Yang F., "Overcoming personal information protection challenges involving real-world data to support public health efforts in China," *Front Public Health.* September 22, 2023.

For any overseas organization or individual whose personal information processing activities damage the personal information rights and interests of citizens of the People's Republic of China, or endanger the national security or



public interests of the People's Republic of China, the State cyberspace administration may include such overseas organization or individual in the list of restricted or prohibited provision of personal information, announce the same, and take measures such as restricting or prohibiting the provision of personal information to such overseas organization or individual. Article 43, Personal Information Protection Law (2020) since amended. In addition, all sensitive data relating to over 10,000 people is subject to review by the government allowing for data transfer of medical data to Chinese companies).

6. How do the Aspirations Outlined in Planning Documents Compare with Actual Spending?

China categorizes the types of government spending on research and development in a number of different ways and it is useful to consider each subfield of the bioeconomy. While the categorization methodology and sourcing are explored further in the appendix, it is important to note that some of these categories such as “Medical” and “Biochemistry, Bioengineering, and Microbiology” are broader than others, and all categories are highly interdisciplinary, so although these numbers are counting discrete entities, they are still estimates of the field’s representation.

It then becomes possible to try and summarize which PRC fields are best funded by awarding a certain number of points per funding source. If all funding sources published monetary awards this would become a simpler calculation, but as they do not, it is necessary to utilize best estimates.

National Level Research Institutions

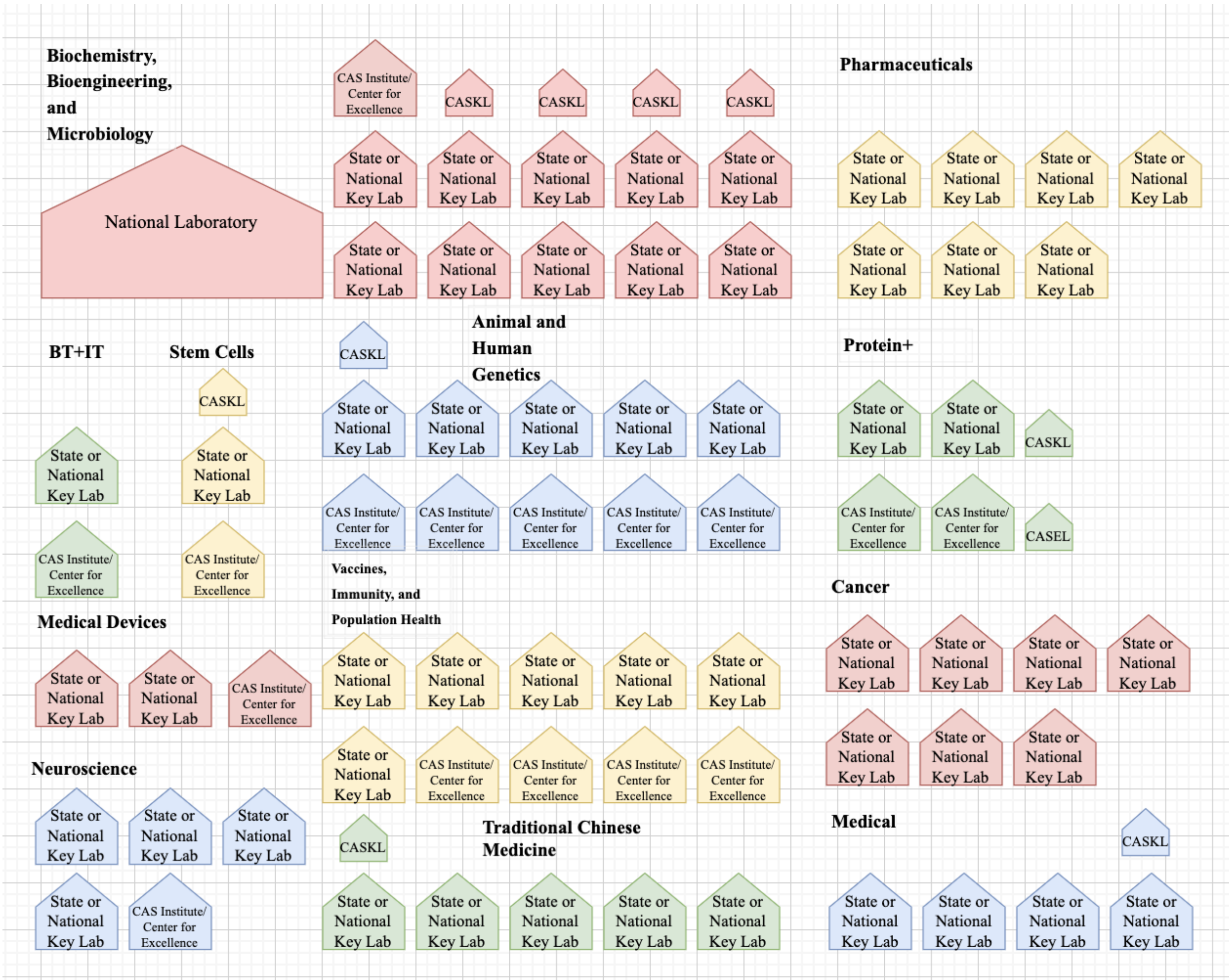
China has a sprawling system of nationally funded research laboratories that provide a backbone to its efforts to create an independent and internationally competitive science and technology industrial base. These laboratories are supervised by one of three sources, the Ministry of Science and Technology (MOST), the Ministry of Education (MOE), and the Chinese Academy of Sciences (CAST). These national-level laboratories are a nearly exhaustive list of PRC laboratories outside of universities and commercial entities on which it is possible to access public information.

PRC National Laboratories can be broken down into several tiers by observing which levels of institutions serve as “supporting units” to others. Larger, more important units support smaller ones. At the top we see national laboratories. These host State Key Labs, National Key Labs, and CAS Institutes, which subsequently host CAS Key Laboratories. The laboratory system is woven into the fabric of military-civil fusion, and a more general fusion and osmosis between all public, private, and academia. Often, National, State, and CAS Key Labs are hosted by prominent PRC universities and run by university professors.

At times these include military-affiliated universities. National and State Key Laboratories, known as enterprise key laboratories, are also often hosted by commercial institutions.[30] (For the purpose of this document, we will not use the word “private” to refer to any government-endorsed PRC institution as it creates a misleading distinction.) Yearly funding for these laboratories was

[30] Emily S. Weinstein, Channing Lee, Ryan Fedasiuk, and Anna Puglisi, “China’s State Key Laboratory System: A View into China’s Innovation System,” *Georgetown CSET,* June 2022.

nearly a billion dollars in 2019, and that number continues to grow.[31] Although funding for each institution can be difficult to ascertain, breaking down laboratories into their sub-fields of biology and biotechnology can allow us an imprecise idea of spending priorities.



The data included in this chart[32] is also provided in the Appendix.

NNSFC Project Funding

On a more granular level, the PRC invests in policies and plans that are typically hosted either by research laboratories or universities. These additional major sources of government

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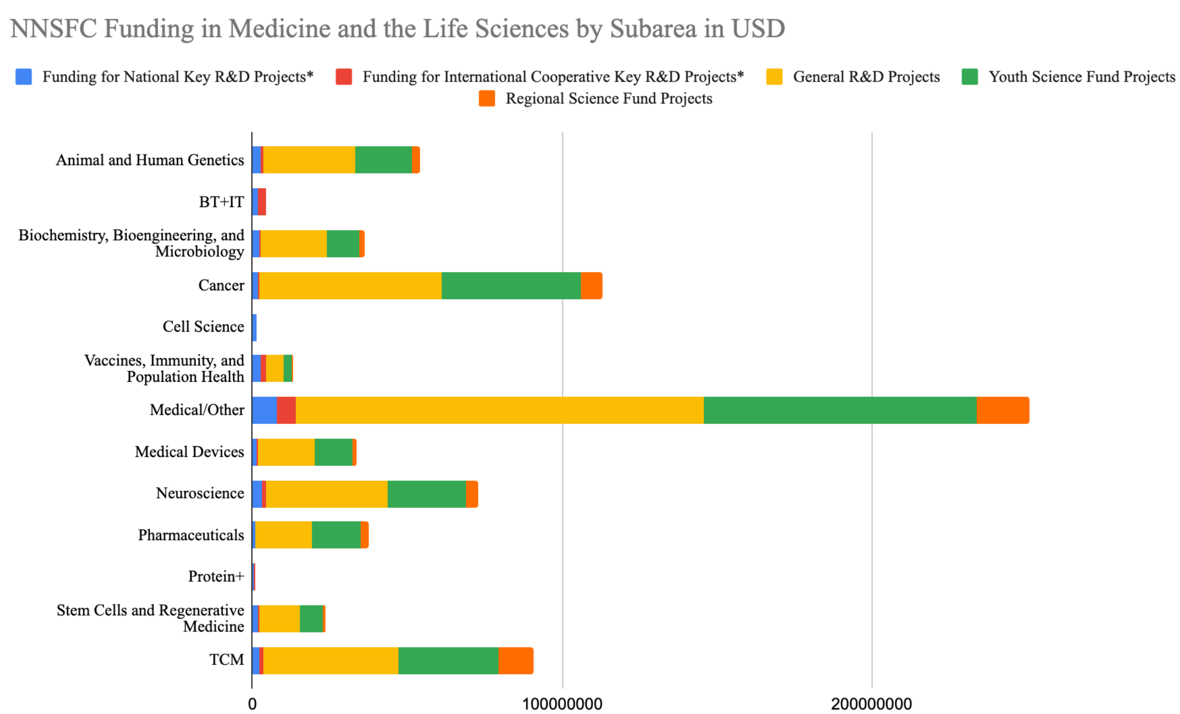
[31] "Emily S. Weinstein, Channing Lee, Ryan Fedasiuk, and Anna Puglisi, "China's State Key Laboratory System: A View into China's Innovation System," *Georgetown CSET,* June 2022.

