Translation

The following document is the 13th Five-Year Plan—covering the years 2016-2020—of the Chinese Academy of Sciences (CAS), a huge state-run complex of laboratories and research institutions. Notably, this Plan names specific breakthroughs for CAS to make in 60 different emerging technologies. The Plan also calls on CAS to improve its S&T-related open-source intelligence collection. CSET has not yet observed a comparable CAS plan covering the years from 2021 on.

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Outline of the Chinese Academy of Sciences 13th Five-Year Development Plan
中国科学院“十三五”发展规划纲要

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Take the Lead Initiative, Leapfrog Development

Outline of the Chinese Academy of Sciences 13th Five-Year Development Plan

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Take the Lead Initiative, Leapfrog Development

Outline of the Chinese Academy of Sciences 13th Five-Year Development Plan

The "13th Five-Year Plan" period [2016-2020] is a decisive stage for China to comprehensively establish a moderately prosperous society (全面建成小康社会), an important period for the comprehensive completion of the task of building an innovation-oriented country (创新型国家), and a leapfrog development stage for the Chinese Academy of Sciences (CAS) to implement the "Take the Lead Initiative"[1] in an in-depth manner and basically achieving the "Four Take the Leads"[2] goals. The Outline of the *Chinese Academy of Sciences 13th Five-Year Development Plan* thoroughly implements the spirit of the National Science and Technology Innovation Conference, follows the relevant arrangements of the *Outline of the National Innovation-Driven Development Strategy*,[3] the *Outline of the 13th Five-Year Plan for National Economic and Social Development*, and the National 13th Five-Year Plan for *Scientific and Technological Innovation*,[4] and is based on the Step 1 strategic goals and key tasks determined in the *Chinese Academy of Sciences' Outline for the "Take the Lead Initiative" Plan and for Comprehensively Deepening Reform*.

Chapter One Overall Strategy

I. Development Environment

[1] Translator's note: The "Take the Lead Initiative" (“率先行动”) is a Chinese Academy of Sciences (CAS) talent recruitment plan launched in 2014. Under the Initiative, CAS aims to "take the lead in achieving leapfrog development of science and technology, take the lead in constructing a national bastion of innovative talent, take the lead in constructing a high-quality national S&T think tank, and take the lead in building a world-class scientific research institute" (率先实现科学技术跨越发展，率先建成国家创新人才高地，率先建成国家高水平科技智库，率先建设国际一流科研机构) by 2030.

[2] Translator's note: Xi Jinping mentioned the "Four Take the Leads" (“四个率先”) during his inspection of the Chinese Academy of Sciences (CAS) on July 17, 2013. The "Four take the Leads" are objectives for CAS to attain by 2030. They are: "Take the lead in achieving leapfrog development of science and technology, take the lead in constructing a national bastion of innovative talent, take the lead in constructing a high-quality national S&T think tank, and take the lead in building a world-class scientific research institute" (率先实现科学技术跨越发展，率先建成国家创新人才高地，率先建成国家高水平科技智库，率先建设国际一流科研机构).

[3] Translator's note: An English translation of the Outline of the National Innovation-Driven Development Strategy is available online at: https://cset.georgetown.edu/publication/outline-of-the-national-innovation-driven-development-strategy/.

[4] Translator's note: An English translation of the National 13th Five-Year Plan for Scientific and Technological Innovation is available online at: https://cset.georgetown.edu/publication/state-council-notice-on-the-publication-of-the-national-13th-five-year-plan-for-st-innovation/.

A new round of scientific and technological (S&T) revolution and industrial transformation is poised to take off, and global S&T innovation is accelerating, becoming the dominant force in reshaping the global structure. When our S&T flourishes, our [Chinese] race (民族) flourishes, and when S&T is strong, our nation is strong. Building China into a world S&T powerhouse[5] is the only way to achieve the great rejuvenation of the Chinese nation. Currently, the world is undergoing in-depth advancement in multi-polarization, economic globalization, cultural diversification, and social informatization (信息化). The world economy going through a tortuous recovery in the course of in-depth adjustment, and its growth is sluggish. The global governance system is undergoing profound changes, and the competition in comprehensive national strength with innovation as the core is becoming increasingly fierce. Global innovation activities have entered a new intensive period, and the trend of multi-polarization in the pattern of innovation is becoming more and more obvious. The United States, the European Union, Germany, Japan, Russia, and other countries have proposed new innovation strategies one after another to strengthen their S&T innovation layouts, reform and improve their innovation systems, and seize the commanding heights in S&T and industry. New innovative organizational models and scientific research paradigms continue to emerge, and S&T development presents a trend of breakthroughs and cross-convergences at multiple points. Cutting-edge basic research moving toward cross-integration development in the directions of expansion on the macro scale, intensification at the micro scale and extreme conditions, and fundamental scientific questions such as the structure of matter, the evolution of the universe, the origin of life, and the nature of consciousness are giving birth to major breakthroughs. The commanding heights of S&T development are advancing to deep space, deep sea, deep earth, and deep blue (深空、深海、深地、深蓝), environmental protection, health, and intelligence have become the key directions of innovation, and countless disruptive technologies are emerging, prompting major changes in industries and the development of emerging industries.

China's economic development has entered a new normal, the need to improve quality and efficiency and achieve transformations and upgrades is more urgent, and the reliance on innovation to drive and shape lead-the-way development (引领型发展) has become a necessary requirement. Currently, the problems of unbalanced, uncoordinated, and unsustainable economic and social development in China remain prominent, structural contradictions are more pronounced, and downward pressure on

[5] Translator's note: This translation renders the Chinese word 强国 qiángguó—which literally means "strong nation"—in English as "powerhouse," as in the phrase "world S&T powerhouse" (世界科技强国). For a more thorough discussion in English of the Chinese word qiángguó, see: https://www.newamerica.org/cybersecurity-initiative/digichina/blog/lexicon-wangluo-qiangguo/.

the economy is increasing. The bottleneck constraints of energy resources and the ecological environment have not been fundamentally reversed, and the shift in gears of economic growth, labor pains of structural adjustment, and difficulties of dynamic conversion (动能转换) are intertwined. We are faced with multiple challenges such as stabilizing growth, adjusting structures, preventing risks, and improving people's livelihoods. During the "13th Five-Year Plan" period, the trend of China's economic development evolving to a stage with a more advanced form, a more optimized division of labor, and a more rational structure is increasingly prominent, and new drivers of growth are being nurtured and formed. We must thoroughly implement the innovation-driven development strategy, adhere to the innovative, coordinated, green, open, and shared development concept, and make innovation the number-one driving force of development. With the implementation of new major national strategies such as the "Belt and Road Initiative,"[6] the coordinated development of Beijing-Tianjin-Hebei, and the Yangtze River Economic Belt, as well as the in-depth promotion of important strategic deployments such as the "Popular Entrepreneurship and Mass Innovation" ("双创") Action Plan, supply-side structural reform, "Internet+" action plans, "Made in China 2025,"[7] big data, and maritime powerhouse, it is urgent that we give full play to the leading role of S&T innovation in comprehensive innovation and cultivate new driving forces and open up new spaces for economic and social development.

China's S&T development stands at an important turning point, the reform of the S&T system is advancing in depth, and the national innovation system and innovation structure are facing profound changes. China has become a great power (大国) with important S&T influence, and its overall S&T capabilities have continued to increase. In some important fields and directions, China stands among the leading ranks of the world. In some cutting-edge directions, China has begun to enter the pulling even and taking the lead stages. China is currently in an important period of transition from quantitative accumulation to qualitative leapfrogging and from breakthroughs at specific points to system capability improvement. On the whole, China has achieved the strategic goal of "securing a seat at the table" in major S&T fields and directions, and is now in a critical period of leapfrog development. However, compared with developed S&T countries and compared with the goal of building China into a world S&T powerhouse, China's S&T foundation is still weak. There is still a big

[6] Translator's note: The "Belt and Road Initiative" ("一带一路"), abbreviated BRI, refers to the Silk Road Economic Belt (丝绸之路经济带) and the 21st Century Maritime Silk Road (21世纪海上丝绸之路).
[7] Translator's note: An English translation of the Made in China 2025 strategy is available online at: https://cset.georgetown.edu/publication/notice-of-the-state-council-on-the-publication-of-made-in-china-2025/.

gap in innovation capability and level, and there are still many problems in institutions, mechanisms, and innovation ecosystems. At present, China is accelerating its drive to become an innovation-oriented country and making all efforts to build itself into a world S&T powerhouse. The reform of the S&T system has entered a critical stage and top-level design has gradually improved. Major reform measures and supporting policies have been intensively introduced, such as the management of central government S&T plans, the conversion of S&T achievements into practical applications (科技成果转化), and comprehensive innovation and reform experiments, the construction of national laboratories, comprehensive national science centers, national technology innovation centers, and S&T innovation centers with global influence has been accelerated, and the establishment of a national innovation system with organic interaction, coordination, and efficiency among all entities, aspects, and links is accelerating. With the deepening of reforms, China's innovation pattern will undergo major changes, prompting a significant improvement in innovation capabilities.

CAS has entered onto its new journey of the "Take the Lead Initiative" and we face a new situation of competitive and cooperative development, with arduous and difficult tasks of reform, innovation, and leapfrog development. During the "12th Five-Year Plan" period [2011-2016], in accordance with the requirements of the "Three Set our Sights on" and the "Four Take the Leads,"[8] CAS took S&T innovation as the central task and "producing achievements, producing talents, and producing ideas" as the mission in earnestly organizing the implementation of the "Take the Lead Initiative" plan to actively deepen the reform of the S&T system and accelerate the production of major achievements. We achieved world-leading original results in basic research fields such as quantum communication, neutrino oscillation, and high-temperature iron-based superconductivity, and achieved a series of breakthroughs in key and core technologies (关键核心技术) in manned spaceflight and lunar exploration projects, deep-sea exploration, the BeiDou Navigation Satellite System, and other major national projects. We also made important innovative contributions to supporting and serving economic and social development and national defense S&T innovation. We

[8] Translator's note: The "Three Set our Sights on and the Four Take the Leads" (“三个面向、四个率先”) is the directive, established in 2015, of how the Chinese Academy of Sciences (CAS) should be run. The "Three Set our Sights on" are: "Set our sights on the cutting edge of world S&T, set our sights on the major needs of the nation, and set our sights on the main battlefield that is the domestic economy" (面向世界科技前沿，面向国家重大需求，面向国民经济主战场). The "Four Take the Leads" are: "Take the lead in achieving leapfrog development of science and technology, take the lead in constructing a national bastion of innovative talent, take the lead in constructing a high-quality national S&T think tank, and take the lead in building a world-class scientific research institute" (率先实现科学技术跨越发展，率先建成国家创新人才高地，率先建成国家高水平科技智库，率先建设国际一流科研机构) by 2030.

made important progress in the reform of the academician system, the reform of the categorization of research institutes, the construction of the talent cadre, the construction of S&T think tanks, open cooperation, the integration of science and education, Party building, and the construction of a culture of innovation. This has laid a solid foundation for leapfrog development during the "13th Five-Year Plan" period.

Box 1: The "Three Set our Sights on" and the "Four Take the Leads"

- On July 17, 2013, General Secretary Xi Jinping inspected CAS and gave an important speech, in which he proposed that CAS "take the lead in achieving leapfrog development of science and technology, take the lead in constructing a national bastion of innovative talent, take the lead in constructing a high-quality national S&T think tank, and take the lead in building a world-class scientific research institute."
- On August 8, 2014, General Secretary Xi Jinping gave important instructions regarding the *Chinese Academy of Sciences Outline for the "Take the Lead Initiative" Plan and for Comprehensively Deepening Reform* and proposed the requirements of the "Three Set our Sights on," which are to “set our sights on the cutting edge of world S&T, set our sights on the major needs of the nation, and set our sights on the main battlefield that is the domestic economy.”
- In January 2015, CAS established the "Three Set our Sights on" and the "Four Take the Leads" as the directive for running CAS in the new era.

As we enter the new era, the CAS is facing a more complex new situation and many difficulties and challenges. We still have a long way to go to basically achieve the "Four Take the Leads" goals. **First**, there is a big gap between our S&T innovation capabilities and S&T layout and the international S&T cutting-edge level and new requirements for leading innovation and development. There are not enough achievements with symbolic significance for S&T progress and that have a leading and driving role in the development of the country and industry, and problems such as low-level duplication, homogeneous competition, and fragmented expansion have not been fundamentally resolved. **Second**, each unit of the national innovation system is accelerating their competitive and cooperative development, and the innovation capabilities of universities, enterprises, and industrial research institutions have significantly improved. The research institutions of CAS need to further clarify their

positioning and enhance their core competitiveness and irreplaceability. **Third**, the pressure of competition for talent continues to increase, the number of leading scientists and high-level academic leaders recognized by international peers is still insufficient, the space where outstanding young talents can grow needs to be expanded, and the mechanisms for attracting and selecting top talents from around the world need to be improved. **Fourth**, innovation governance capacity needs to be improved, and the institutions and mechanisms for categorized management and interdisciplinary organization of major innovation activities still need to be improved and perfected.