[32] "国家重点实验室 [State Key Laboratories]," *Baidu Baike,* accessed July 1, 2024.

"中国科学院重点实验室 [Key Laboratories of Chinese Academy of Sciences]," *Baidu Baike*, accessed July 1, 2024.

funding can paint a finer picture of research investment. These investments are substantial. In 2023, in the department of Life Sciences, "7,773 projects were funded, with direct funding costs of 4.48 billion yuan," while "the Department of Medical Sciences has funded a total of 11,821 projects of various types, with a direct funding of 6.2277316 billion yuan."[33] Those funded projects are broken down into many programs, each of which has a different strategic purpose.

This research found precise funding data on four project types: National Key R&D Projects, General R&D Projects, Youth Sciences Fund Projects, and Regional Science Fund Projects. It also found more general data on International Cooperative Key R&D Projects. This data allows us to estimate the total funding across acquired NNSFC funding sources is in the chart below:



Funding estimates and project types are broken down below.

National Key Research and Development Projects

Life Sciences projects received approximately RMB 2,420,000,000 in funding in 2023 ($332,961,750 USD) while Medical Science received approximately RMB 2,794,000,000 in funding in 2023 ($384,419,475 USD). Although we do not have direct funding amounts for each project, we know that each of the 814 Medical Sciences projects has an average funding amount

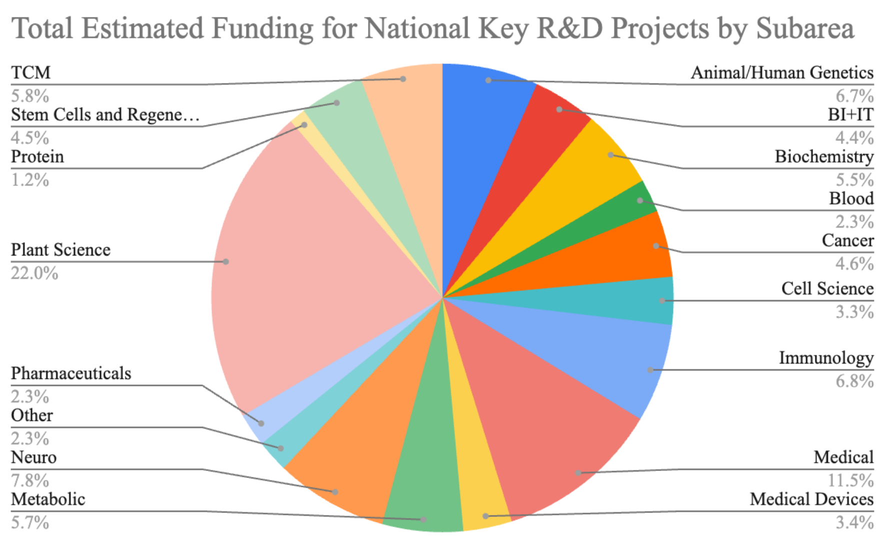
[33] "基金委：23个项目单项资助≥6000万，最高8498万元!, [NSFC: 23 projects received individual funding ≥ 60 million yuan, with the highest amount being 84.98 million yuan!]" M*edical Micro Guest, Baijiahao, Baidu,* March 14, 2024. https://baijiahao.baidu.com/s?id=1793497001047596476&wfr=spider&for=pc

of $472,260 USD, and each of the 738 Life Sciences projects has an average funding amount of $451,168 USD.

By categorizing each National Key Research and Development Project[34] and leveraging these averages, we can thereby estimate spending on each R&D sub-area in the life sciences and medicine. Specifics are contained in the Appendix. The accompanying chart provides a size comparison.

General Projects, Youth Science Fund Projects, and Regional Science Fund Projects

Below is a summary of a rare chart published by the PRC breaking down spending by project type and area. In the appendix the reader can find the breakdown of these projects into subfields.[35] Categorizing all funding from the three awards, we obtain the accompanying statistics

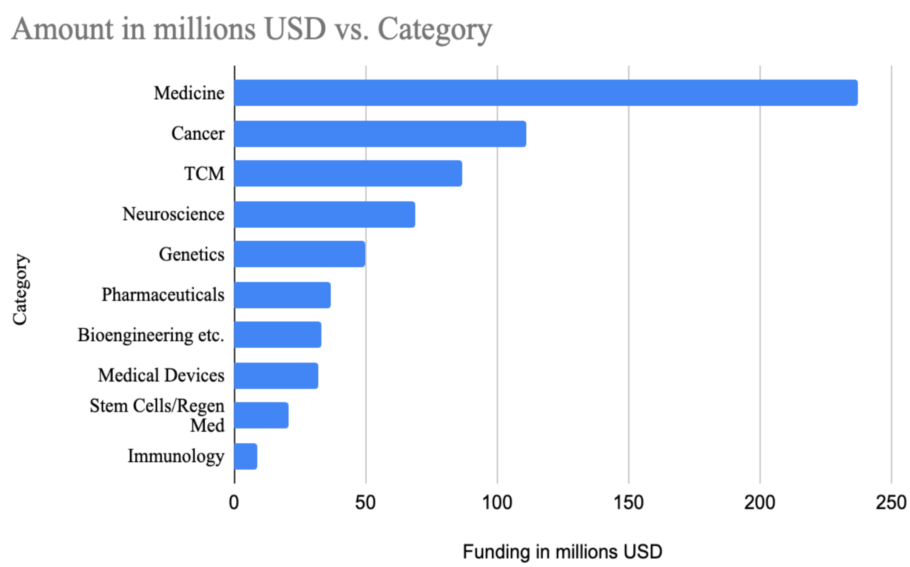


34 “重磅！2024年国自然9大科学部’重点项目’资助领域发布 [Big news! The funding areas of the 9 major science departments of the National Natural Science Foundation of China in 2024 are released],” *QQ*, Novi, January 14, 2024. https://new.qq.com/rain/a/20240114A025HR00.

35 “科学部资助领域和注意事项: 生命科学部 [Science Department Funding Areas and Notes: Life Sciences Department],” *National Natural Science Foundation of China,* 2024. https://www.nsfc.gov.cn/publish/portal0/tab1517/.

“科学部资助领域和注意事项: 医学科学部 [Science Department Funding Areas and Notes: Medical Sciences Department],” *National Natural Science Foundation of China*, 2024. https://www.nsfc.gov.cn/publish/portal0/tab1518/.

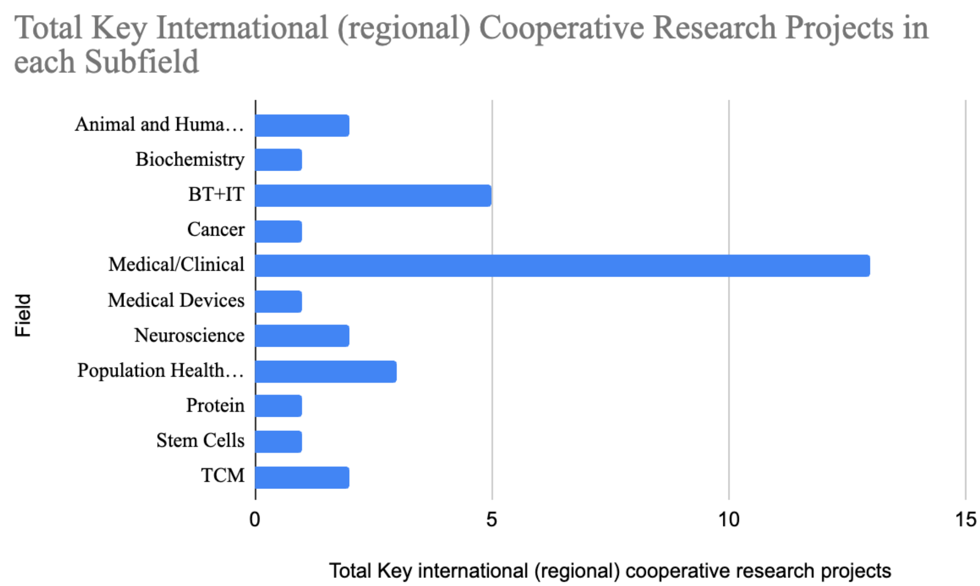
Key International Cooperative Research Projects



Finally, it has been possible to obtain recommended project types for Key International Cooperative Research Projects.[36] In the Life Sciences, 73 projects were awarded a total of RMB 248,400,000 ($34,176,735 USD), or on average, $468,174 USD. In Medical Sciences 133 projects were awarded a total of RMB 462,000,000 ($63,565,425 USD) for an average of RMB 477935 per project.

[36] "国际（地区）合作研究与交流项目 [International (regional) cooperative research and exchange projects]," *National Natural Science Foundation of China*, 2024. https://www.nsfc.gov.cn/publish/portal0/tab1540/info91320.htm

Commercial Inputs



Single Champions are commercial enterprises selected by the Chinese government for their capacity for manufacturing any particular good that is relevant to national priorities. Each Single Champion is published with its main product that qualifies it as a single champion

These companies are given large sums of money, tax breaks, access to subsidies, upstream materials, and access to relevant intellectual property. They often receive other benefits like housing for their employees, or in certain cases forced labor. Single Champions are an intermediate category of commercial champions, existing between little giants (which have the potential to become single champions) and Unicorns (which single champions may someday become.)

Concept stocks are a vehicle by which investors can invest in PRC sectors as a whole. They bundle stocks in top companies in the industry (the number can vary from about ten to several hundred). These concept stocks have specific names such as "synthetic biology" or "Dexamethasone."

Comparing Concept Stocks to single champions allows us to create a more detailed understanding of PRC industrial policy. Single Champions constitute industries that are typically not yet consolidated and require substantial innovation and support. This means that if the concept stock for an industry is much larger than its representation is on the single champion list, that industry is likely already consolidated.

The absence of genetic sequencing companies, for example, from this list is likely because of their already concentrated and developed nature. Genetic sequencing technology already exists in China, and the Chinese government is not interested in new small businesses in the sector.

But simply counting concept stocks does not represent the size of each. Taking into account the average daily capital in the concept stock, which determines where it appears on the concept stock list,[37] we can weight our results. This leads to slightly different conclusions, for example, although there are a similar number of vaccine concept stocks and pharmaceutical concept stocks, pharmaceutical stocks far outweigh concept stocks.

Commercial Datasets

Subject Area	Products produced by the 8th batch of 2023 Single Champions	Number of Concept Stocks	Weighted sum of products produced by the 8th batch of 2023 Single Champions
Bioengineering, microbiology	0	1	0
BT+IT	1	2	470
Cancer	1	1	214
Genetics	0	2	597
Health/Policy	0	3	1,336
Immunity	0	2	957
Medical	1	5	641
Medical Device	8	2	302
Neuroscience	1	2	458
Pharmaceutical	5	8	2,015
Pharmaceutical Production	5	0	421
Protein+	0	1	403
Prosthetics	2	0	0
Synthetic Bio	0	1	152
TCM	1	1	155
Vaccines +	0	7	1,593

[37] This is accomplished by subtracting the ranking of the concept stock from 457, or the total number of concept stocks to assign each concept stock a weight, and then taking a sum of those weights.

7. Conclusion and Recommendations

The Chinese government traditionally has taken a vacuum cleaner approach to the collection of foreign data, whether government or private, and does not distinguish between the two as in the United States. Partly this behavior reflected the fact that China's population size makes it relatively easy to utilize a large number of people to sift and analyze overwhelming quantities of data. As computers replaced people, the practice continued on the theory that the data, whatever they were, might become useful at some future time and in some unknowable future context, either for government or commercial purposes.

It is unclear whether the same philosophy underpins China's apparent pursuit of Western, particularly, U.S. medical data. What is clear is that medical data and medical technology are potential targets for a hostile adversary just as industrial, financial and national security information are.

While much of this analysis focuses on the PRC's goals for enhancing its competitiveness in medical research, pharmaceuticals, medical devices, and health care generally, other motives of the Chinese government for cyber intrusion into the U.S. health care sector should not be overlooked. For one, the U.S. health care sector holds highly personal and confidential data on Americans, including U.S. government personnel, as well as Chinese nationals and other persons of interest to China living in the United States. This personal data can be useful for espionage as well as blackmail purposes.[38]

Cyber intrusion is but one means China uses to acquire data. Cyber intrusion is particularly relevant as medicine and ancillary fields rely on information systems to store, analyze, and accumulate data. Such information systems also are involved in advanced medical devices. To the extent healthcare information systems are vulnerable—and they are extremely vulnerable to outside intrusion, cyber-attack, and theft using the tools of cyber—they create a large attack surface vulnerable to cyber intrusion. Part of the problem is that industry standards for cyber security in healthcare and other industries are woefully inadequate measured in terms of the capabilities of those seeking to steal western data using cyber methods.

With respect to health care, China has an advanced industry, but the Chinese government apparently still seeks western data to use in making improvements. It seems to believe that China's population and its medical histories do not provide data that are as useful as western healthcare

[38] For China's appetite for and success in illegally obtaining personal data on Americans, including from the Office of Personnel Management and Anthem Health Insurance, see for example https://www.wired.com/story/china-equifax-anthem-marriott-opm-hacks-data/.

data. It is also the case that medical research in China lags well behind that in the United States and the PRC uses many vehicles to exfiltrate data from U.S. research labs for a range of purposes.

Whether for brain scans that will eventually lead to new therapies or medications, brain pacemakers, genetic data to make super soldiers, or simply hard-to-measure data in enough quantity to develop personalized medical solutions, China needs U.S. medical data which substantially aid in the pursuit of China's aspirations to an independent and internationally competitive biotechnology sector that can contribute to national security goals.

China's planning documents clearly spell out the nation's goals. Yet PRC spending on research is not congruent with them. Vaccines and immunity research, for example, which have entire sections devoted to them in multiple planning documents emphasizing the importance of these fields, are among the least well-funded among sectors supported financially by the National Natural Science Foundation of China.

The CCP leadership is at least aware of these inconsistencies. They likely indicate that, instead of investing in cutting edge vaccine research, China is investing in its production capacity and plans to attain vaccine research data through other means when necessary. In other words, China is content to use its tried and true techniques for acquiring other countries' information to suit its purposes, often by simply stealing the information.

PRC security organizations have a number of non-cyber modalities for espionage that are relevant in industrial and healthcare espionage. They can coerce western companies into joint ventures using the lure of the Chinese market; such joint ventures continue to open doors to theft of intellectual property. China also plants individuals working for western companies and universities who either are actual Chinese government agents or susceptible to coercion based on relatives in China or who see economic incentives for returning home with knowledge they have gained.

Similarly, the PRC security services have placed large numbers of students, often medical students, graduate students and research assistants, into programs at U.S. universities where they are able to access research data and send it back to China. Often PRC institutions offer to provide these students and assistants to the host institutions and labs as free labor, with the claim that it is worth the cost as they are learning important skills. In many cases, these claims are true. Education in the United States or the West more broadly is seen as a key credential for PRC researchers in the medical and health care areas.

For many host institutions it is an offer that is hard to refuse, particularly at a time when the competitive cost of supporting American graduate students and postdocs is high and the NIH funding has become increasingly competitive and difficult to obtain. It is important to understand that allowing the PRC to pay these students' salaries is not dissimilar in data exfiltration risk to collaborating with a PRC lab.

Chinese planning documents hardly mention microbiology, biochemistry, and bioengineering despite the fact that they receive the lion's share of Chinese funding. It may be that these fields already are relatively strong and therefore contribute less dramatically to national security or prestige.

Official research efforts to amass data are few and far between. This may indicate that China has all the data it needs, but in an ever-evolving data-rich field, this is unlikely. Stealing U.S. medical data is not just a money grab. In many cases it may give the Chinese a "leg up" on new products or technologies, and a jump on publication in professional journals.

Recommendations

1. Face the Reality of Cyber Vulnerability

The first conclusion and recommendation is that the reality of cyber vulnerability needs to be faced and addressed in healthcare as it is in other critical sectors and industries. Healthcare now constitutes some 17% of the U.S. gross domestic product.[39] The tools exist to make information systems far more resilient, including those used in medical devices, and create sophisticated systems of resiliency.

The most important lesson, however, is that in all areas of cyber security the issue is risk management. There is no such thing as perfect security so long as a computer is connected to the Internet.

2. Consider Alternative Means of Data Theft

Cyberattacks are not the only potential method of data exfiltration. Many students who have been funded by programs like the PRC's flagship 10,000 talents program and who intend to return to China after their studies work legally at United States research institutions.[40] Although under Chinese law, citizens are obligated to support China's intelligence services while abroad, most typical students are not called upon to support those intelligence services. However, students actively receiving money from the PRC are more likely to feel compelled to share information than typical students from the PRC studying abroad. Because virtually no data related to biotechnology is classified or controlled, these students' legitimate access and credentials give them an unrestricted ability to steal from even the most "secure" systems implemented.

3. Track Chinese Competitiveness Strategies

The U.S. Intelligence Community, in cooperation with U.S. market leaders, should track Chinese competitiveness strategies across industries and the role that theft of intellectual property plays in these strategies. U.S. Intelligence, in cooperation with liaison services, should monitor Chinese multi-dimensional industrial espionage with a view to understanding with as great granularity as possible the threats. This understanding can then be the basis for working with private sector actors to resist them.

4. Recognize the Healthcare System Vulnerabilities

[39] Munira Z. Gunja, Evan D. Gumas, and Reginald D. Williams II, "U.S. Health Care from a Global Perspective, 2022: Accelerating Spending, Worsening Outcomes," Commonwealth Fund, January 31, 2023. https://www.commonwealthfund.org/publications/issue-briefs/2023/jan/us-health-care-global-perspective-2022

[40] *China' Cyber Power and Military-Civil Fusion, op. cit*

As in the case of other critical sectors and industries, health care needs to take the insecurity of its information systems, including information systems embedded in medical devices, seriously. Cyber intrusion and manipulation can lead to death.