Our overall judgment is that CAS is in a critical period of difficult reforms and leapfrog development, with both opportunities and challenges. It is necessary to further enhance the sense of responsibility and urgency for reform and innovation, firmly establish self-confidence in innovation, actively adapt to development requirements, unswervingly deepen reform, concentrate efforts to promote innovation, and strive to achieve the goals of the "Four Take the Leads."

II. Guiding Ideology and Development Goals

(i) Guiding Ideology

Guided by the theory system of socialism with Chinese characteristics, we shall earnestly implement the spirit of the 18th Party Congress and the Third, Fourth, and Fifth Plenums of the 18th Central Committee, implement the spirit of General Secretary Xi Jinping's series of important speeches, implement the "Four Comprehensivelys"[9] strategic layout and the innovative, coordinated, green, open, and shared development concept, implement the spirit of the National Science and Technology Innovation Conference, act in accordance with the general requirements of the national innovation-driven development strategy, adhere to the new era policies of the **"Three Set our Sights on"** and the **"Four Take the Leads"** in running CAS, adhere to **running CAS democratically, strengthening CAS with talents, and opening up to allow CAS to prosper (民主办院、人才强院、开放兴院)**, focus on improving innovation capabilities and leading innovation and development, take the production of innovative achievements, innovative talents, and innovative thinking as our orientation,

[9] Translator's note: The "Four Comprehensivelys" ("四个全面"), as defined at the time of the 2016 publication of the CAS 13th Five-Year Plan, were: comprehensively establish a moderately prosperous society, comprehensively deepen reform, comprehensively govern the country according to law, and comprehensively govern the Party strictly (全面建成小康社会、全面深化改革、全面依法治国、全面从严治党). When the Chinese Communist Party declared in October 2020 that China had achieved a moderately prosperous society, the Party swapped out the original first "comprehensively" for a new one, namely "comprehensively build a modernized socialist country" (全面建设社会主义现代化国家).

be driven by comprehensively deepening reforms, take the categorization reform of research institutes and the construction of national laboratories as our focus and breakthrough point, adjust and optimize the S&T layout, strengthen the construction of the talent cadre, an S&T think tank, and a first-class scientific research institute, and ensure that the goals of the "Four Take the Leads" are basically achieved as scheduled, so as to make major innovation contributions by virtue of national strategic S&T forces in the service of building an innovation-oriented country and a world S&T powerhouse.

(ii) Development Goals

According to the phased goals of the "two-step" (“两步走”) development strategy of the "Take the Lead Initiative" plan, by 2020, we will basically achieve the goals of the "Four Take the Leads." As China implements the innovation-driven development strategy and builds an innovation-oriented country, we will give full play to the backbone and leading role of national strategic S&T forces and lay a more solid foundation for the full realization of the goals of the "Four Take the Leads" by around 2030.

Box 2: "Two-step" Development Strategy of the "Take the Lead Initiative" Plan
• Step 1 is to complete the tasks of "Innovation 2020" (“创新2020”) with high quality by around 2020, that is, by the 100th anniversary [2021] of the founding of the Party, basically achieving the goals of the "Four Take the Leads" and making important contributions to China's entry into the ranks of innovation-oriented countries. • Step 2 is to fully realize the goals of the "Four Take the Leads" by around 2030 and play an irreplaceable role in bringing China to the forefront of innovation-oriented countries. This will lay a solid foundation for building China into a world S&T powerhouse by the 100th anniversary [2049] of the founding of New China and the 100th anniversary [also 2049] of the founding of CAS and provide strong support for the realization of the Chinese dream of the great rejuvenation of the Chinese nation.

1. Take the Lead in Achieving Leapfrog Development of Science and Technology

Setting our sights on the cutting edge of world S&T, setting our sights on the

major needs of the nation, and setting our sights on the main battlefield that is the domestic economy, and focusing on the key directions of the five major sectors, namely strategic areas of competition (战略必争领域), basic science and cutting-edge interdisciplinary research (交叉前沿), strategic emerging industries, population health and sustainable development, and national defense S&T innovation, we will work hard for originality and uniqueness, make efforts to compensate for shortcomings, seize the commanding heights in some strategically contested areas, become a leader and pioneer in several emerging cutting-edge interdisciplinary fields, play a leading and key role in major national S&T tasks, make breakthroughs in a number of key and core technologies that restrict economic and social development, effectively solve a number of strategic S&T issues related to the overall situation of modernization, strive to produce a batch of major original achievements with symbolic significance in building an innovation-oriented country, produce a batch of major strategic technologies and products with significant visibility, produce a batch of major demonstration and transformation projects with significant benefits and leading and driving roles, provide a more effective supply of mid-to-high-end technology, lead the development of future technologies and industries, and significantly enhance national innovation capabilities and the international competitiveness of related industries, so as to greatly increase our contributions to S&T progress, national security, and economic and social development.

Box 3: Indicators Relevant to the Leapfrog Development of Science and Technology

- By 2020, the ratio of expenditures among basic research, applied research, and experimental development R&D (试验发展研发) activities will remain at roughly 4:5:1.
- Our overall level in disciplines such as physics, chemistry, materials science, mathematics, environment and ecology, and earth sciences will rank among the world leaders.
- In major disciplines, the number of citations in international S&T papers will place us among the best major national scientific research institutions in the world.
- We will form a batch of independent intellectual property (IP) and industrial technology standards, provide system solutions, and promote technology demonstrations and industrialization.
- The quality of patents will greatly improve, with more than 10,000 patents implemented, and the five-year implementation rate of valid patents will increase from 10% in the "12th Five-Year Plan" to 20%. In 2020, the total contract transactions in the technology market will exceed 5 billion Chinese yuan Renminbi (RMB).
- IP profits in 2020 will double compared to 2015. The transfer and conversion of S&T achievements into practical applications will bring new sales revenue to social enterprises (社会企业) and CAS-invested enterprises totaling more than RMB 4.8 trillion, generate RMB 480 billion in taxes on profits, and create 150,000 jobs. We will incubate 5,000 "popular entrepreneurship and mass innovation" enterprises, strengthen and expand a batch of globally competitive innovative enterprises and "hidden champion" enterprises, and provide the "four technology" services (technology development, technology ownership transfer, technology consulting, and technology services) for no less than 20,000 enterprises.

Box 4: "Three Majors" Output

The "Three Majors" (“三重大”) output goals are the fundamental guarantee for basically achieving the "Four Take the Leads."

- **Major original achievements** mainly refer to making major scientific discoveries, opening up new disciplines, putting forward major innovative theories, leading the development of disciplines and technologies, and creatively solving major S&T problems.
- **Major strategic technologies and products** mainly refer to achieving breakthroughs in key and core technologies, systems integration, and system solutions provision, forming first-mover advantages to support China's innovation and development, and seizing the strategic commanding heights related to the overall situation and long-term development of the country.
- **Major demonstration and conversion projects** mainly refer to the promotion, conversion, and application of major technologies, creating new products, new demands, and new business formats (新业态), leading and driving the transformation and upgrading of relevant industries, or directly producing significant economic and social benefits.

2. Take the Lead in Constructing a National Bastion of Innovative Talent

We will optimize the structure of the academician team, effectively play the role of academicians, and build a bastion of talent that brings together experts. We will adhere to the combination of innovation and practice and of [talent] training and recruitment, build an S&T innovation team of good quality, appropriate scale, and reasonable structure that adapts to needs and possesses international competitiveness, and strive to achieve the goal of building a bastion with "Tens of Millions" of innovative talents. We will make breakthrough progress in the innovation of talent development institutions and mechanisms and greatly improve the internationalization level of the talent cadre. We will build a world-class education system with Chinese characteristics that integrates science and education, and we will form a new model for training innovative talents.

Box 5: Indicators Relevant to Innovative Talent Cadre Building
• Goals of building the "Tens of Millions" cadre: dozens of S&T experts with global influence, more than 100 strategic scientists and leading talents, more than 1,000 top-notch S&T talents, and more than 10,000 backbone talents. • By 2020, we will have 68,000 institutional (事业编制) personnel throughout CAS, including 10,000 senior specialists and technical personnel. • The average annual turnover rate of personnel will remain around 10%. The number of postdoctoral researchers (postdocs) working at stations will exceed 100,000. • Foreign recruits will account for more than 3% of scientific research personnel, of which more than 6% are in basic and cutting-edge fields. • Foreign students will account for more than 5% of graduate students. • During the "13th Five-Year Plan," a total of 77,000 graduate students and a batch of high-quality innovative and entrepreneurial talents will be sent out into society.

3. Take the Lead in Constructing a High-Quality National S&T Think Tank

We will give full play to the advantages of S&T, build a research system and management platform for a high-level S&T think tank, continuously generate innovative ideas, form a series of outputs and academic brands, and put forward scientific and forward-looking constructive suggestions on major issues in China's economic and social development. We will exert an authoritative influence in national S&T planning, scientific policy, and S&T decision-making and become a distinctive and internationally renowned S&T think tank that is relied on by the state and trusted by society.

Box 6: Main Goals of S&T Think Tank Construction
• We will build a high-level and normalized [academic] discipline development strategy research system with academic departments as the mainstay. We will deploy projects covering all major disciplines and focus on the deployment of research on certain emerging and interdisciplinary development strategies. • We will establish a consultation and evaluation system combining academic departments and institutional departments, complete third-party evaluation tasks assigned by the state, and independently deploy consultation tasks on major S&T issues related to China's economic and social development. • We will establish a research and monitoring system based on scientific data and S&T intelligence (科技情报) and focus on monitoring the development trends in global S&T and the S&T strategies and major action plans of major countries throughout the world. We will build a sustainable development scientific data monitoring integration platform and decision support system for China. • We will focus on building the Institutes of Science and Development (科技战略咨询研究院), build a service platform that efficiently helps academic departments play the role of think tanks and a comprehensive integrated platform to allow all of CAS to carry out research on S&T strategies and S&T policies, and become an important vehicle for high-end S&T think tanks in CAS.

4. Take the Lead in Building a World-Class Scientific Research Institute

We will give full play to the advantages of integrating scientific research institutes, academic departments, and educational institutions and build a world-class scientific research institution with significant influence, appeal, and competitiveness. We will basically form the institutions and mechanisms of modern scientific research institutes with accurate positioning and scientific management and develop and improve the innovation ecosystem. In some disciplines and fields in which we have an advantage (优势学科领域), we will create a number of scientific research centers and bastions of innovation with distinctive academic characteristics and global influence, which will become landmark achievements in China's leapfrog S&T development and the construction of an innovation-oriented country.

Box 7: Main Goals of First-Class Scientific Research Institution Construction
• On the whole, the research institutes affiliated with CAS will have a leading position in China. Most research institutes will keep pace with research institutes in scientifically and technologically developed countries, and about one-third of the research institutes will occupy international leading positions in fields in which we have an advantage. • We will build a batch of innovation research institutes, innovation centers of excellence, big science research centers (大科学研究中心), and specialized research institutes (特色研究所). We will basically complete the design of institutions and mechanisms for the overall layout of, categorized positioning of, and categorized management of in the construction of these four types of institutions. • Targeting the cutting edge of international S&T and guided by national goals and strategic needs, we will actively organize forces to undertake the tasks of national laboratory (国家实验室) construction. • By 2020, per-capita scientific research equipment throughout CAS will basically reach the level of the middle ranks of developed countries, and an open and shared system of scientific research equipment featuring high-quality operations, high-efficiency services, and high-level support will be initially established. • We will initiate 3-5 major international science programs and build about 10 overseas scientific and educational institutions and 5-10 CAS-The World Academy of Science (TWAS) centers of excellence. • We will play an important role in major international S&T organizations and deeply integrate into the global innovation network and innovation governance system.