It is not the case the health care providers are unaware of the threats or have done little or nothing to avert them. Quite to the contrary. Most providers have acquired the best commercial security products on the market and have adopted the best practices for their users. At the same time these IT departments are not in the intelligence or research business, and even the best of the products available aren't designed or built to withstand the type of cyber intrusion the PRC and others are developing. Industry standards need to be changed and regulations must be enacted to encourage stronger cyber defenses, resilient systems, and a culture that takes cyber risks seriously.

What Can ARPA-H Do?

1. Inform the Healthcare Ecosystem

With the exception of some cyberattacks that make the national news, most working in the health care sector are largely unaware of the extent of the actual attack surface and the nature of the threat posed by China and other potential adversaries. Efforts to make this information more widely available to this community would be well worth it.

It is also essential to make sure that institutions accepting students, grad students, medical students, research assistants and post-docs receiving PRC government funding in order to avoid paying additional students and researchers understand the risk they may be undertaking. Instead, institutions should be encouraged to only accept students and researchers from the PRC that they are willing to pay or fund just as they would pay or fund a researcher from the United States or elsewhere. Doing this removes one of the main incentives to exfiltrate data. Creating pathways to stay in the U.S. removes another incentive, the eventual need to return to China. Similarly, U.S. university research laboratories with sensitive data should be wary of accepting scholarship tuition from PRC government programs.

These institutions should also be informed that when possible, preventing all lower-level researchers from accessing information that they do not need to access to perform their duties has the potential to add another layer of security against insider threat data exfiltration.

2. Enhance Supply Chain Security for Medical Data

Utilizing the experience of the Defense Department and the Intelligence Community with securing data and a new generation of clouds, ARPA-H could explore how a secure cloud architecture could be utilized by the healthcare sector for medical data. Some providers and firms are already transitioning to a data cloud architecture and this could enhance these efforts.

3. Additional Security for Vaccine and Brain-Related IP

One lesson learned from the COVID19 experience is that data related to the development of vaccines may require some additional care and protection. Here it might be useful for ARPA-H to explore the various issues related to data protection in this area, as well as brain-related research, and determine if a program addressing these particular areas is warranted.

4. Improving the Resilience of Healthcare IT

Current work under the ARPA-H DIGIHEALS program has explored the nature of the attack surface. As a companion, additional work could be undertaken to explore the range of programs that might be undertaken to improve the resilience of the range of current systems to potential cyber-attack.

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“科学部资助领域和注意事项: 医学科学部 [Science Department Funding Areas and Notes: Medical Sciences Department],” *National Natural Science Foundation of China*, 2024

“国际（地区）合作研究与交流项目 [International (regional) cooperative research and exchange projects],” *National Natural Science Foundation of China*, 2024

Appendix

National Key Laboratories and Hosts

National Key Laboratories		
National Key Laboratory (supporting institution) (cn)	**National Key Laboratory (supporting institution) (en)**	**Sub-area tag**
天然药物及仿生药物国家重点实验室（北京大学）	State Key Laboratory of Natural and Biomimetic Drugs (Peking University)	Pharmaceuticals
蛋白质工程和植物基因工程国家重点实验室（北京大学）	State Key Laboratory of Protein Engineering and Plant Genetic Engineering (Peking University)	Protein+
家蚕基因组学国家重点实验室（西南大学）	State Key Laboratory of Silkworm Genomics (Southwest University)	Animal/Human Genetics
认知神经科学与学习国家重点实验室（北京师范大学）	State Key Laboratory of Cognitive Neuroscience and Learning (Beijing Normal University)	Neuroscience
生物电子学国家重点实验室（东南大学）	State Key Laboratory of Bioelectronics (Southeast University)	BT+IT
医学神经生物学国家重点实验室（复旦大学）	State Key Laboratory of Medical Neurobiology (Fudan University)	Neuroscience
遗传工程国家重点实验室（复旦大学）	State Key Laboratory of Genetic Engineering (Fudan University)	Animal/Human Genetics
化学生物传感与计量学国家重点实验室（湖南大学）	State Key Laboratory of Chemo-Biosensing and Chemo-Metrics (Hunan University)	Biochemistry
医药生物技术国家重点实验室（南京大学）	State Key Laboratory of Pharmaceutical Biotechnology (Nanjing University)	Pharmaceuticals
天然药物活性组分与药效国家重点实验室（中国药科大学）	State Key Laboratory of Active Components and Efficacy of Natural Drugs (China Pharmaceutical University)	TCM
药物化学生物学国家重点实验室（南开大学） [2]	State Key Laboratory of Medicinal Chemical Biology (Nankai University) [2]	Biochemistry
微生物技术国家重点实验室（山东大学）	State Key Laboratory of Microbial Technology (Shandong University)	Biochemistry
医学基因组学国家重点实验室（上海交通大学）	State Key Laboratory of Medical Genomics (Shanghai Jiao Tong University)	Animal/Human Genetics
口腔疾病研究国家重点实验室（四川大学）	State Key Laboratory of Oral Diseases (Sichuan University)	Medical
生物治疗国家重点实验室（四川大学）	State Key Laboratory of Biotherapy (Sichuan University)	Cancer
传染病诊治国家重点实验室（浙江大学）	State Key Laboratory of Diagnosis and Treatment of Infectious Diseases (Zhejiang University)	Public Health/Vaccines

华南肿瘤学国家重点实验室（中山大学）	State Key Laboratory of Oncology in South China (Sun Yat-sen University)	Cancer
眼科学国家重点实验室（中山大学）	State Key Laboratory of Ophthalmology (Sun Yat-sen University)	Medical
病毒学国家重点实验室（武汉大学、中国科学院武汉病毒研究所）	State Key Laboratory of Virology (Wuhan University, Wuhan Institute of Virology, Chinese Academy of Sciences)	Public Health/Vaccines
中药质量研究国家重点实验室（澳门大学、澳门科技大学）	State Key Laboratory of Quality Research in Chinese Medicines (University of Macau, Macau University of Science and Technology)	TCM
组分中药国家重点实验室（天津中医药大学） [4]	State Key Laboratory of Component Traditional Chinese Medicine (Tianjin University of Traditional Chinese Medicine) [4]	TCM
呼吸疾病国家重点实验室（广州医科大学）	State Key Laboratory of Respiratory Diseases (Guangzhou Medical University)	Public Health/Vaccines
医学免疫学国家重点实验室（中国人民解放军海军军医大学）	State Key Laboratory of Medical Immunology (Naval Medical University of the Chinese People's Liberation Army)	Medical
创伤、烧伤与复合伤研究国家重点实验室（中国人民解放军陆军军医大学）	State Key Laboratory of Trauma, Burns and Combined Injuries (Army Medical University of the Chinese People's Liberation Army)	Medical
肿瘤生物学国家重点实验室（中国人民解放军空军军医大学）	State Key Laboratory of Tumor Biology (Air Force Medical University)	Cancer
生物膜与膜生物工程国家重点实验室（中国科学院动物研究所）	State Key Laboratory of Biomembranes and Membrane Bioengineering (Institute of Zoology, Chinese Academy of Sciences)	Biochemistry
计划生育生殖生物学国家重点实验室（中国科学院动物研究所）	State Key Laboratory of Reproductive Biology for Family Planning (Institute of Zoology, Chinese Academy of Sciences)	Human/Animal Genetics
生化工程国家重点实验室（中国科学院过程工程研究所）	State Key Laboratory of Biochemical Engineering (Institute of Process Engineering, Chinese Academy of Sciences)	Biochemistry
遗传资源与进化国家重点实验室（中国科学院昆明动物研究所）	State Key Laboratory of Genetic Resources and Evolution (Kunming Institute of Zoology, Chinese Academy of Sciences)	Human/Animal Genetics
分子生物学国家重点实验室（中国科学院上海生命科学研究院）	State Key Laboratory of Molecular Biology (Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences)	Biochemistry
神经科学国家重点实验室（中国科学院上海生命科学研究院）	State Key Laboratory of Neuroscience (Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences)	Neuro
新药研究国家重点实验室（中国科学院上海药物研究所）	State Key Laboratory of Drug Research (Shanghai Institute of Materia Medica, Chinese Academy of Sciences)	Pharmaceuticals
生命有机化学国家重点实验室（中国科学院上海有机化学研究所）	State Key Laboratory of Bioorganic Chemistry (Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences)	Biochemistry
脑与认知科学国家重点实验室（中国科学院生物物理研究所）	State Key Laboratory of Brain and Cognitive Sciences (Institute of Biophysics, Chinese Academy of Sciences)	Neuro
生物大分子国家重点实验室（中国科学院生物物理研究所）	State Key Laboratory of Biomacromolecules (Institute of Biophysics, Chinese Academy of Sciences)	Biochemistry

创新药物与制药工艺国家重点实验室（上海医药工业研究院）	State Key Laboratory of Innovative Drugs and Pharmaceutical Processing (Shanghai Institute of Pharmaceutical Industry)	Pharma
分子肿瘤学国家重点实验室（中国医学科学院肿瘤医院肿瘤研究所）	State Key Laboratory of Molecular Oncology (Institute of Oncology, Cancer Hospital, Chinese Academy of Medical Sciences)	Cancer
医学分子生物学国家重点实验室（中国医学科学院基础医学研究所）	State Key Laboratory of Medical Molecular Biology (Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences)	Biochemistry
实验血液学国家重点实验室（中国医学科学院血液学研究所）	State Key Laboratory of Experimental Hematology (Institute of Hematology, Chinese Academy of Medical Sciences)	Cancer
病毒基因工程国家重点实验室（中国预防医学科学院病毒学研究所）	State Key Laboratory of Viral Genetic Engineering (Institute of Virology, Chinese Academy of Preventive Medicine)	Public Health/Vaccines
传染病预防控制国家重点实验室（中国疾病预防控制中心）	State Key Laboratory of Infectious Disease Prevention and Control (Chinese Center for Disease Control and Prevention)	Public Health/Vaccines
癌基因及相关基因国家重点实验室（上海市肿瘤研究所）	State Key Laboratory of Oncogenes and Related Genes (Shanghai Institute of Oncology)	Cancer
航天医学基础与应用国家重点实验室（中国航天员科研训练中心）	State Key Laboratory of Fundamentals and Applications of Space Medicine (China Astronaut Research and Training Center)	Other
病原微生物生物安全国家重点实验室（中国人民解放军军事医学科学院）	State Key Laboratory of Biosafety of Pathogenic Microorganisms (Academy of Military Medical Sciences)	Public Health/Vaccines
蛋白质组学国家重点实验室（中国人民解放军军事医学科学院）	State Key Laboratory of Proteomics (Academy of Military Medical Sciences)	Protein
创新中药关键技术国家重点实验室（天士力制药集团股份有限公司）	State Key Laboratory of Key Technologies for Innovative Traditional Chinese Medicine (Tasly Pharmaceutical Group Co., Ltd.)	TCM
长效缓控释和靶向制剂及技术国家重点实验室（山东绿叶制药股份有限公司）	State Key Laboratory of Long-Acting Sustained-Release and Targeted Formulations and Technologies (Shandong Luye Pharmaceutical Co., Ltd.)	Pharmaceuticals
中药制药新技术国家重点实验室（鲁南制药集团股份有限公司）	State Key Laboratory of New Technologies in Traditional Chinese Medicine Pharmaceuticals (Lunan Pharmaceutical Group Co., Ltd.)	TCM
药物先导化合物研究国家重点实验室（上海药明康德新药开发有限公司）	State Key Laboratory of Drug Lead Research (Shanghai WuXi AppTec Pharmaceutical Co., Ltd.)	Pharmaceuticals
药物制剂新技术国家重点实验室（扬子江药业集团有限公司）	State Key Laboratory of New Technologies in Pharmaceutical Formulations (Yangtze River Pharmaceutical Group Co., Ltd.)	Pharmaceuticals
省部共建超声医学工程国家重点实验室（重庆医科大学） 省部共建山区桥梁及隧道工程国家重点实验室（重庆交通大学）	State Key Laboratory of Ultrasound Medical Engineering (Chongqing Medical University) State Key Laboratory of Mountain Bridge and Tunnel Engineering (Chongqing Jiaotong University)	Medical Devices
省部共建食管癌防治国家重点实验室（郑州大学）	Provincial and ministerial co-construction of the State Key Laboratory for the Prevention and Treatment of Esophageal Cancer (Zhengzhou University)	Cancer

省部共建生物催化与酶工程国家重点实验室 [13]（湖北大学）	The State Key Laboratory of Biocatalysis and Enzyme Engineering jointly established by the province and the ministry (Hubei University)	Biochemistry
省部共建放射医学与辐射防护国家重点实验室（苏州大学）	State Key Laboratory of Radiation Medicine and Radiation Protection (Soochow University)	Cancer
省部共建精密电子制造技术与装备国家重点实验室（广东工业大学） [24] 省部共建器官衰竭防治国家重点实验室 [30]（南方医科大学）	The State Key Laboratory of Precision Electronic Manufacturing Technology and Equipment (Guangdong University of Technology) The Provincial and Ministry jointly established the National Key Laboratory for Organ Failure Prevention and Treatment (Southern Medical University)	Medical Devices

CAS funded Institutions

CAS funded Institutions:					
Laboratory name (cn)	**Laboratory name (en)**	**Supporting unit (cn)**	**Supporting unit (en)**	**Type**	**Sub-area tag**
中国科学院基因组科学与信息重点实验室	Key Laboratory of Genome Science and Information, Chinese Academy of Sciences	中国科学院基因组研究所	Institute of Genomics, Chinese Academy of Sciences	CASKL	Animal/Human Genetics
中国科学院分子发育生物学重点实验室	Key Laboratory of Molecular Developmental Biology, Chinese Academy of Sciences	中国科学院遗传与发育生物学研究所	Institute of Genetics and Developmental Biology, Chinese Academy of Sciences	CASKL	Biochemistry
中国科学院分子纳米结构与纳米技术重点实验室	Key Laboratory of Molecular Nanostructures and Nanotechnology, Chinese Academy of Sciences	中国科学院化学研究所	Institute of Chemistry, Chinese Academy of Sciences	CASKL	Biochemistry
中国科学院分子细胞生物学重点实验室	Key Laboratory of Molecular Cell Biology, Chinese Academy of Sciences	中科院上海生命科学研究院（生化所）	Shanghai Institutes of Biological Sciences, Chinese Academy of Sciences (Institute of Biochemistry)	CASKL	Biochemistry
中国科学院系统生物学重点实验室	Key Laboratory of Systems Biology, Chinese Academy of Sciences	中国科学院上海生命科学研究院	Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences	CASKL	Medical
中国科学院结构生物学重点实验室	Key Laboratory of Structural Biology, Chinese Academy of Sciences	中国科学技术大学	University of Science and Technology of China	CASKL	Protein
中国科学院干细胞生物学重点实验室	Key Laboratory of Stem Cell Biology, Chinese Academy of Sciences	中国科学院上海生命科学研究院	Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences	CASKL	Stem Cell
中国科学院离子束生物工程学重点实验室	Key Laboratory of Ion Beam Bioengineering, Chinese Academy of Sciences	中国科学院合肥物质科学研究院	Hefei Institute of Physical Sciences, Chinese Academy of Sciences	CASKL	Biochemistry

北京分子科学国家实验室	Beijing National Laboratory of Molecular Sciences	北京大学、中国科学院化学研究所	Peking University, Institute of Chemistry, Chinese Academy of Sciences	CAS Hosted national lab	Biochemistry
蛋白质科学国家实验室	National Laboratory for Protein Sciences	中国科学院生物物理研究所	Institute of Biophysics, Chinese Academy of Sciences	CAS Hosted national lab	Protein
工业酶国家工程实验室	National Engineering Laboratory of Industrial Enzymes	中国科学院微生物研究所等	Institute of Microbiology, Chinese Academy of Sciences, etc.	CAS Engineering Lab	Protein
中药标准化技术国家工程实验室	National Engineering Laboratory of Traditional Chinese Medicine Standardization Technology	中国科学院上海药物所	Shanghai Institute of Materia Medica, Chinese Academy of Sciences	CAS Engineering Lab	TCM

PRC government-funded research laboratories broken down by subfield

Subfield	National Laboratories	CAS Institutes and Centers for Innovation	State/ National Key Laboratories	CAS Engineering Laboratories	CAS Key Laboratories
Animal and Human Genetics	0	5	5	0	1
BT+IT	0	1	1	0	0
Biochemistry, Bioengineering, and Microbiology	1	1	10	0	4
Cancer	0	1	8	0	0
Medical	0	0	4	0	1
Medical Devices	0	1	2	0	0
Neuroscience	0	1	4	0	0
Pharmaceuticals	0	0	7	0	0
Protein+	0	2	2	1	1
Stem Cells	0	2	0	0	1
Synthetic Biology	0	1	0	0	0
TCM	0	0	5	1	0
Vaccines, Immunity, and Population Health	0	4	6	0	0

National Institutes

Name of the Innovation Institute (cn)	Name of the Innovation Institute (en)	Area
药物创新研究院	Institute of Drug Innovation	Pharma
干细胞与再生医学创新研究院	Institute of Stem Cell and Regenerative Medicine Innovation	Stem Cell
脑科学与智能技术卓越创新中心	Innovation Center of Excellence in Brain Science and Intelligent Technology	Neuro
分子细胞科学卓越创新中心	Innovation Center of Excellence in Molecular Cell Science	Biochemistry+
生物大分子卓越创新中心	Center of Excellence in Biomacromolecules	Biochemistry+
分子合成科学卓越创新中心	Center of Excellence in Molecular Synthesis	Pharma
动物进化与遗传前沿交叉卓越创新中心	Center of Excellence in Animal Evolution and Genetic Frontiers	Genetics
生物互作卓越创新中心	Center of Excellence in Biointeractions	Biosafety
生物安全大科学研究中心	Big Science Research Center for Biosafety	Biosafety
心理研究所	Institute of Psychology	Neuro
营养与健康特色研究所	Special Research Institute of Nutrition and Health	Health/Clinical
分子科学卓越创新中心	Innovation Center of Excellence in Molecular Science	Other
生物演化与环境卓越创新中心	Center of Excellence in Biological Evolution and Environment	Other
海洋信息技术创新研究院	Institute of Marine Information Technology Innovation	Other
机器人与智能制造创新研究院	Institute of Robotics and Intelligent Manufacturing Innovation	Other
精密测量科学与技术创新研究院	Institute of Precision Measurement Science and Technology Innovation	Other
种子创新研究院	Institute of Seed Innovation	Other
分子植物科学卓越创新中心	Innovation Center of Excellence in Molecular Plant Science	Other
纳米科学卓越创新中心	Innovation Center of Excellence in Nanoscience	Other
合肥大科学中心	Hefei Big Science Center	Other
上海大科学中心	Shanghai Big Science Center	Other
昆明植物研究所	Kunming Institute of Botany	Other
长春应用化学研究所	Changchun Institute of Applied Chemistry	Other
生态草牧业特色研究所	Special Research Institute of Ecological Grassland and Animal Husbandry	Other
核心植物园特色研究所	Special Research Institute of Core Botanical Gardens	Other