Chapter Two Technology Layout Concerning the Realization of Leapfrog Development

According to "setting our sights on the cutting edge of world S&T, setting our sights on the major needs of the nation, and setting our sights on the main battlefield that is the domestic economy," based on the requirements of the goal of taking the lead in achieving leapfrog development of science and technology, and on the basis of the discipline foundation and important fields the CAS has formed over the long term, we will leverage the advantage of teams and platforms and insist on doing what must be done and refraining from what must not be done. In accordance with the principles

of "**adhering to positioning, highlighting distinctive strengths, pursuing excellence, focusing on interdisciplinary fields, strengthening the foundation, grasping important points and learning new things, integrating advantages, and collaborating openly**" (“恪守定位、突出特色，追求卓越、注重交叉，强基固本、抓重育新，集成优势、开放协同”), we will focus on eight major innovation fields and related key directions, including **basic and cutting-edge interdisciplinary research, advanced materials, energy, life and health, marine, resources and ecological environment, information, and optoelectronics (光电) and space** as well as two types of public support platforms, including **major national S&T infrastructure and data and computing platforms**. We will implement the future S&T layout for CAS, deploy a batch of major breakthroughs that are expected to achieve innovative leaps, presciently cultivate a batch of key directions that will shape new advantages in the future, coordinate and promote the categorization reform of research institutes and the construction of national laboratories, coordinate and organize major S&T innovation activities, promote the "Three Majors" outputs, ensure the achievement of leapfrog development goals, and support and lead economic and social development.

Box 8: Key Fields and Directions in the S&T Layout	
Eight Major Innovation Fields	**Research Directions**
1. Basic and cutting-edge interdisciplinary research	Interdisciplinary research incorporating mathematics, physics, and chemistry
2. Advanced materials	Material creation and new material applications
3. Energy	Energy
4. Life and health	Health, biodiversity, and modern agriculture
5. Marine	Marine
6. Resources and ecological environment	Resources and ecological environment
7. Information	Information and smart manufacturing
8. Optoelectronics and space	Optoelectronics and space

I. Major Breakthroughs Expected to Achieve Innovative Leaps (60, excluding national defense S&T innovation)

(i) Basic and Cutting-Edge Interdisciplinary Research (8)

1. Mathematics interdisciplinary research direction

(1) The Langlands Program and the Millennium Prize Problems. Through the cross-integration of multiple branches such as number theory, representation theory, algebraic geometry, and harmonic analysis, we will cultivate and condense mathematical problems and conjectures that can guide the development of mathematics. We will strive to achieve results on the level of international mathematical and science awards in several directions of major mathematical problems such as the Langlands Program, the Riemann conjecture, and the Birch and Swinnerton-Dyer (BSD) conjecture.

2. Physics interdisciplinary research direction

(2) Several cutting-edge issues in condensed matter science. We will explore new high-temperature superconducting materials, study superconducting mechanisms in depth, and develop new theories of high-temperature superconductivity. We will explore new topological insulators, topological semimetals, and topological superconductors, discover new phenomena, and establish new theories. In accordance with the concept of "new phenomena, new effects, new theories, and new algorithms," we will develop new growth points for condensed matter physics and continue to produce major achievements of international importance.

(3) New discoveries and research in particle physics. Relying on the experiments of large scientific facilities, we will carry out cutting-edge research on particle physics and particle astrophysics, including neutrino physics, cosmology, charm [quark] physics, and hadron physics, and make major breakthroughs in the search for and study of multiquark states and glueballs. We will complete the Jiangmen neutrino experiment, use the Daya Bay neutrino experiment to further improve the measurement accuracy of neutrino mixing angle θ_{13}, test the unitarity of the mixing matrix, and search for the new physics, and strive to maintain China's international superiority in this direction.

(4) The structure, formation, and evolution of galaxies. We will use the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST), the Five-hundred-meter Aperture Spherical radio Telescope (FAST), the Delingha Millimeter Wave Telescope, Tianma Radio Telescope, Lijiang 2.4-meter Telescope, and other multi-band and multi-method observation equipment along with large-scale numerical simulations and original ideas about physics to accurately describe the structure of the Milky Way, detect the characteristics of galaxies in various stages in the universe, build accurate formation and evolution models, improve our understanding of the origin of

galaxies and related structures, and provide a basis for the study of the origin of the universe, dark matter, and dark energy.

(5) Superconducting quantum detection and applications. We will carry out cutting-edge research on superconducting sensors, detectors, and superconducting circuits, form a series of superconducting sensors and detectors, achieve world-class performance, and realize application demonstrations in the fields of quantum information, high-precision satellite ranging, and single-photon imaging.

(6) Research and verification of system mechanics problems in extreme environments. Focusing on major projects such as high-speed cruise [missiles], deep-sea oil-gas-water separation, and high-speed rail, we will use the methods of system mechanics to make breakthroughs in hypersonic cruise [missile] theory, make advances in key technologies such as multiphase flow centrifugal separation methods and material/structure very high cycle fatigue damage, form system solutions, and test and verify hypersonic cruise flight, deep-water oil-gas-water separation technology, and high-speed train key component life extension.

3. Chemistry interdisciplinary research direction

(7) Molecular engineering and molecular imaging of functional systems (功能体系). Targeting key scientific issues such as the synergistic effects of intermolecular interactions and the controllable construction of surface and interface structures, we will explore the relationship between molecular nanostructure and function at different levels, develop structural characterization and property measurement techniques with extreme resolution capabilities (极限分辨能力), and realize cross-scale physical and chemical property research and imaging technology with spatial, temporal, and energy resolution. With the precise fabrication of optoelectronic functional systems as the core and multi-component and multi-level nano-assembly as the means, we will construct functional modules for wearables and artificial intelligence (AI) applications and promote the development of molecular function and nano-system creation towards greater intelligentization (智能化).

(8) The dynamic nature and regulation of energy-chemical conversion. With the goal of solving major S&T problems in the process of energy-chemical conversion in China, we will develop new experimental techniques, theoretical methods, and models, achieve high-sensitivity in-situ dynamic detection of relevant chemical reactions, and reveal the basic laws and mechanisms of important processes such as combustion, heterogeneous catalysis, and photocatalysis at the microscopic atomic and molecular level and the macroscopic statistical level and achieve dynamic regulation.

(ii) Advanced Materials (4)

1. Material creation direction

(9) Exploration of the structural design, preparation, and application of high-performance materials. Based on the concept of "material genomes," we will design and develop high-performance metals and energy conversion and biomedical materials, realize the scale-controlled preparation of graphene and carbon nanotubes, develop new theories for the multi-scale regulation of material structure and properties, significantly improve the comprehensive performance of nano-metal materials, thermoelectric materials, two-dimensional atomic crystal materials, and biomedical materials, and provide a solid theoretical basis and technical support for the development of strategic emerging industries such as information, high-end equipment manufacturing, new energy, and human health.

(10) Synthetic natural rubbers. We will research low-cost and high-purity isoprene monomer production technology, develop new serialized high-performance products, continue to promote the industrialization of the artificial synthesis of natural rubber, achieve large-scale production, and ensure the safe and stable operation of already constructed rare earth isoprene rubber industrialization equipment with an annual output of 30,000 tons.

2. New materials application direction

(11) Focus on transformative nano-industry manufacturing technology. We will strengthen the research and development of safe starter batteries with long life mainly based on lithium batteries and improve the industrial level of starter batteries through nanotechnology. We will promote the application of nanoscale green printing, nanoscale printing of electronics, and 3D printing in several important industries. We will develop nanocatalysis technologies such as oxygen-free synthesis of olefins from methane and realize the efficient utilization of methane and other bulk chemicals.

(12) New energy vehicles. We will integrate the R&D advantages of CAS in batteries, motors, electronic controls, and lightweight body materials and support Chinese auto companies as they build a new generation of new energy vehicles. We will focus on the research and development of high-performance power lithium batteries, low-cost carbon fiber, and their composite parts, solve the processing and engineering problems in the mass production process, and realize the launch of new energy vehicles that use carbon fiber composite materials as their body structure.

(iii) Energy (5)

(13) Cutting-edge research in fusion plasma physics. Relying on the Experimental Advanced Superconducting Tokamak (EAST) installation that has

completed major upgrading and transformation projects, we will solve several key S&T problems in the research of steady-state high-performance plasma physics, break through the key S&T bottlenecks for the construction of 1-2 fusion reactors, and maintain China's high-performance steady-state plasma research at the international leading level for the long term.

(14) Clean and efficient coal use technology and demonstrations. We will carry out research and development for coal pyrolysis-combustion and pyrolysis-gasification system integration technology and complete technology demonstrations such as for 350MW supercritical circulating fluidized beds, improving energy efficiency by 5-8 percentage points. We will optimize and upgrade key technologies for coal conversion/synthesis, complete a series of coal liquefaction and gasification and high-value chemical demonstration projects, achieve oil substitution of more than 30 million tons, and promote technological progress in the coal utilization industry.

(15) Advanced nuclear fission energy of the future. We will make breakthroughs in all key technologies and integration technologies, master the R&D technology for a series of key materials, processes, and special equipment, build the world's first molten salt simulation reactor, build a $2MW_t$ molten salt experimental reactor for the purpose of experimental verification of the thorium-uranium cycle, raise the overall technical level to the international leading level, and form a thorium molten salt reactor (TMSR) technology industry chain through cooperation with enterprises. We will build an accelerator-driven spent fuel regeneration cycle verification system with a fast neutron flux of 1014, carry out 100g-scale spent fuel processing experiments, carry out irradiation testing on renewable fuel model components and structural materials, complete the integrated verification of transmutation, growth, and production capacity, provide original system solutions for the sustainable development of nuclear fission energy, carry out substantive cooperation with enterprises, and build large-scale R&D demonstration bases.

(16) Advanced power technology based on efficient thermal conversion. We will carry out research and development for light engine and new-principle engine (新原理发动机) technology and establish a light power propulsion (轻型动力推进) design R&D verification system. We will carry out R&D for the high-efficiency power technology of distributed energy system power islands and complete the demonstration and verification of 35MW gas turbines.

(17) Demonstration of renewable energy and multi-energy complementary applications. We will integrate many key technologies such as photovoltaics, solar thermal, wind power, compressed air energy storage, all-vanadium redox flow batteries, sodium-sulfur batteries, and other large-scale energy storage and

distributed energy supply technologies. In the Zhangjiakou Renewable Energy Application and Comprehensive Innovation Demonstration Zone (张家口可再生能源应用综合创新示范区) and other places, we will complete large-scale application demonstrations of multi-energy complementary technologies to lay the foundation for subsequent industrialization.

(iv) Life and Health (17)

1. Health Direction

(18) Brain science and brain-inspired intelligence research. Taking the neural basis of brain cognitive function and a brain-like intelligence computing model as our core scientific issue, we will achieve world-leading results in cutting-edge fields such as brain science, brain-like machine intelligence technology, and early diagnosis and precise intervention for brain diseases and promote the development of the Chinese population health and intelligence industry.

(19) The structure, function and regulation of biological macromolecular complexes. Guided by major basic scientific issues in the life process and supported by the development of new technologies and methods for the study of biological macromolecular complexes, we will conduct research in fields such as chromatin and genetic information decoding, membrane protein structure and function, biofilm integration, pathogens, and other macromolecular machines. We will make major achievements in areas such as advanced chromatin structure, autophagy, eukaryotic membrane proteins, highly pathogenic pathogens, non-coding nucleic acids, and in situ bioimaging and advance our knowledge and understanding of the nature of life.

(20) Molecular regulation of cell fate determination. We will focus on the regulation of epigenetics by nucleic acid modification and metabolism, the regulation of cell lineage establishment by signaling networks, and the regulation of cellular activities by dynamic changes in subcellular structure, and unravel the mysteries of how biomolecules regulate cell proliferation and movement, differentiation and transdifferentiation, apoptosis and necrosis, and aging and disease.

(21) Pathogenic microorganisms and host immunity. We will focus on the traceability and cross-species transmission mechanisms of important pathogenic microorganisms and their interaction with the host and study important scientific issues such as the transmission processes and laws of mutation of pathogenic microorganisms, the key mechanisms by which pathogenic microorganisms establish and maintain infection, and host immune response and protection against pathogens. We will provide new targets and new strategies for the development of effective infectious disease prevention and treatment and provides a theoretical basis for the

prevention and treatment of major infectious diseases in China.

(22) Personalized medicine—Inclusive new drug development based on disease molecular typing. Focusing on tumors and metabolic diseases and targeting liver cancer, gastric cancer, type 2 diabetes, and other major and complex diseases with high incidence in the Chinese population, we will develop new theories, new methods and new technologies for personalized medicine research and promote the transformation from disease molecular typing to personalized medicine R&D.

(23) Organ repair and reconstruction. For major diseases of the nervous, cardiovascular, digestive, reproductive, and metabolic systems and with the goal of tissue regeneration, organ repair, organ reconstruction, and replacement, we will answer basic scientific questions such as cell potency and fate transition mechanisms, research and develop key technologies for organ repair and reconstruction, and promote the improvement of the people's health and the development of the health industry.

(24) Biosynthesis. Concentrating on the needs of green and low-carbon sustainable development, based on methods such as synthetic biology and systems biology, and focusing on the development of enzyme catalytic systems and cell catalytic systems, we will achieve the biosynthesis of major chemical products, technological improvements for fermented products, and green and clean production in heavily polluting industries, promote the development of the bio-based materials industry, develop the construction of technology platforms such as single-cell high-throughput screening, achieve breakthroughs in a number of key technology systems and representative products in the field of biomanufacturing, and promote improved industrial competitiveness.

(25) Health assurance technology and equipment. With the goal of improving the physical functioning of urban and rural residents, the awareness rate and control rate of chronic illnesses, and healthy aging, we will comprehensively apply relevant research methods from biology, physics, information, engineering materials, and other disciplines, develop various health management technologies and products such as health identification, assessment, decision-making, and intervention, and carry out the collection, analysis, and application of health big data based on biosensing, wearable devices, and mobile medical technology. We will research and develop the high-end medical equipment and low-cost serialized health promotion equipment that are urgently needed in clinical practice to provide scientific and technological support for the establishment of an inclusive health system.

2. Biodiversity direction

(26) Evolutionary analysis and regulation of complex animal traits. We will perform cross-species, large-scale, multi-omics analysis of the causes of complex traits in important animals, focusing on non-human primates and other important animals, to achieve efficient gene editing and trait regulation, establish a theoretical and technical system of evolutionary systems biology for the study of complex traits, and provide a new theoretical and technical basis for the prevention and treatment of human diseases, improvement of the economic traits of animals, and special-function bionics.

(27) Evaluation and transformation of strategic biological resources. We will build a national strategic biological resource industrialization service system, systematically carry out the exploration and functional evaluation of biological resources as well as research on their applications in the industrial and agricultural fields, convert biological resources into reactive intermediate matter (活性中间物质) libraries, cooperate with downstream enterprises to convert active matter (活性物质) into potential drugs and functional compounds, promote the development of the biological industry, and provide system solutions.

(28) Large-scale regional biodiversity patterns and life strategies. Through big data-driven methods, we will conduct integrated research on the overall biodiversity of various categories. Through the application of environmental DNA barcoding, large-scale field test observations, and remote sensing visualization technology, we will conduct quantitative, geo-located, and fine-grained research on biodiversity pattern dynamics and species adaptation strategies, explore the establishment of a universal life strategy index, predict the increase and decline of species and their distribution patterns, and achieve major breakthroughs in the fields of ecology and evolutionary biology.

3. Modern agriculture direction

(29) Major principles and technologies of pest-oriented prevention and control based on biological information flow manipulation. We will systemically analyze the signaling pathways of information flow between organisms and molecular mechanisms for regulation during the outbreak of crop pests and diseases, conduct artificial simulation, interference, and manipulation of information flows, develop innovative pest prevention and control strategies and general technologies for life sciences, and make new breakthroughs in major scientific theories of crop pest prevention and control.

(30) Analysis of the regulation mechanisms of specific plant trait formation and directional development. We will focus on the basis of genetics, material, and

energy metabolism for the formation of complex traits in plants, clarify the molecular regulation mechanisms of plant growth and development and the environmental shaping mechanisms of trait formation, and develop innovative theoretical systems for high-yield, high-quality, efficient, and sustainable agricultural production.

(31) Innovative molecular modular design breeding system. With rice as our primary focus and wheat and carp as secondary foci, we will analyze the molecular modules (分子模块) of important agronomic (economic) traits such as high yield, stable yield, high quality, and high efficiency, reveal the systematic analysis and coupling rules of molecular modules, optimize the best variety design strategies for multi-module assembly, cultivate new strains (species) of elementary module designs with significantly improved yields, create system solutions and new breeding technologies for the cultivation of a new generation of super varieties, establish a modern biotechnology breeding innovation system, and provide S&T support for ensuring China's food security.

(32) Demonstrations of agricultural transformation and development. On the basis of the "Bohai Granary" demonstration project, targeting the main distribution area of 60% low- and medium-yield fields (800 million *mu* [131,800,000 acres]) with great potential for improving production capacity and working from the six directions of soil improvement and quality improvement - stress tolerance (耐逆适生) - resource optimization - precise management - model innovation - industrialization, we will carry out three-level end-to-end design and innovation for basic research, general purpose key technologies, and technology integration demonstrations, carry out S&T projects for the transformation of low- and medium-yield fields, and achieve sustainable production and efficiency gains.

(33) Regional demonstration of modern agriculture. We will carry out the integration of mechanization, informatization, intelligentization, and efficient agricultural production technology suitable for modern large-scale farms in the Northeastern plains. In Hulunbuir, Ningxia, Gansu, and other regions, we will build ecological grass industry technology R&D and applications and integration and demonstrations for "introducing grass into fields." We will carry out integration and demonstrations of characteristic high-value ecological agriculture technology in western provinces and regions according to local conditions. In Qinghai and other ethnic minority areas, we will explore the construction of a marketized and feasible technology system for increasing the income of farmers and herdsmen.

(34) Environmentally friendly offshore aquaculture techniques. We will build marine ecological pastures in Shandong, Guangdong, and other places, form key technology integration for breed creation, healthy breeding, and disease control of fish,

shrimp, sea cucumber, shellfish, and seaweeds, develop intensive processing, build demonstration models of marine ecological pastures in typical sea areas, and produce significant social and economic benefits.

(v) Marine (3)

(35) Research and investigation on cutting-edge S&T issues in hadal trenches. We will focus on the cutting-edge issues of trench science and establish a hadal trench discipline system for China's trench biology, geology, and environmental science. We will develop trench exploration equipment and technology systems to support China's trench scientific research and technological breakthroughs.

(36) Marine ecological environmental security engineering. We will carry out research on holographic ecosystem reconstruction, coral island and reef stability and geological safety, equipment anti-corrosion and corrosion-resistance technology, and intelligent three-dimensional observation of the marine environment to provide S&T support for the construction of an ecological environmental security layout, the improvement of ecosystem service functions, and the promotion of sustainable development.

(37) Research and demonstration of seafloor scientific observation networks and equipment. We will build major infrastructure for seafloor scientific observation networks, develop deep-sea acoustic observation equipment, deep-sea operation equipment, and technology for the investigation and development of seabed mineral resources, develop full-sea depth multibeam bathymetry systems, 4,500m-class manned submersibles, 6,000m-class unmanned submersibles, and 11,000-meter-class submersibles, achieve the goal of all-weather, comprehensive, long-term and continuous real-time observation of ocean internal processes and their interrelationships, provide support for national marine security, deep-sea energy and resource development, environmental monitoring, and marine disaster early warning and forecasting, and promote the development of marine observation technology.

(vi) Ecological Environment (11)

1. Resource direction

(38) Basic theories and key technologies for shale gas exploration and development. Based on the shale gas exploration and development process, we will strive to solve scientific problems such as the source-reservoir (生储) mechanisms and evaluation methods, seam network fracturing mechanisms, methane transport mechanisms, and multi-scale seepage, make breakthroughs in core technologies such as in-situ gas volume testing, high-precision geosteering for horizontal drilling (平水钻

井), and water-free fracturing, and build micro- and nano-scale research and testing platforms.

(39) Theory and technical systems for deep intelligent guided drilling. We will carry out research on the key technologies of high-temperature and high-pressure sensors, deep logging while drilling technology and equipment, deep steering control technology and equipment, and system integration and well site testing, form a complete set of intelligentized rotary guidance technology and equipment, and provide S&T support for the exploration and development of China's deep and ultra-deep oil and gas resources.

(40) Efficient, clean, and comprehensive utilization of metal deposits with special characteristics. We will complete the engineering construction and commissioning of a number of demonstration projects for efficient and clean utilization of vanadium titanomagnetite and other characteristic resources, accelerate the high-value utilization of metals such as vanadium, titanium, and chromium, increase the guaranteed amount of China's strategic metal resources, and promote the sustainable development of China's vanadium, titanium, chromium, and other industries.

2. Ecological environment direction

(41) Multi-sphere[10] interactions in the Qinghai-Tibet Plateau and their resource and environmental effects. Focusing on the basic characteristics, processes, and mechanisms of the interaction of various spheres of the Qinghai-Tibet Plateau, we will make new scientific breakthroughs in the time and manner of collision between India and Eurasia, plateau uplift and ancient height, the influence of westerly winds and monsoons, and their environmental effects and contribute to the economic and social development of the Qinghai-Tibet region.

(42) Causes and control of atmospheric haze. Focusing on Beijing-Tianjin-Hebei, the Yangtze River Delta, and the Pearl River Delta, we will clarify the key physical and chemical mechanisms of haze formation, identify key pollutants, determine the trans-regional and cross-border transport volume of air pollutants, develop decision-making models for air pollution prediction, diagnosis, and control, research and develop key pollutant source control and process control technologies, and conduct regional application demonstrations.

(43) Environmental exposure and health hazard mechanisms of typical pollutants. Focusing on core scientific issues such as the exposure characteristics of

[10] Translator's note: The term "multi-sphere" (多圈层) refers to phenomena that involve multiple layers—such as the biosphere, atmosphere, hydrosphere, lithosphere, cryosphere, and so on—of an area or environment.

pollutants in typical regions in China, the main control factors and the list of pollutants for priority control (优控污染物), and the mechanisms of interaction between biomolecules and epigenetic effects, we will obtain international-level original achievements in molecular mechanisms such as exposure and bioavailability, pathways of toxicity, and epigenetics.

(44) Soil-microbial system function regulation and soil pollution control. Focusing on core scientific issues such as the diversity and regional distribution of typical soil organisms at multiple scales, the influence of soil organisms on nitrogen and phosphorus biogeochemical cycles, and the interaction between soil, plants, and microorganisms, we will improve the overall awareness of soil microbial resources in China and significantly improve the nutrient utilization rate by regulating soil microorganisms. We will deepen research on soil heavy metal pollution control technologies and models, promote the construction of a national comprehensive demonstration zone for soil heavy metal pollution control, carry out demonstration engineering construction "by region, by type, and by level" based on different typical pollution regions, different pollution types, and different pollution intensities, preliminarily build a nationwide networkized (网络化) demonstration platform, and play a backbone and leading role in national soil pollution control work

(45) Assessment and restoration of national and key regional ecological environments. We will optimize monitoring technology and evaluation methods and carry out the assessment of ecological environment changes and evaluation of resource and environmental carrying capacity at the national scale and in key regions such as the Yangtze River Economic Belt and the Silk Road Economic Belt. We will build a technical system for the restoration and protection of fragile ecosystems that adapts to local conditions and takes into account both ecology and economic benefits and provide technical support and a basis for decision-making to allow the country to promote the construction of main functional areas (主体功能区) and the "two screens and three belts."[11]

(46) Comprehensive treatment technology for water pollution in typical regions. In view of the severe water pollution in dense urban areas such as Beijing-Tianjin-Hebei and the Yangtze River Delta, we will select typical areas with suitable spatial scales, carry out tests and demonstrations of comprehensive treatment technology for urban black and odorous bodies of water, rural scattered sewage (分散

[11] Translator's note: The "two screens and three belts" (“两屏三带”) are: the Qinghai-Tibet Plateau ecological screen, the Loess Plateau-Sichuan-Yunnan ecological screen, the Northeastern forest belt, the Northern sand-blocking belt, and the Southern hill and mountain belt. The Chinese Communist Party (CCP) considers the "two screens and three belts" to be its "ecological security" strategy.

性污染), bodies of water suffering from lake eutrophication, and agricultural nonpoint source pollution, and gradually promote and apply this technology to provide a demonstration for the construction of national and regional ecological civilization.

(47) Protection of major construction and engineering projects. In response to the needs of important transportation routes, major water conservancy and hydropower projects, ecological environmental protection around key cities and towns, and natural disaster prevention and control, we will carry out risk assessment and management, research and develop technical systems such as the rapid reconstruction of damaged ecosystems, wind and sand defense and removal, comprehensive prevention and control of landslides and debris flows and other geological disasters, high slope safety protection, and roadbed stability protection and conduct engineering demonstrations, and provide S&T support for relevant major projects and for the safety of people's lives and property.

(48) Simulation study on the evolution of geo-environmental systems (地缘环境系统) in typical regions of the Belt and Road Initiative (BRI). Relying on modern geographic information technology, big data technology, earth observation from space, and other technologies, we will carry out monitoring and tracking of major natural disasters, environmental resource patterns and their evolution, extreme climate events, and sudden societal security incidents (突发社会事件) in hotspot areas, conduct simulation, early warning, and countermeasure research on their geo-environmental impact, improve our ability to respond to major events along the BRI [countries] and their geo-environmental impacts, and establish a prompt and available rapid early warning system and system solutions.