Tagging Related to Project Funding

Research fields or research directions and relevant requirements for key projects funded by the National Natural Science Foundation of China in 2024			
Department	**Name (cn)**	**Name (en)**	**Sub-area**
Medical Sciences	脏器纤维化的中西医结合防治策略与机制	Strategies and mechanisms for prevention and treatment of organ fibrosis by combining traditional Chinese and Western medicine	TCM
Medical Sciences	中药低丰度高活性药效成分的发现及作用机制解析	Discovery and mechanism analysis of low-abundance and high-activity active ingredients in traditional Chinese medicine	TCM
Medical Sciences	针刺促进神经损伤修复的作用机制研究	Research on the mechanism of action of acupuncture in promoting nerve damage repair	TCM
Medical Sciences	中医药防治肿瘤复发、转移的生物学基础及作用机制研究	Research on the biological basis and mechanism of action of traditional Chinese medicine in preventing and treating tumor recurrence and metastasis	TCM
Medical Sciences	脑卒中药物靶标发现及候选新药研究	Discovery of drug targets for stroke and research on candidate new drugs	Pharmaceuticals
Medical Sciences	重大疾病药物反应个体差异的发生机制及干预策略研究	Research on the mechanism of individual differences in drug responses to major diseases and intervention strategies	Pharmaceuticals
Medical Sciences	靶向膜蛋白或核受体的候选新药发现研究	Research on discovery of candidate new drugs targeting membrane proteins or nuclear receptors	Protein
Medical Sciences	话性天然产物高效发现的新策略研究	Research on new strategies for efficient discovery of natural products	TCM
Medical Sciences	重要慢性病发生的营养机制及精准防控策略	Nutritional mechanisms and precise prevention and control strategies for major chronic diseases	Medical
Medical Sciences	环境暴露健康效应与防控策略	Environmental exposure health effects and prevention and control strategies	Medical
Medical Sciences	放射损伤机制及防治新策略	Radiation injury mechanism and new prevention and treatment strategies	Medical
Medical Sciences	重大皮肤疾病的发生发展机制与干预	Occurrence and development mechanism and intervention of major skin diseases	Medical
Medical Sciences	肿瘤与组织器官代谢网络互作机理	Tumor and tissue organ metabolic network interaction mechanism	Cancer
Medical Sciences	肿瘤微环境异质性与治疗响应	Tumor microenvironment heterogeneity and treatment response	Cancer
Medical Sciences	微生物与肿瘤演进和治疗响应	Microorganisms and tumor evolution and treatment response	Cancer
Medical Sciences	肿瘤联合靶向治疗策略与临床转化	Tumor combined targeted therapy strategy and clinical transformation	Cancer
Medical Sciences	代谢障碍与调控在危重症多器官功能损伤中的作用及机制	The role and mechanism of metabolic disorders and regulation in critical multi-organ dysfunction	Metabolic
Medical Sciences	病原体与宿主互作影响非肿瘤性疾病发生发展进程的机制	The mechanism of pathogen-host interaction affecting the occurrence and development of non-neoplastic diseases	Immunology

Medical Sciences	严重创伤/烧伤致重要脏器损伤的机制及干预策略	The mechanism and intervention strategy of major organ damage caused by severe trauma/burns	Medical
Medical Sciences	力学生物传导在运动系统疾病发生发展中的作用及机制	The role and mechanism of mechanical bioconduction in the occurrence and development of locomotor system diseases	Medical
Medical Sciences	针对重大慢性疾病的数字化医疗关键技术研究	Digitalization for major chronic diseases Research on key medical technologies	BI+IT
Medical Sciences	影像驱动的重大疾病诊疗和评估技术研究	Research on imaging-driven diagnosis, treatment and evaluation technologies for major diseases	Medical Devices
Medical Sciences	复杂死因证据获取的新技术研究	Research on new technologies for obtaining evidence of complex causes of death	Medical Devices
Medical Sciences	特殊环境下机体稳态失衡的调控机制研究	Research on regulatory mechanisms of homeostasis imbalance in special environments	Medical
Medical Sciences	非感染性炎症性疾病的免疫学机制与干预策略	Immunological mechanisms and intervention strategies for non-infectious inflammatory diseases	Immunology
Medical Sciences	免疫治疗新靶点发现与治疗新策略	Discovery of new targets for immunotherapy and new strategies for treatment	Immunology
Medical Sciences	出生缺陷/罕见病的遗传基础与干预策略	Genetic basis and intervention strategies for birth defects/rare diseases	Animal/Human Genetics
Medical Sciences	生殖障碍的发生机制及干预策略	Mechanisms and intervention strategies for reproductive disorders	Animal/Human Genetics
Medical Sciences	衰老标志物的筛选、验证及转化研究	Screening, verification and translational research of aging markers	Medical
Medical Sciences	常见精神障碍核心特征的机制及干预	Mechanisms and interventions of core features of common mental disorders	Neuro
Medical Sciences	麻醉相关意识改变的机制	Mechanisms of anesthesia-related changes in consciousness	Neuro
Medical Sciences	神经系统免疫异常及相关疾病的机制及干预	Mechanisms and interventions of immune abnormalities of the nervous system and related diseases	Immunology
Medical Sciences	耳鼻咽喉头颈疾病的神经/免疫调节机制与干预研究	Neural/immune regulatory mechanism and intervention of otolaryngology and head and neck diseases Research	Neuro
Medical Sciences	颅颌面组织器官发育与修复再生的调控机制及干预策略	Regulatory mechanism and intervention strategy of craniofacial tissue and organ development and repair and regeneration	Medical
Medical Sciences	新型代谢调节分泌因子的鉴定及机制研究	Identification and mechanism study of new metabolic regulatory secretory factors	Metabolic
Medical Sciences	肾脏炎症形成机制及干预策略	Mechanism and intervention strategy of kidney inflammation	Other
Medical Sciences	肝胆胰疾病发生发展的机制和干预策略研究	Research on the mechanism and intervention strategy of the occurrence and development of hepatobiliary and pancreatic diseases	Medical
Medical Sciences	代谢紊乱在血管损伤中的作用机制及干预	The mechanism and intervention of metabolic disorders in vascular injury	Metabolic
Medical Sciences	心脏细胞异质性在心肌损伤修复中的作用	The role of cardiac cell heterogeneity in myocardial injury and repair	Stem Cells and Regenerative Medicine
Medical Sciences	血小板功能异质性及其生理和病理意义	Heterogeneity of platelet function and its physiological and pathological significance	Blood

Medical Sciences	造血稳态失衡与血液相关疾病的发生发展	Imbalance of hematopoietic homeostasis and the occurrence and development of blood-related diseases	Blood
Medical Sciences	肺部损伤与修复机制	Lung injury and repair mechanism	Stem Cells and Regenerative Medicine
Life Sciences	发育、疾病与重要表型的遗传与表观遗传调控	Genetic and epigenetic regulation of development, disease and important phenotypes	Animal/Human Genetics
Life Sciences	遗传物质的结构、修饰、功能与进化	The structure, modification, function and evolution of genetic material	Animal/Human Genetics
Life Sciences	配子发生与合子发育的调控机制	Regulation mechanism of gametogenesis and zygote development	Animal/Human Genetics
Life Sciences	重要生命活动中生物信息流的产生与调控	Generation and regulation of biological information flow in important life activities	BI+IT
Life Sciences	生物大数据的获取、挖掘与数据驱动的生物学研究	Acquisition, mining and data-driven biological research of biological big data	BI+IT
Life Sciences	生命组学大数据解析的理论、方法、工具及应用	Theory, methods, tools and applications of big data analysis of biogenomics	BI+IT
Life Sciences	生物学过程的设计、操控与创新应用	Design, manipulation and innovative application of biological processes	Biochemistry
Life Sciences	在体生物分子事件探测、解析与操控	Detection, analysis and manipulation of in vivo biomolecular events	Biochemistry
Life Sciences	生物功能分子动态过程描绘、信号转导及调控机制	Description of dynamic processes of biological functional molecules, signal transduction and regulatory mechanisms	Biochemistry
Life Sciences	糖、脂及其复合物的结构与功能	Structure and function of sugars, lipids and their complexes	Biochemistry
Life Sciences	微生物间及与宿主或环境的相互作用	Interactions between microorganisms and with hosts or the environment	Biochemistry
Life Sciences	微生物多样性与演化或代谢调控	Microbial diversity and evolution or metabolic regulation	Metabolic
Life Sciences	植物多样性形成及环境适应分子机制	Molecular mechanisms of plant diversity formation and environmental adaptation	Plant
Life Sciences	植物重要活性成分的代谢及其调控	Metabolism and regulation of important active ingredients in plants	Plant
Life Sciences	生命系统对全球变化的响应与适应	Response and adaptation of life systems to global changes	Plant
Life Sciences	重大工程的基础生态学问题	Basic ecological issues of major projects	Plant
Life Sciences	动物重要性状的进化与适应	Evolution and adaptation of important animal traits	Animal/Human Genetics
Life Sciences	动物分类与多样性形成	Animal classification and diversity formation	Other
Life Sciences	细胞内外信息交互与细胞稳态	Intracellular and extracellular information interaction and cell homeostasis	Cell Science
Life Sciences	细胞精细结构与功能	Cellular fine structure and function	Cell Science
Life Sciences	免疫细胞发音、分化与应答机制	Immune cell pronunciation, differentiation and response mechanism	Immunology
Life Sciences	免疫调控机制及其异常与干预	Immune regulation mechanism and its abnormality and intervention	Immunology