(vii) Information (7)

1. Information direction

(49) Quantum communication. We will strengthen independent R&D (自主研发) of core devices, strengthen integration with classic networks (such as cloud encryption), promote the formulation of standards, launch R&D on key technologies for city quantum communication, intercity quantum communication, and satellite quantum communication, initially form the capabilities to build a wide-area quantum communication network system integrating air and ground, and make breakthroughs in round-the-clock quantum communication technology.

(50) Key technologies and applications of cybersecurity (网络空间安全). We will strengthen basic and cutting-edge theoretical research in fields such as new cryptography theory and new defense theory, make breakthroughs in core and key technologies (核心关键技术) such as new built-in security based on system

architecture, cyberspace situational awareness, early warning, and punishment, big data security and privacy protection, cyberspace trust systems, cybersecurity audits, and key information infrastructure security protection technology, effectively solve a number of key and difficult S&T problems that constrain China's cybersecurity, play a backbone and leading role, and provide strong S&T support for the national cyber powerhouse (网络强国) strategy.

(51) Key technologies and applications of high-performance computing and network communication. We will propose a highly energy-efficient (100 GOPS/W) network computing architecture and develop reconfigurable (可重塑) processor chips; develop an independently controllable (自主可控) desktop operating system and promote its application; develop core equipment, such as Internet of Things (IoT)-terminal computers (物端计算机), servers and routers, and extra-large base stations (超级基站), build world-leading service center networks, 5G wireless communications, and a space-ground integrated information network (天地一体化网络), and provide core and key technology support for the development of informatization applications in key industries, IoT, and the information industry.

(52) Big data and AI. We will strengthen research on basic scientific issues in the application of big data, research and develop large-scale machine learning methods and pattern recognition technologies, make breakthroughs in multi-source heterogeneous perception (异构感知) big data processing models with deep understanding (深度理解) capabilities, develop key software and hardware technologies that play industry-leading roles, improve big data processing capabilities, establish big data-oriented AI methods and technologies, and play an irreplaceable role in related application fields.

(53) Human-computer interaction and virtual reality. For natural human-computer interaction, we will make breakthroughs in the understanding of visual, auditory, and other interactive information and explore new types of interactive methods. We will research key technologies such as 3D perception, modeling, transmission, rendering, display, and interaction for environments and human behavior, develop technologies and devices such as high-precision 3D cameras, real-time realistic rendering, pixel-level high-precision positioning and tracking, large-scale physical and behavioral real-time rendering, multi-sensory virtual-real fusion interaction, and true 3D display, establish Internet-based virtual reality (VR) content and interaction standards, achieve remote immersive VR systems, break through the limitations of human beings at the frontiers of reality, and expand the scope of human imagination.

(54) Integrated circuits and core basic devices. We will achieve breakthroughs

in advanced integrated circuit processing, large-scale silicon wafer materials, and photolithography machine components, independently develop (自主研制) new high-power electric and electronic devices and various sensors, and realize the large-scale application of independently controllable core basic devices in high-speed rail, electric power, new energy vehicles, and other fields. We will carry out the development and industrialization of relevant microelectronic devices, laser devices, photodetectors and optical waveguides, optical amplifiers, optical switches, and other basic photonics components. We will research the productization design and production technology of high-definition laser display core devices, realize their large-scale production, and promote the entry of high-definition serialized laser display products into the consumer market.

2. Smart manufacturing direction

(55) Robots and ultra-precision extreme manufacturing. We will conduct research on key technologies and core components of next-generation robots, industrial IoT, and networked collaborative manufacturing, research and develop high-end industrial robots, specialized robots, service robots, unmanned intelligent equipment systems, and smart manufacturing control technologies, and build complete smart manufacturing solutions for key industries. We will conduct research on ultra-precision extreme manufacturing processes and equipment, develop ultra-large-scale integrated circuit processes and equipment, build an ultra-precision extreme manufacturing platform, and provide technical support for improving the nation's manufacturing capabilities and level.

(viii) Optoelectronics and Space (5)

(56) Space Science Pilot Project (Phase II). We will complete the "12th Five-Year Plan" [2011-2015] satellite launch missions and strive to achieve major scientific discoveries and breakthroughs in the fields of space astronomy, space physics, microgravity science, and space life sciences. We will establish a project to develop 3-6 satellites, strive to launch them around 2020, and achieve original results in areas such as the laws of coupling in space (地球空间耦合规律), the detection of electromagnetic counterparts to gravitational waves, global change and the water cycle, and the relationship between the solar magnetosphere and explosive activities.

(57) Manned space station and space laboratory space applications. We will conduct scientific research, experiments, and ground applications of the Tiangong-2 space laboratory, the Tianzhou-1 cargo spacecraft, and core space station modules, conduct the design and development of multi-functional optical facilities, scientific laboratory cabinets, application information systems, and in-orbit support systems to

lay the foundation for the implementation of space station application tasks, develop and operate the world's first space cold atomic clock, conduct satellite-to-earth quantum key communications experiments, and conduct high-sensitivity polarization detection of cosmic gamma rays to open up a new window for astronomical observation.

(58) Scientific exploration of the Moon and first scientific exploration of Mars. We will complete the R&D and construction tasks related to the ground application systems, payload, and orbit determination for the Chang'e 5, Chang'e 4, and China's first Mars exploration. We will carry out the storage, processing, preparation, and research work for lunar sampling and the returned samples, conduct low-frequency radio astronomical observations on the far side of the moon and, in a world first, establish a local and comprehensive geological profile on the far side of the moon that integrates topography, geological structures, material composition, and shallow structures, and conduct exploration and research on the ionosphere of the Martian atmosphere, surface climate and environment, surface topography, and geological structures. We will research and formulate scientific goals for subsequent missions to the Moon, Mars, and asteroids.

(59) BeiDou global satellite navigation system. For the construction of the BeiDou global networking system, we will conduct research and development on networking satellites, improve the performance indicators of the networking satellites in batches, and ensure the completion of the global system in 2020. We will further enhance the miniaturization, weight reduction, intelligentization, and low-cost design capabilities of navigation satellites, possess the capabilities for the overall design of integrated high-performance and high-function density payload platforms (高性能与高功能密度载荷平台), and achieve the long life and high reliability of navigation satellites in medium and high orbits.

(60) Stratospheric airships. We will design and develop a long-endurance powered flight stratospheric airship system able to stay airborne for a long time, make breakthroughs in a series of core and key technologies, successfully conduct a 20,000m-altitude airborne duration test verification, achieve a world-first by mastering controllable airship operation platform technology with a certain payload capacity at stratospheric altitude, drive the development of related disciplines and technologies, and form new economic growth points.

II. Key Cultivation Directions to Shape New Advantages in the Future

(i) Basic and Cutting-Edge Interdisciplinary Research (17)

1. Mathematics interdisciplinary research direction

(1) Some cutting-edge research in finite and infinite dimensional mathematics (维数学)

(2) Key general purpose methods of applied mathematics

2. Physics interdisciplinary research direction

(3) Multi-band gravitational wave cosmology research

(4) Atom-based precision measurement physics cutting-edge interdisciplinary research

(5) Quantum state of matter and its tuning for future information technology

(6) New photoelectromagnetic effects based on special structures

(7) Low-dimensional quantum structures that are controllable and can be integrated

(8) Soft matter science and cutting-edge interdisciplinary research

(9) Astrophysical processes and phenomena under extreme conditions

(10) Cutting-edge technology research for major engineering mechanics

(11) Cutting-edge technology research on lasers

(12) Cutting-edge and interdisciplinary research for nuclear physics based on heavy ion accelerators

(13) Multidisciplinary research based on platform-type large scientific devices such as synchrotron radiation light sources, spallation neutron sources, and steady-state strong magnetic fields

(14) Cutting-edge research on particle physics based on high-energy accelerators

3. Chemistry interdisciplinary research direction

(15) New substance creation and new function discovery

(16) Green carbon science

(17) Revolutionary industrial production technology for fine chemicals

(ii) Advanced Materials (4)

(18) Precise fabrication and functions of multi-level sub-nano structures

(19) Key structural materials and new methods of materials research

(20) Nuclear power key material R&D and service safety assurance technology

(21) New functional materials research and application exploration

(iii) Energy (5)

(22) Basic research on advanced microgrid and power electronics technology

(23) Basic research on advanced electric energy and power system applications

(24) Cutting-edge technology research for renewable energy

(25) Efficient conversion mechanisms and key technologies of clean energy

(26) Mesoscale science theory and engineering applications

(iv) Life and Health (22)

1. Health Direction

(27) Biological big data research

(28) Nucleic acids and human health

(29) Primate phenotypes and genetics

(30) Molecular mechanisms of cell development and differentiation

(31) Precision medicine research

(32) Reproductive biology

(33) Computational and systems biology

(34) Biofilm dynamics

(35) Epigenetic regulation and function

(36) Synthetic biology

(37) Advanced biomanuacturing

(38) Construction of biosafety S&T support systems

(39) Development and evaluation of novel vaccines, antibodies, and biosimilars

(40) Research on new mechanisms of action, new targets, and new strategies for major and rare disease prevention and treatment drugs

(41) New technologies and methods for life sciences

(42) Cutting-edge research on the intersection of life sciences and mathematics,

chemistry and technical sciences

2. Biodiversity direction

(43) Biological DNA barcoding and biodiversity cataloging and informatization

(44) Species formation, coevolution, and their adaptation to special environments

(45) Biodiversity loss dynamics and endangered species assessment and conservation

(46) Invasion mechanisms of and prevention and control technology for harmful exotic species

3. Modern agriculture direction

(47) R&D and integration of key technologies in plant factories

(48) Innovative cultivation of new crop varieties

(v) Marine (5)

(49) Typical oceanic multi-sphere actions and processes and their environmental effects

(50) Offshore ecological security

(51) Mining and exploitation of microbial resources in the deep sea environment

(52) Pilot study on key sea areas of tropical oceans, the Arctic Ocean, and the Southern Ocean

(53) Pioneering research on extraterrestrial ocean systems

(vi) Ecological Environment (11)

1. Resource direction

(54) Working mechanisms of the Earth's interior and surface responses

(55) "Silk Road Seas" (“思路沧海”) geological evolution and resource and energy effects

(56) Clean transformation and recycling of major characteristic resources (特色资源)

2. Ecological environment direction

(57) Biological evolution and environments

(58) Numerical models of Earth systems

(59) Comparative planetology

(60) Prediction, prevention, and control of typical geological hazards

(61) Research on cryosphere change and its impacts

(62) Coupling processes of natural and human elements on land surfaces

(63) Urban ecosystem processes and human stress mechanisms

(64) Emerging pollutant evaluation and control technologies

(vii) Information (11)

1. Information direction

(65) New computing architecture

(66) Ultra-low-power processor technology

(67) New device mechanisms and micro-nano device research

(68) Multimodal sensing technology

(69) Next-generation Internet technology and next-generation optical communication technology

(70) Photonic information technology and optoelectronic integration technology

(71) Brain-inspired computing and intelligence

(72) Hybrid intelligence (混合智能) and human-computer coordination

(73) Core basic software for mobile internet

2. Smart manufacturing direction

(74) New principles and cutting-edge technologies of advanced manufacturing

(75) Precise perception and control

(viii) Optoelectronics and Space (5)

(76) Space laser communication technology

(77) Cutting-edge technology for ultra-high-resolution payloads

(78) Ultra-high-precision spacetime reference point (时空基准) technology

(79) Modular micro-nano satellite smart manufacturing technology

(80) New generation navigation technology

Box 9: Field Distribution of Major Breakthroughs and Key Cultivation Directions		
Eight Major Innovation Fields	**Major Breakthroughs**	**Key Cultivation Directions**
1. Basic and cutting-edge interdisciplinary research	8	17
2. Advanced materials	4	4
3. Energy	5	5
4. Life and health	17	22
5. Marine	3	5
6. Resources and ecological environment	11	11
7. Information	7	11
8. Optoelectronics and space	5	5
Total	60	80

III. Research Institute Categorization Reform and National Laboratory Construction

In accordance with the deployments of the "Take the Lead Initiative" plan and on the basis of the continuous and in-depth implementation of the "one-three-five"[12] plans for institutes and a summary of the pilot experience of the four types of institutions,[13] we will further strengthen top-level design, coordinate the layout of fields, make innovations in institutions and mechanisms, and continue to promote research institute categorization reform. Combined with the construction of four types of institutions, we will further integrate and develop advantages in relevant key fields and actively organize forces to undertake the tasks of national laboratory construction.

[12] Translator's note: "One-three-five" refers to the one R&D direction (一个研发定位), three major breakthroughs (三个重大突破), and five key lines of training (五个重点培育方向) that each institute of the Chinese Academy of Sciences (CAS) should have every five years.

[13] Translator's note: As part of its "Take the Lead Initiative" (“率先行动”) reform plan, CAS aims to categorize all of its institutes as one of "four types of institutions" (四类机构). These four types are: Innovation research institutes (创新研究院), innovation centers of excellence (卓越创新中心), big science research centers (大科学研究中心), and specialized research institutes (特色研究所).

(i) Deeply Promote Research Institute Categorization Reform

Adhering to the positioning of innovation research institutes, innovation centers of excellence, big science research centers, and specialized research institutes, aiming at the frontiers of worldwide S&T, focusing on national strategic goals and the major needs of economic and social development, and highlighting the advantages and key development directions of CAS, we will coordinate top-level design, clarify the overall layout of the construction of four types of institutions, reflect their irreplaceability, prevent new fragmentation and low-level duplication in construction, and promote the achievement of the "three majors"[14] output goals in the eight major innovation fields of **basic and cutting-edge interdisciplinary research, advanced materials, energy, life and health, marine, resources and ecological environment, information, and optoelectronics and space** and the two public support platforms types of major national S&T infrastructure and data and computing platforms. We will comprehensively consider the organic linkages and transformations between different types of institutions and coordinate national tasks and the construction of national laboratories to form overall competitiveness in relevant fields.

Box 10: Research Institute Categorization Reform—Four Types of Institutions

- Oriented toward the major needs of the country, we will establish a number of **innovation research institutes** that closely integrate scientific research tasks and national strategies and organically connect the innovation chain and the production chain.
- Oriented toward the world's technological cutting edge, we will build a batch of **innovation centers of excellence** with leading positions in China and important influence internationally.
- Oriented toward the main battlefield—the domestic economy—and relying on disciplines with distinctive characteristics that we have the advantage in, we will build a batch of **specialized research institutes** with core competitiveness.
- Relying on the nation's major S&T infrastructure, we will build a batch of **big science research centers** with international world-class levels that are open (开放) to China and the world.

[14] Translator's note: The "three majors" (“三重大”) that Chinese Academy of Sciences (CAS) aims to accomplish are: major achievements in original innovation (重大原创成果), major strategic technologies and products (重大战略性技术与产品), and major demonstration and transformation projects (重大示范转化工程).

We will summarize the pilot experience of building the four types of institutions during the "12th Five-Year Plan" period, analyze the problems in the pilot work, and formulate and implement guidelines for further promoting research institute categorization reform. We will follow the principles of adhering to standards, focusing on quality, optimizing structures, and improving capabilities, focus on eight major innovation fields, consolidate strengths, integrate advantages, make overall arrangements for the construction of the four types of institutions, and actively and steadily advance research institute categorization reform. We will strengthen the top-level design and overall coordination of research institute categorization reform, closely focus on fundamental, critical, and deep-seated issues, deepen and implement major measures for categorization reform, and improve policy regulation and institutional design. Based on the different characteristics of the four types of institutions, we will improve the institutional mechanisms and institutional systems for optimizing categorized positioning, categorized organization of innovation activities, categorized evaluation, and categorized resource allocation and improve policy differentiation and pertinence. We will build operating mechanisms for close cooperation, open collaboration, and dynamic transformation among the four types of institutions and build a bastion of national innovation that leads the development of S&T in relevant fields.

For institutions of the four types that have already started construction, we will perform approvals in strict accordance with the pilot program and construction standards, strengthen merit-based support according to the approval situation, and implement dynamic adjustment and exit mechanisms. For the institutes that are not yet one of the four types, we will continue merit-based support according to the deployments of the "one-three-five" plans and guide and promote the research institutes to follow the direction and requirements of categorized positioning, further improve their internal strength, and continuously enhance their core competitiveness.

(ii) Actively Organize Forces to Undertake the Tasks of National Laboratory Construction

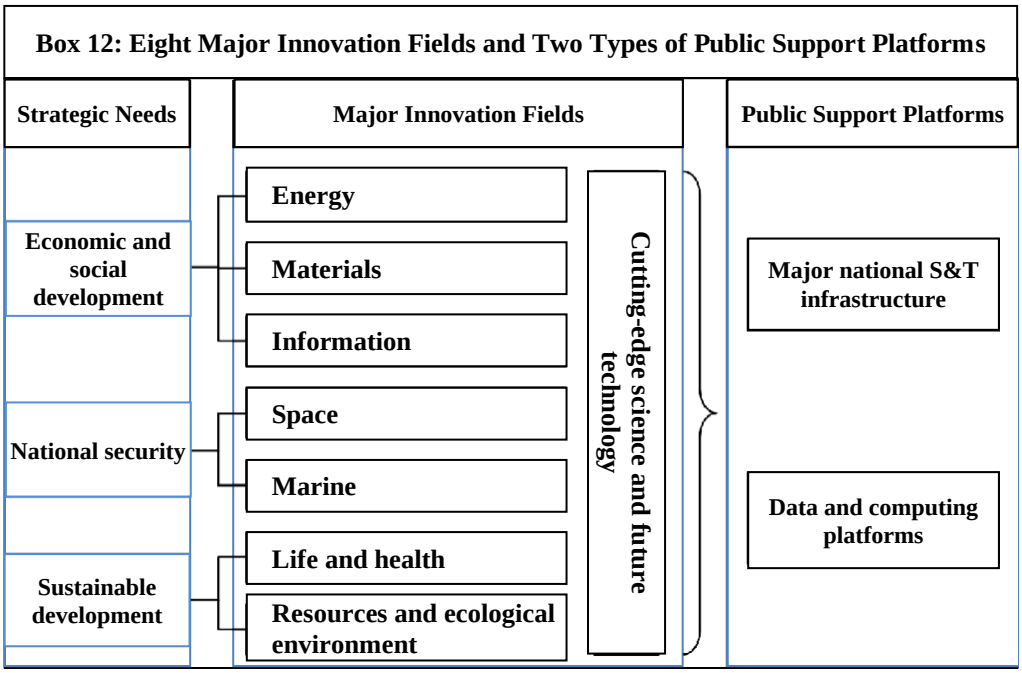
In accordance with the spirit of the Fifth Plenum of the 18th Central Committee and in accordance with the deployments of the national "13th Five-Year Plan," we will actively organize forces to undertake the tasks of national laboratory construction and strive to play a core backbone and leading role in the construction of China's national laboratories.

Box 11: National Laboratories

The Fifth Plenum of the 18th Central Committee proposed that a number of national laboratories should be established in major innovation fields. This is a measure of strategic significance for S&T innovation in China. We must take the construction of national laboratories as the starting point to strengthen national strategic S&T strength. In key fields where national goals and urgent strategic needs are identified and at the strategic commanding heights (战略制高点) that are expected to lead future development, we must view major S&T tasks and national large-scale S&T infrastructure as the main line, rely on our most well-positioned innovation units (最有优势的创新单位), integrate national innovation resources, establish new operating mechanisms featuring goal orientation, performance management, collaborative research, openness, and sharing, and build national laboratories that are of a breakthrough, leading, and platform-based type. Such national laboratories shall become a strategic S&T force to overcome difficulties and lead development. They shall form a new pattern of collaborative innovation with complementary functions and benign interaction with other various scientific research institutions, universities, and enterprise R&D institutions.

–Xi Jinping's *Speech on Striving to Build China into an S&T Powerhouse at the National Science and Technology Innovation Conference, the Conferences of Academicians of CAS and the Chinese Academy of Engineering (CAE), and the Ninth Congress of the China Association for Science and Technology (CAST)*

In the eight major innovation fields of **energy, materials, and information** related to China's economic and social development, **space and maritime** related to national security and core interests, **life and health** and **resources and ecological environment** related to sustainable development, and **cutting-edge science and future technology** related to China's original innovation capabilities and the two public support platforms types of **major national S&T infrastructure** and **data and computing platforms**, we will give full play to the institutionalized advantages of national strategic S&T forces and actively organize forces to undertake the tasks of national laboratory construction.



For the above-mentioned eight major innovation fields and two types of public support platforms and in accordance with the positioning, direction, and construction goals and requirements of national laboratories, we will strengthen the S&T layout, make innovations in institutions and mechanisms, integrate advantageous forces inside and outside CAS, and undertake the task of building national laboratories.

In the process of undertaking the task of building national laboratories, we will integrate the four types of institutions and the superior resources of CAS as a whole and even the whole country, carry out cutting-edge, systematic, and integrated scientific research, build a research base that supports interdisciplinary and high-intensity collaborative innovation with a wide range of collaborators, solve major S&T issues related to the overall situation and long-term development of the country, and effectively support and lead innovation and development. We will carefully design and vigorously promote reforms, strengthen innovation-driven organizational consolidation, explore the establishment of a new type of governance system for national scientific research institutions with distinctive Chinese characteristics, and lead the reform of China's S&T institutions.

IV. Organize and Implement Major Innovation Activities

We will uphold the leading role of major national needs and major scientific issues, give full play to the institutionalization and comprehensive interdisciplinary advantages of CAS, and closely coordinate with the construction of the four types of institutions and national laboratories. At the top level of CAS, we will forge linkages

with major national S&T tasks and relevant plans and deployments, and at the level of CAS research institutes, we will forge linkages with the S&T layout of CAS and the "one-three-five" plans. We will explore and improve the institutions and mechanisms for collaborative research across institutes, disciplines, and fields, innovate and improve the organizational models for large-scale, long-term, and end-to-end innovative activities, coordinate the organization and implementation of major S&T innovation activities, strive to achieve major innovation breakthroughs, and promote the production of major achievements.

(i) Actively Propose Undertaking and Completing Major National S&T Tasks

For major S&T projects and major engineering projects launched according to the deployments of the *S&T Innovation 2030—Major Projects*, we will actively organize forces to lead or participate in key tasks and play a backbone and key role in areas such as aerospace engines and gas turbines, deep-sea and space stations, quantum communications and quantum computing, brain science and brain-inspired research, national cybersecurity, deep space exploration and in-orbit spacecraft service and maintenance systems, independent innovation in the seed industry, the clean and efficient use of coal, smart grids, integrated space-to-ground information networks, big data, smart manufacturing and robotics, R&D and applications of key new materials, integrated governance of the Beijing-Tianjin-Hebei environment, and health protection.

Box 13: S&T Innovation 2030—Major Projects

Major S&T Projects:

1. **Aerospace engines and gas turbines.** Carry out general purpose basic technology and interdisciplinary research in areas such as materials, manufacturing processes, and testing and achieve key technologies such as overall designs.

2. **Deep-sea and space stations.** Carry out research on cutting-edge and general purpose technologies for deep-sea exploration and operations and core and key technologies for general and specialized, mobile and fixed deep-sea and space stations.

3. **Quantum communications and quantum computing.** Research and develop intra-city, inter-city, and free-space quantum communication technologies and develop a general quantum computing prototype and a practical quantum simulator.

4. **Brain science and brain-inspired research.** Based on the principles of brain cognition, use brain-inspired computing and brain-like machine intelligence (脑机智能) as two ways to diagnose and treat major brain diseases, build key technology platforms, and seize the commanding heights of cutting-edge research in brain science.

5. **National cybersecurity.** Develop a cybersecurity technology system covering both the information and network levels and improve technical capabilities such as information protection and

network defense.

6. **Deep space exploration and in-orbit spacecraft service and maintenance systems.** Focus on breakthroughs in in-orbit service and maintenance technologies, improve the efficiency of China's space assets, and ensure the safe and reliable operation of spacecraft in orbit.

Major Engineering Projects:

1. **Independent innovation in the seed industry.** Focusing on the four major seed industry fields of agricultural plants, animals, forests, and microorganisms, make key breakthroughs in modern seed industry key technologies such as the use of heterosis, breeding by molecular design (分子设计育种), and provide support for the national food security strategy

2. **Clean and efficient use of coal.** Accelerate the development of core and key technologies such as green coal development, high-efficiency coal power generation, clean coal conversion, coal pollution control, and carbon capture and storage, demonstrate and promote a number of advanced and applicable technologies, achieve overall leadership in coal-fired power generation and ultra-low emission technologies, and make major breakthroughs in modern coal chemical and polygeneration technologies.

3. **Smart grid.** Focus on the deployment of large-scale renewable energy grid-connected control, flexible interconnection of large power grids, multi-user interactive power supply and demand, smart grid basic support technology, and other key tasks to achieve total domestic production of smart grid technology equipment and systems and increase China's global market share of electric power equipment.

4. **Integrated space-to-ground information networks.**

Promote the comprehensive integration of space-based information networks, the Internet of the future, and mobile communication networks to form a global space-to-ground integrated information network.

5. **Big data.**

Make breakthroughs in general purpose key technologies related to big data standards systems and exchange platforms for open data sharing, form a consensus application model and technical solution for typical applications, and form a big data industry cluster with global competitive advantage.