Life Sciences	感觉与认知功能及其障碍的分子和细胞基础	Molecular and cellular basis of sensory and cognitive functions and disorders	Neuro
Life Sciences	人类认知与情感的神经及心理机制	Neural and psychological mechanisms of human cognition and emotion	Neuro
Life Sciences	脑信息编码与处理的神经机制解析与应用	Analysis and application of neural mechanisms of brain information encoding and processing	Neuro
Life Sciences	仿生/工程化组织器官构建与调控	Construction and regulation of bionic/engineered tissues and organs	Stem Cells and Regenerative Medicine
Life Sciences	智能材料设计、生物效应及机制	Smart material design, biological effects and mechanisms	Medical Devices
Life Sciences	机体感知及应对内外环境变化的生理和病理生理调节机制	Physiological and pathophysiological regulation mechanisms of the body's perception and response to changes in the internal and external environment	Neuro
Life Sciences	机体代谢调控与衰老和疾病	Organism Metabolic regulation and aging and disease	Metabolic
Life Sciences	细胞命运可塑性及发育潜能调控机制	Regulation mechanism of cell fate plasticity and developmental potential	Cell Science
Life Sciences	组织再生修复的生物学机制	Biological mechanism of tissue regeneration and repair	Stem Cells and Regenerative Medicine
Life Sciences	作物复杂性状形成的分子基础与遗传调控网络解析	Molecular basis and genetic regulation network analysis of complex crop traits	Plant Genetics
Life Sciences	作物高产、优质、抗逆生理与绿色高效生产基础	High-yield, high-quality, stress-resistant physiology and green and efficient production basis of crops	Plant Genetics
Life Sciences	农作物有害生物致害成灾机制与绿色防控	Mechanism of crop pests causing disasters and green prevention and control	Plant
Life Sciences	农作物对重要病虫害抗性机制	Mechanism of crop resistance to important diseases and insect pests	Plant
Life Sciences	园艺作物重要农艺性状形成机制及调控	Mechanism of formation and regulation of important agronomic traits of horticultural crops	Plant
Life Sciences	养分资源高效利用机制与调控	Mechanism and regulation of efficient utilization of nutrient resources	Plant
Life Sciences	林草资源定向培育或高效利用	Directed cultivation or efficient utilization of forest and grass resources	Plant
Life Sciences	林草种质资源挖掘与创新	Exploration and innovation of forest and grass germplasm resources	Plant
Life Sciences	畜禽、蜂蚕重要性状的形成与调控机制	Formation of important traits of livestock, poultry, bees and silkworms and regulatory mechanisms	Plant
Life Sciences	畜禽饲料养分高效利用与新型饲料资源挖掘的生物学基础	The biological basis for efficient use of nutrients in livestock and poultry feed and the exploration of new feed resources	Plant
Life Sciences	畜禽重要疫病与人兽共患病病原致病、免疫与耐药	Pathogenicity, immunity and drug resistance of pathogens of important livestock and poultry diseases and zoonoses	Plant
Life Sciences	畜禽重要疾病的病理/生理学基础与宿主响应	Pathological/physiological basis and host response of important livestock and poultry diseases	Plant

Life Sciences	水产养殖生物重要疾病发生与防控机制	Occurrence and prevention and control mechanisms of important diseases in aquaculture organisms	Plant
Life Sciences	水产生物重要经济性状形成与调控机理	Formation and regulatory mechanisms of important economic traits of aquatic organisms	Plant
Life Sciences	食品绿色加工、生物制造和贮藏的调控机制	Regulatory mechanisms of green food processing, biomanufacturing and storage	Plant
Life Sciences	食品营养、风味形成与安全控制机理	Food nutrition, flavor formation and safety control mechanisms	Plant

NNSFC Project Funding Subarea Tags		
Type	**Category Summary**	**Sub-area tag**
Biology	Genetics and Bioinformatics	Animal and Human Genetics
Biology	Cell Biology	Bioengineering etc.
Biology	Developmental Biology and Reproductive Biology	Stem Cells and Regenerative Medicine
Biology	Immunology	Immunology
Biology	Neuroscience and Psychology	Neuroscience
Biology	Physiology and Integrative Biology	Medicine
Biology	Biophysics and Biochemistry	Bioengineering etc.
Biology	Biomaterials, Imaging and Tissue Engineering	Stem Cells and Regenerative Medicine
Biology	Molecular Biology and Biotechnology	Bioengineering etc.
Medicine	Respiratory System, circulatory system, blood	Medicine
Medicine	Organs	Medicine
Medicine	Nervous System, Mental Health, Brain Medicine, and Geriatrics	Neuroscience
Medicine	Reproduction/ medical genetics	Animal and Human Genetics
Medicine	Imaging, BME, regenerative medicine	Medical Devices
Medicine	Critical Care etc.	Medicine
Medicine	Oncology	Cancer
Medicine	Dermatology, radiation, preventative medicine	Medicine
Medicine	Pharmacology	Pharmaceuticals
Medicine	TCM	TCM

Summaries of Project Funding

PRC government funded projects and project awards, 2023-2024 in biotechnology and medical sectors					
Subfield	**Medical Key Projects**	**Life Sciences Key Projects**	**Life Sciences Key international cooperative research projects**	**Medical Sciences Key international cooperative research projects**	**2023 National Natural Science Award**
Animal and Human Genetics	2	4	2	0	6
BT+IT	1	3	2	3	0
Biochemistry, Bioengineering, and Microbiology	0	5	1	0	1
Cancer	4	0	0	1	2

Medical	16	6	3	10	0
Medical Devices	2	1	0	1	0
Neuroscience	3	4	1	1	1
Pharmaceuticals	2	0	0	0	0
Protein+	1	0	0	1	0
Stem Cells	2	2	0	1	0
Synthetic Biology	0	0	0	0	0
TCM	5	0	0	2	0
Vaccines, Immunity, and Population Health	4	2	0	3	2

PRC government funded International regional cooperative Key R&D Projects and project awards, 2023-2024 in biotechnology and medical sectors					
Subfield	**Life Sciences Key international cooperative research projects**	**Estimated Funding, Life Sciences Key international cooperative research projects**	**Medical Sciences Key international cooperative research projects**	**Estimated Funding, Medical Sciences Key international cooperative research projects**	**Total estimated funding**
Animal and Human Genetics	2	936,348	0	0	936,348
BT+IT	2	936,348	3	1,433,805	2,370,153
Biochemistry, Bioengineering, and Microbiology	1	468,174	0	0	468,174
Cancer	0	0	1	477,935	477,935
Medical	3	1,404,522	10	4,779,350	61,83,872
Medical Devices	0	0	1	477,935	477,935
Neuroscience	1	468,174	1	477,935	946,109
Pharmaceuticals	0	0	0	0	0
Protein+	0	0	1	477,935	477,935
Stem Cells	0	0	1	477,935	477,935
Synthetic Biology	0	0	0	0	0
TCM	0	0	2	955,870	955,870

Vaccines, Immunity, and Population Health	0	0	3	1,433,805	1,433,805

National Key R&D Projects with Estimated Funding indexed by Sub-area

	Medical Key Projects	Estimated Funding in USD Medical	Life Sciences Key Projects	Estimated Funding in USD Life	Total Estimated Funding
Animal/Human Genetics	2	944,520	4	1,804,672	2,749,192
BI+IT	1	472,260	3	1,353,504	1,825,764
Biochemistry	0	0	5	2,255,840	2,255,840
Blood	2	944,520	0	0	944,520
Cancer	4	1,889,040	0	0	1,889,040
Cell Science	0	0	3	1,353,504	1,353,504
Immunology	4	1,889,040	2	902,336	2,791,376
Medical	10	4,722,600	0	0	4,722,600
Medical Devices	2	944,520	1	451,168	1,395,688
Metabolic	3	1,416,780	2	902,336	2,319,116
Neuro	3	1,416,780	4	1,804,672	3,221,452
Other	1	472,260	1	451,168	923,428
Pharmaceuticals	2	944,520	0	0	944,520
Plant Science	0	0	20	9,023,360	9,023,360
Protein	1	472,260	0	0	472,260
Stem Cells and Regenerative Medicine	2	944,520	2	902,336	1,846,856
TCM	5	2,361,300	0	0	2,361,300