6. **Smart manufacturing and robotics.**

With the overall goals of intelligent, efficient, collaborative, environmentally friendly, and safe development, build networked collaborative manufacturing platforms, research and develop intelligent robots, high-end complete sets of equipment (高端成套装备), and three-dimensional (3D) printing equipment to consolidate our ability to provide basic assurance for manufacturing.

7. **R&D and applications of key new materials.**

Focus on the development of carbon fiber and its composite materials, high-temperature alloys, advanced semiconductor materials, new displays and relevant materials, special alloys for high-end equipment, new rare earth materials, new military materials, and other materials and make breakthroughs in core and key technologies related to preparation, evaluation, and application.

8. Integrated governance of the Beijing-Tianjin-Hebei environment.

Establish a core technology, industrial equipment, and standardized policy system for water-soil-air coordinated management, industrial-agricultural-urban resources coordinated cycles, and regional environment coordinated control. Construct a number of comprehensive demonstration projects to form a solution for comprehensive regional environmental management systems.

9. Health protection.

Focusing on the needs of building a healthy China (健康中国), strengthen the research and development of technologies such as precision medicine, arrange for prevention and control of chronic non-communicable diseases and common and frequently occurring diseases, research the prevention and control of reproductive health and birth defects, accelerate the transfer and conversion of technological achievements, and promote demonstration services to benefit the people.

—— *National Thirteenth Five-Year Plan for S&T Innovation*[15]

We will keep a good grasp on major national S&T special projects we have already taken on, such as the manned spaceflight and lunar probe project, the high-precision earth observation system, mega-scale integrated circuit manufacturing equipment and all of the techniques associated with it, and the breeding of new varieties of genetically modified organisms, as well as on key special projects for national key R&D programs, such as nanotechnology, protein machines and precision regulation of life processes, research on recovery from and protection from representative cases of frail ecology (典型脆弱生态), strategic advanced electronic materials, earth observation and navigation, quantum control (量子调控) and quantum information, key deep-sea technology and equipment, and cutting-edge research on big science installations, as well as the construction of major national S&T infrastructure, we will complete tasks with high quality, make breakthroughs in a number of major scientific issues and key and core technologies (关键核心技术), and improve the S&T strength and core competitiveness of China and CAS in relevant major innovation fields.

We will actively participate in the planning of major national S&T tasks, condense and put forward major scientific issues drawn from S&T development trends and major national needs, make forward-looking deployments of advance research projects (预先研究项目), and provide project reserves and suggestions for the country's deployment

[15] Translator's note: An English translation of the National 13th Five-Year Plan for S&T Innovation is available online at: https://cset.georgetown.edu/publication/state-council-notice-on-the-publication-of-the-national-13th-five-year-plan-for-st-innovation/.

of new S&T tasks.

According to the reformed central government fiscally funded S&T plan project organization and management model, we will strengthen overall coordination at the top level of CAS and at the institute level and organize and propose to undertake key tasks of the five types of science and technology plans: those of the National Natural Science Foundation of China, national science and technology major special projects (国家科技重大专项), the National Key Research and Development Program (国家重点研发计划), technology innovation guidance special projects (funds), and base and talent special projects (基地和人才专项). We will strengthen project process management and performance evaluation and promote major outputs.

In terms of national defense S&T innovation, we will adapt to the new requirements of military-civil deep fusion (军民深度融合) development and the establishment of a national defense S&T collaborative innovation mechanism, actively organize and undertake major tasks in the fields of space, marine, and cyberspace, do a good job in the major tasks of national defense S&T innovation that we undertake, focus on making breakthroughs in strategic and cutting-edge key and core technologies, research and develop several new types of equipment, give play to the advantages and roles of the military in important strategic areas of national defense S&T, and provide strong S&T support for safeguarding China's traditional and non-traditional security.

(ii) Assiduously Organize and Implement Strategic Pilot S&T Projects

Concentrating on the goals and tasks of the "Take the Lead Initiative" plan and focusing on the frontiers of international S&T development and major national needs, we will condense major S&T issues in related fields and organize, plan, deploy, and implement several new pilot projects. We will deploy a number of Class A pilot projects in areas such as South China Sea ecological environment security, "space-based Internet+," intelligent information technology, ubiquitous informatized smart manufacturing, marine autonomous equipment, major engineering materials, bulk daily-use chemicals, spent fuel treatment, clean and low-carbon energy, deep resource detection theory and equipment, orderly adaptation to climate change, efficient utilization of characteristic resources (特色资源), advanced biomanufacturing, early intervention for chronic diseases, and tissue and organ regeneration and manufacturing. We will deploy a number of Class B pilot projects in areas such as gravitational wave research, precision measurement physics, new substance creation, cell fate, internal operating mechanisms of the Earth and surface responses, energy-chemical conversion, super-intense laser fusion physics (超强激光聚变物理), photonic chips, and system mechanics and verification.

We will conscientiously do a good job in the organization and implementation of the 11 Class A and 16 Class B pilot projects deployed during the "12th Five-Year Plan" period, strictly carry out mid-term inspection and acceptance work according to the plans, summarize achievements and experience, analyze problems and gaps, and establish and improve dynamic adjustment mechanisms. According to the project implementation situation, we will research and promote phase-two plans for some projects.

We will strengthen organizational coordination and process management for the deployment and implementation of pilot projects, promote linkages between the deployment and implementation of pilot projects and major national S&T tasks, and promote the open sharing, conversion, and application of major achievements.

(iii) Deploy and Organize the Implementation of a Number of Key CAS Projects

Concentrating on the key layouts of basic cutting-edge and interdisciplinary fields of CAS, concentrating on supporting the implementation of major national strategies such as the BRI, concentrating on promoting sustainable economic and social development, and concentrating on national security and national defense construction, we will focus on the major breakthroughs and key cultivation directions condensed at the CAS level, incorporate the four types of institutions and national laboratory construction, and deploy and organize the implementation of a number of key projects. Through the deployment of key projects by CAS, we will provide a basis for planning and deploying pilot projects and proposing or undertaking major national S&T tasks. We will focus on the cultivation of emerging industries, the upgrading of pillar industries, the development of areas such as modern agriculture, natural resources and ecological conservation, urbanization and urban environments, and promote the S&T service network program (科技服务网络计划). We will do a good job in the organization and implementation of key projects such as the BRI international S&T cooperation plan, development projects for scientific and educational cooperation in developing countries, and the special initiative to promote the transfer and conversion of S&T achievements.

V. Promotion of Economic and Social Development by S&T

We will give full play to the basic, key, and supporting roles of S&T innovation in supply-side structural reforms, concentrate on major national strategic deployments and the S&T needs of regional economic and social development, taking the Science and Technology Achievement Transfer and Conversion Special Project Initiative (科技成果转移转化专项行动) as our starting point, cooperate with local governments,

industries, and enterprises, rely on the vehicles for the transfer and conversion of S&T achievements, form a network for the transfer and conversion of S&T achievements with the goal of supporting and leading the development and growth of emerging industries, focus on promoting the conversion and application of a number of major S&T achievements with good foundations, quickly apparent results, and strong driving force, provide strong S&T support for "popular entrepreneurship and mass innovation" (大众创业、万众创新) and make obvious contributions to the optimization, upgrading, transformation, and development of the industrial structure.

(i) Actively Participate in the Construction of Regional Innovation Systems and Play a Leading Role in Their Wider Influence

We will make full use of the relatively concentrated advantages in scientific research institutions, innovative talents, scientific research facilities, and S&T achievements of CAS, actively participate in the construction of S&T innovation centers with global influence in Beijing and Shanghai, and play a core supporting and backbone leading role. We will actively participate in the national comprehensive innovation reform experiments systematically promoted in regions such as Beijing-Tianjin-Hebei, Shanghai, Anhui, Guangdong, and Sichuan and in Shenyang, Wuhan, and Xi'an and give play to the leading role of S&T innovation in comprehensive innovation. We will concentrate on major national strategic deployments such as the coordinated development of Beijing, Tianjin and Hebei, the development of the Yangtze River Economic Belt, and the revitalization of old industrial bases in Northeast China, strengthen industry-academia-research institute cooperation, promote the interconnection, openness, and sharing of S&T resources, and unleash innovation efficiency. We will support the improvement of innovation capabilities in the central and western regions, strengthen support for innovation in key industries, and strengthen the supporting role of S&T innovation in targeted poverty alleviation and targeted poverty elimination.

(ii) Promote a Number of Major S&T Achievement Outputs and Implement their Conversion into Practical Applications

We will further strengthen the industrial application-oriented forward-looking layout of major S&T tasks, such as pilot projects. We will continue to promote the Science and Technology Service Network (STS Network) program, implement key special projects for the transfer and conversion of S&T achievements, further focus on goals, highlight key points, integrate advantageous resources, and mobilize social resources, implement a number of major demonstration and conversion projects, provide a number of key technologies and products, propose a number of key systems solutions, and push industries and products to leap to the mid-to-high end of the value

chain. At the same time, we will deepen the reform of institutions and mechanisms, strengthen the "three-chain linkage" of the innovation chain, production chain, and capital chain, promote the output of major achievements, and support the development of emerging industries.

(iii) Establish an S&T Achievement Management System with IP as Its Core

We will improve the work system for the transfer and conversion of S&T achievements from throughout CAS and build an intellectual property (IP) service network covering the entire chain of IP creation, protection, application, and technology transfer. We will strengthen the creation of IP, establish a graded and categorized evaluation mechanism for IP that meets market demands, promote the end-to-end management of intellectual property rights (IPR) in scientific research projects, optimize the patent structure, improve the quality of patents, and cultivate and form a group of core patents and patent portfolios that support industrial innovation and development. We will build an IP operation and management center, cooperate with social institutions (社会机构) or CAS-run service institutions in a market-oriented manner, and build an IP service system consisting of an "operation management center" and several "operation service platforms." We will establish achievement conversion and IP operation funds and support the projectization and productization of S&T achievements with market-oriented mechanisms. We will guide institutions affiliated with CAS to strengthen IP management, improve IP protection capabilities, and promote IP investment and the transfer and conversion of achievements.

(iv) Develop and Train Teams of S&T Achievement Transfer and Conversion Talents

Relying on the University of Chinese Academy of Sciences, we will build an Institute of Intellectual Property to cultivate IP professionals. Relying on the Legend Institute (联想学院), we will explore diversified innovation and entrepreneurial talent training models featuring industry-academia-research institute integration. We will establish an "Industry and Research Institute Talent Support Project" to give key support to S&T talents who are engaged in S&T achievement conversion and driving industrial upgrades. We will dispatch S&T deputies (科技副职) and enterprise science and technology envoys (企业科技特派员) and organize the S&T staff of CAS to carry out in-depth, grassroots-level S&T achievement transfer and conversion activities.

(v) Construct Innovative Vehicles for Promoting the Transfer and Conversion of S&T Achievements

We will strengthen the construction of S&T service network nodes; deeply promote the construction of "Technological Innovation and Industrialization Alliances"

(“技术创新与产业化联盟”), strengthen, expand, and optimize the enterprises CAS has invested in, and cultivate a group of "hidden champion enterprises" in industry; and build a new type of incubator and investor supermarket and form a nationwide S&T incubation network system. We will strengthen the construction of scientific research bases such as engineering laboratories and engineering (technology) research centers, build an industrial technology innovation platform with big science centers as its core, and improve the service capabilities provided to industry. We will continue to build cross-departmental platforms such as the Nationwide Academy of Sciences Alliance (全国科学院联盟), the Field Station Alliance (野外站联盟), and the China Union of Botanical Gardens (中国植物园联盟).

(vi) Create an Environment and Culture Conducive to the Transfer and Conversion of S&T Achievements

We will formulate and implement supporting policies and systems for the *Law on Promoting the Commercialization of Scientific and Technological Achievements*, clarify the innovation and entrepreneurship rights and obligations of S&T personnel, and establish new personnel management mechanisms to encourage and support S&T personnel as they engage in the transfer and conversion of S&T achievements. We will incorporate S&T achievement transfer and conversion performance into the CAS performance appraisal system. We will implement, study, and improve equity incentive policies and increase scientific researchers’ share of revenue. In accordance with the requirements of "supply side" reforms, we will strictly control the "entry" of independently deployed projects and the "exit" of industrialization. In line with national strategic deployments such as the BRI, we will promote the transfer and conversion of S&T achievements to developing countries.