Commercial Inputs

Single Champions, 8th Batch 2023				
Name (cn)	**Name (en)**	**Product (cn)**	**Product (en)**	**Sub-area tag**
江苏新时代造船有限公司	Jiangsu New Era Shipbuilding Co., Ltd.	医学影像智能显示系统设备	Medical imaging intelligent display system equipment	BT+IT
厦门艾德生物医药科技股份有限公司	Xiamen Aide Biomedical Technology Co., Ltd.	肿瘤精准医疗分子诊断试剂	Precision tumor medical molecular diagnostic reagents	Cancer
厦门致善生物科技股份有限公司	Xiamen Zhishan Biotechnology Co., Ltd.	结核分枝杆菌耐药突变分子诊断试剂及仪器	Molecular diagnostic reagents and instruments for drug-resistant mutations of Mycobacterium tuberculosis	Medical
山东新华医疗器械股份有限公司	Shandong Xinhua Medical Equipment Co., Ltd.	脉动真空灭南器	Pulsating vacuum extinguisher	Medical Device
广东非鹏生物有限公司	Guangdong Feipeng Biological Co., Ltd.	重症监护仪	Intensive care monitor	Medical Devices
江苏新扬子造船有限公司	Jiangsu New Yangzi Shipbuilding Co., Ltd.	智能盆底生殖康复诊疗系统	Intelligent pelvic floor reproductive rehabilitation diagnosis and treatment system	Medical Devices
浙江威泰汽配有限公司	Xiamen Aide Biomedical Technology Co., Ltd.	链锯	Chainsaw	Medical Devices
烟台宏远氧业股份有限公司	Yantai Hongyuan Oxygen Co., Ltd.	氧舱	Oxygen chamber	Medical Devices
洛阳建龙微纳新材料股份有限公司	Luoyang Jianlong Micro-Nano New Materials Co., Ltd.	无机非金属医用制氧分子筛	Inorganic non-metallic medical oxygen molecular sieve	Medical Devices
湖南明康中锦医疗科技股份有限公司	Hunan Mingkang Zhongjin Medical Technology Co., Ltd.	高流量呼吸湿化治疗仪(FC)	High-flow respiratory humidification therapy device (FC)	Medical Devices
沈阳仪表科学研究院有限公司	Baoji Titanium Co., Ltd.	生物医学精密光学滤光片	Biomedical precision optical filters	Medical Devices
天新福（北京）医疗器材股份有限公司	Tianxinfu (Beijing) Medical Equipment Co., Ltd.	硬脑（脊）膜补片	Dura mater patch	Neurosurgery
一东正业科技股份有限公司	Yidong Zhengye Technology Co., Ltd.	血塞通软胶囊	Xuesetong soft capsule	Pharmaceutical
北京通美晶体技术股份有限公司	Beijing Tongmei Crystal Technology Co., Ltd.	磷化铟衬底	Indium phosphide substrate	Pharmaceutical Production
广州极飞科技股份有限公司	Guangzhou Jifei Technology Co., Ltd.	锂电池X射线探伤检测设备	Lithium battery X-ray flaw detection equipment	Pharmaceutical Production
广东聚石化学股份有限公司	Guangdong Jushi Chemical Co., Ltd.	成核剂	Nucleating agent	Pharmaceutical Production
乐凯胶片股份有限公司	Lucky Film Co., Ltd.	癸二酸	Sebacic acid	Pharmaceutical Production
中天储能科技有限公司	Zhongtian Energy Storage Technology Co., Ltd.	半导体工艺用关键光刻胶材料	Key photoresist materials for semiconductor processes	Pharmaceutical Production

江苏湘园化工有限公司	Jiangsu Xiangyuan Chemical Co., Ltd.	常温有机过氧化物	Organic peroxides at room temperature	Pharmaceutical Production
江苏新瑞贝生物科技股份有限公司	Jiangsu Xinruibei Biotechnology Co., Ltd.	超高强耐磨钢板	Ultra-high-strength wear-resistant steel plate	Pharmaceutical Production
南京麦澜德医疗科技股份有限公司	Nanjing Mylande Medical Technology Co., Ltd.	3X小丝束碳纤维	3X small-tow carbon fiber Maintenance	Pharmaceutical Production
青岛高测科技股份有限公司	Qingdao Gaoce Technology Co., Ltd.	生物膜流化床(MBBR)集成设备	Biomembrane fluidized bed (MBBR) integrated equipment	Pharmaceutical Production
烟台台海玛努尔核电设备有限公司	Yantai Taihai Manuel Nuclear Power Equipment Co., Ltd.	欧六以上排放标准尾气催化净化用分子筛	Molecular catalytic purification of exhaust gas with emission standards above Euro VI Sieve	Pharmaceutical Production
山东奔腾漆业股份有限公司	Shandong Pentium Paint Co., Ltd.	丁二酸	Succinic acid	Pharmaceutical Production
武汉远大弘元股份有限公司	Wuhan Yuanda Hongyuan Co., Ltd.	含硫氨基酸营养强化剂	Sulfur-containing amino acid nutrition enhancer	Pharmaceutical Production
华润三九医药股份有限公司	China Resources Sanjiu Pharmaceutical Co., Ltd.	锂离子电池电解液	Lithium-ion battery electrolyte	Pharmaceutical Production
北京康辰药业股份有限公司	Beijing Kangchen Pharmaceutical Co., Ltd.	注射用尖吻蝮蛇血凝酶	Injectable agkistrodon hemocoagulase	Pharmaceutical
浙江海正药业股份有限公司	Zhejiang Hisun Pharmaceutical Co., Ltd.	米卡芬净钠	Micafungin sodium	Pharmaceutical
山东新华制药股份有限公司	Shandong Xinhua Pharmaceutical Co., Ltd.	布洛芬原料药	Ibuprofen API	Pharmaceutical
浙江仙居君业药业有限公司	Zhejiang Xianju Junye Pharmaceutical Co., Ltd.	留休激素类原料药	Resistance hormone APIs	Pharmaceutical
东富龙科技集团股份有限公司	Dongfulong Technology Group Co., Ltd.	药用真空冷冻干燥机	Medicinal vacuum freeze dryer	Pharmaceutical Production
上海群力化工有限公司	Shanghai Qunli Chemical Co., Ltd.	砜吡草唑原药	Methacrysalis sulfone technical	Pharmaceutical Production
河北宝力工程装备股份有限公司	Hebei Baoli Engineering Equipment Co., Ltd.	体外诊断试剂原料	In vitro diagnostic reagent raw materials	Pharmaceutical Production
常州博瑞电力自动化设备有限公司	Changzhou Borui Electric Automation Equipment Co., Ltd.	药用中硼硅玻璃管	Medicinal medium borosilicate glass tube	Pharmaceutical Production
山东省药用玻璃股份有限公司	Shandong Pharmaceutical Glass Co., Ltd.	中性硼硅玻璃模制药瓶	Neutral borosilicate glass molded pharmaceutical bottles	Pharmaceutical Production
北京市春立正达医疗器械股份有限公司	Beijing Chunli Zhengda Medical Equipment Co., Ltd.	人工关节假体	Artificial joint prosthesis	Prosthetics
上海微创医疗器械（集团）有限公司	Shanghai Micro-invasive Medical Devices (Group) Co., Ltd.	冠脉药物支架系统	Coronary drug stent system	Prosthetics
天士力医药集团股份有限公司	Tasly Pharmaceutical Group Co., Ltd.	复方丹参滴丸	Compound Danshen dripping pill	TCM

Concept Stocks

Concept Stock Name	Subarea	Ranking	Points
Dexamethasone	Immunity	28	429
Poxvirus prevention and treatment	Vaccines+	165	292
Monoclonal antibody concept	Vaccines+	176	281
immunity therapy	Immunity	177	280
Biological vaccines	Vaccines+	203	254
COVID-19 Drugs	Immunity	209	248
Vaccine cold chain	Vaccines+	231	226
influenza	Vaccines+	274	183
COVID-19 Testing	Vaccines+	275	182
Virus prevention	Vaccines+	282	175
Chinese medicine concept	TCM	302	155
Synthetic Biology	Synthetic Biology	305	152
Recombinant protein	Protein+	54	403
Syringe concept	Pharmaceutical Production	36	421
Heparin concept	Pharma	70	387
Longevity Drug	Pharma	87	370
Artemisinin	Pharma	94	363
Ursodeoxycholic acid	Pharma	164	293
Exclusive medicines	Pharma	216	241
Innovative drugs	Pharma	272	185
Weight loss pills	Pharma	281	176
Alzheimer's	Neuro	161	296
Human Brain Engineering	Neuro	295	162
Hepatitis concept	Medicine	181	276
Helicobacter pylori concept	Medicine	188	269
biomedicine	Medicine	361	96
In vitro diagnostics	Medical Devices	219	238
Medical device concept	Medical Devices	393	64
Montmorillonite powder	Health/Other	45	412
DRG/DIP	Health/Other	102	355
Vitamins	Health/Other	220	237

Healthy China	Health/Other	284	173
Medical Aesthetics	Health/Other	298	159
Gene Sequencing	Genetics	127	330
Assisted Reproduction	Genetics	190	267
CAR-T cell therapy	Cancer	243	214
Precision Medicine	BT+IT	133	324
Biometrics	BT+IT	311	146