Chapter Three: Construction of a National Bastion of Innovative Talent

Taking the improvement of talent quality and optimization of team structures as our foci, we will continue to strengthen innovation capacity building of the talent cadre, strengthen the construction of the academician cadre, deeply implement talent training and recruitment system projects, optimize the human resources management of CAS, promote the coordinated development of the talent cadre, deepen talent development system and mechanism reforms, maintain the innovative vitality of the talent cadre, and create a good environment for talent development. We will “take the training of people as the center” (“育人为本”), promote the in-depth integration of science and education, achieve mutual complementarity, and cultivate high-level innovative and entrepreneurial talents. We will adhere to the combination of training and recruitment and continuously improve the level of internationalization of the talent cadre.

I. Academician Cadre Building

(i) Deepen the Reform of the Academician System and Improve the Academician Election Mechanism

Improve the election (增选) workflow. We will uphold the academic and honorary nature of the title of academician, strengthen the construction of the academician cadre, and strive to bring together a team of strategic scientists. We will further optimize the discipline layout and age structure of the academician cadre and focus on the prompt selection of young and middle-aged outstanding scientists for the academician cadre.

(ii) Improve the Academician Management System and Allow Academicians to Better Play Their Group Role

We will work with relevant departments to implement the relevant decisions and deployments of the central government to improve and perfect the academician system. We will cooperate with relevant departments to implement the academician retirement system and implement relevant measures relevant to adjunct academic work of academicians and their compensation. We will further promote the role of the academician group as a model of morality and effectively allow academicians to play their roles in decision-making consultation, review and evaluation, science popularization, and knowledge dissemination.

II. Deeply Implement Talent System Projects

(i) Strengthen Talent Training and Recruitment Work

By systematically designing talent plans, innovating institutions and mechanisms, optimizing the policy environment, and strengthening safeguards, we will vigorously strengthen the cultivation and recruitment of high-level talents and outstanding young talents. We will use the national "Thousand Talents Program" and " Ten Thousand Talents Program" to recruit and cultivate leading talents in S&T and top-notch young talents. Linked with national talent plans, we will implement the "Hundred Talents Program" of the Take the Lead Initiative and recruit academic leaders, technical talents, and youth talents as needed. We will strengthen the construction of the "Youth Innovation Promotion Association" and build a platform and create good growth conditions for youth talents with high potential. We will enlarge the stable income guarantee for "distinguished researchers" (“特派研究员”) and create a good environment to allow core backbone talents to devote themselves to research. We will give full play to the main role of employers, strengthen the management of the talent project process, and establish constraint and exit mechanisms.

(ii) Enhance the Strengths of Talent Teams

We will guide research institutes to pay more attention to the construction of various types of talent teams and form an effective cohesion among human, financial, and material resources. CAS will provide merit-based support to a group of Lu Jiaxi International Teams (卢嘉锡国际团队) and Interdisciplinary Innovation Teams (创新交叉团队) and accelerates the construction of a talent base. Through the strong cooperation of outstanding scientists in China and abroad and inside and outside CAS, we will further improve team cohesion and collaborative innovation capabilities.

(iii) Improve the Level of Internationalization of Talent Teams

We will implement the "[CAS] President's International Fellowship Initiative" (国际人才计划) make full use of the national "Thousand Talents Program" and "Thousand Foreign Experts Program," and attract world-class scientists and outstanding young scientists to work at, study at, or visit CAS. We will strengthen the training of international talents in CAS, improve the level of internationalization of scientific research teams, and strengthen the international training of scientific research management talents. We will broaden the training channels for young talents and send outstanding young talents or groups to foreign advanced institutions for exchange and study. We will explore the establishment of a visiting scholar system for senior scholars. We will strengthen work on the recruitment of foreign talents and further standardize the employment and management systems for foreign scientific researchers. We will further optimize and improve the management and service work for foreign talents and enhance CAS' attractiveness to international talents.

(iv) Establish and Improve Talent and Knowledge Sharing Mechanisms

We will uphold the principle of mutual benefit for all parties, give full play to the advantages of CAS's talents, large scientific projects, and innovation platforms, and explore the establishment of talent and knowledge sharing mechanisms between CAS-affiliated units and universities and scientific research institutions outside CAS. We will actively take measures to intensify efforts, establish open and diverse international talent and knowledge sharing mechanisms, and gradually form a favorable environment conducive to recruiting and gathering international talents and knowledge.

III. Talent and Personnel System Reforms

(i) Improve and Perfect Employment Mechanisms

Implement the national *Opinions on Deepening the Reform of the Talent*

Development System and Mechanism, focus on breaking down the obstacles in institutions and mechanisms, reform the employment management model, and accelerate the construction of a globally competitive talent system. We will implement categorized management for staff (事业编制) and contract or temporary (非事业编制) personnel. We will establish a diversified tenure system. Scientific research units will implement limited-term employment, provisional employment, and long-term employment systems for institutional personnel in S&T posts, establish and implement a talent flow system, and promote a rational and orderly flow of personnel. We will strengthen the guiding role of assessment and establish and improve assessment and exit mechanisms. We will implement a postdoc employment system, increase the attractiveness of CAS to bring outstanding PhDs to come to CAS for postdoctoral research, and expand the scale of foreign postdocs.

(ii) Promote the Reform of Income Distribution and Social Security Systems

In accordance with the performance-based salary system of public institutions,[16] we will reform and improve the income distribution policy for staff. We will implement a salary distribution incentive mechanism suited to the characteristics of high-level talents, explore annual salary systems and negotiated salary systems, and further bring together and stabilize high-level talents. We will implement a salary distribution policy oriented to increasing the value of knowledge and implement policies to increase the share of revenue from the conversion of S&T achievements into practical applications that is then given to scientific researchers. We will reform and improve the retirement pension and health insurance systems for staff and promote the establishment of basic pension insurance and occupational annuities for staff.

(iii) Improve Human Resource Management Efficiency

We will clarify the responsibilities of human resources management at the top level and institute level of CAS and improve management models with some degree of decentralization and clear powers and responsibilities. We will strengthen the overall coordination of human resource allocations and optimize the allocation of funds and assurance mechanisms. We will strengthen the categorized management and responsibilities of employers as the main entities and strengthen the guidance and

[16] Translator's note: "Public institutions" (事业单位) are organizations created and led by Chinese government departments that provide social services. Unlike state-owned enterprises (SOEs), public institutions do not create material products and are non-profit. Public institutions are not considered government agencies, and their employees are not civil servants. Most public institutions are fully or partially government-funded, but some fully privately funded (but still government-led) public institutions exist. Public institutions typically provide services in areas such as education, science and technology, culture, health, and sanitation.

supervision of the whole process of human resources management.

(vi) Implement a New Type of Personnel Management System for the Four Types of Institutions

We will strengthen categorized guidance and institutional construction for the personnel management of different types of institutions. We will promote the reform of the talent evaluation mechanism in a categorized manner, establish and improve talent evaluation systems oriented by S&T innovation quality, contributions, and performance, and improve the scientific nature of talent evaluation. We will implement a management model with parallel positions and grades for the staff of the four types of institutions. We will encourage the four types of institutions to carry out diversified explorations in areas such as position setup, personnel employment, assessment and evaluation, and salary management. Taking account of their characteristics and actual conditions, the four types of institutions will establish staffing systems that suit their own development, strengthen the establishment of positions on demand and the determination of salaries according to one's position, and promote personnel mobility and dynamic updates.

VI. Construction of an Education System Fusing Science and Education

(i) Build a Distinctive Talent Training System that Fuses Science and Education

We will support the University of Chinese Academy of Sciences and University of Science and Technology of China as they build world-class universities and world-class curricula. We will promote the joint establishment of colleges that fuse science and education by universities and CAS research institutes, improve the organizational structure, and establish a basic education system for the colleges and universities run by research institutes. We will uphold the policy of "the whole CAS runs the school and all departments are integrated" (“全院办校、所系结合) and improve the level of school administration and scientific research and teaching strength of the University of Science and Technology of China. We will cooperate with Shanghai Municipality to run ShanghaiTech University well.

We will establish and improve mechanisms for the allocation and sharing of educational resources in CAS to achieve "co-possession, co-governance, co-enjoyment, and co-development." We will establish a dual-assessment system for scientific research and educational work in research institutions affiliated with CAS. We will stimulate the enthusiasm of the research institutes affiliated with CAS to serve as the main entities responsible for graduate training, and allow CAS branches and the education bases to play their important roles in the two-stage training of graduate

students.

(ii) Strengthen the Construction of Faculty Teams

We will establish staff teacher (岗位教师) appointment and salary distribution systems, set up CAS-level teaching achievement awards, provide incentives to outstanding teaching workers, and encourage front-line high-level scientific researchers to devote themselves to teaching. We will set up a 5,000-person staff teacher team composed of high-level scientific researchers. We will strengthen the mentor position responsibility system, improve the selection and evaluation system for mentors, and build a faculty team with high academic level, good teaching performance, and advanced educational concepts.

(iii) Improve the Graduate Student Enrollment and Selection System

We will adjust and improve the allocation methods of graduate enrollment indicators, gradually establish an enrollment indicator allocation mechanism that combines factors such as student source quality, training quality, academic level, and teaching contribution, and match limited enrollment indicators to high-level research institutes and excellent mentor teams. We will expand the pilot scale of the "application-examination system" for PhD student enrollment and selection and select students who love science and have innovative potential under open, fair, and impartial conditions.

(iv) Strengthen Student Training Management

We will establish a leading group (领导小组) for the ideological and political work of CAS students and strengthen and improve the ideological and political education of students. We will promote the reform of training models in a categorized manner and advocate three-stage training for undergraduates, two-stage training for master's students, and a training model centered on scientific research for doctoral students. We will strengthen and improve curriculum system construction, improve the teaching methods for the curriculum, and strengthen the cultivation of students' spirit of questioning and originality. We will establish and improve a quality assurance system for education. We will strengthen students' career development education and employment guidance and improve students' employment and entrepreneurial capabilities.

(v) Strengthen Domestic and International Cooperation in Talent Training

We will jointly implement the "Coordinated Training Action Plan for Science-Education Integration" (科教结合协同育人行动计划) with the Ministry of Education, implement the "University Student Innovation Practice Training Program" (大学生创新

实践训练计划) and strengthen cooperation with universities inside and outside CAS in talent training. We will implement the CAS-TWAS President Scholarship Program to develop the education of foreign exchange students who come to study in China. We will implement international cooperation training plans for graduate students and expand the scale of joint cooperation with overseas institutions to train students. We will plan to introduce first-class experts and scholars from abroad to improve the proportion and quality of foreign teachers.

Box 14: University of the Chinese Academy of Sciences and the University of Science and Technology of China

According to the overall requirements of the country to implement the innovation-driven development strategy and under the guidance of CAS's "Take the Lead Initiative" plan, we will give full play to the comprehensive advantages of the "three-in-one" model of the scientific research institutions, academic departments, and educational institutions of CAS, put improving the quality of personnel training at the center, improve the institutions and mechanisms for the integration of science and education, reform the training models for graduate students and undergraduates, and realize the leapfrog development of the University of Chinese Academy of Sciences and the University of Science and Technology of China.

University of Chinese Academy of Sciences: By 2020, the school departments will have nearly 1,000 full-time teachers, including about 220 senior professional and technical personnel and about 3,000 staff teachers. During the "13th Five-Year Plan" period, the cumulative number of graduate students will be about 49,000. Its first-level disciplines (一级学科) such as mathematics, physics, mechanics, astronomy, chemistry, materials science and engineering, biology, pharmacy, atmospheric science, geology, geography, environmental science and engineering, computer science and technology, electronic science and technology, management science, and engineering will reach leading positions in China and rank among the best in the world.

University of Science and Technology of China: By 2020, the faculty cadre will have about 2,700 people, including nearly 700 senior professional and technical personnel. During the "13th Five-Year Plan" period, the cumulative number of graduate students will be about 28,000. Its science disciplines will maintain a leading position in China, engineering disciplines will enter the top ranks in China, several cutting-edge and emerging interdisciplinary disciplines will rank among the best in the world, and management and humanities disciplines will have outstanding characteristics and advantages. The school will produce a number of original achievements with great scientific value and application prospects.

Chapter Four Construction of a National High-Level S&T Think Tank

We will make better use of the functions of a national high-end S&T think tank, grasp the general trends in global S&T development, identify and grasp new directions of the global S&T revolution, and provide accurate, forward-looking, and timely advice for national S&T decision-making. We will build a three-in-one multi-level, systematic,

regularized, and focused strategic research system, and make CAS into a distinctive and internationally renowned S&T think tank that is relied on by the state and trusted by society.

I. Academic Department Development

(i) Strengthen Academic Department Organizational Coordination

We will abide by the academician charter and smoothly complete the transition of the academic department leadership institution. We will optimize the functions and setup of the special committees of academic departments according to the actual development needs of departments. We will strengthen moral self-discipline, abide by scientific ethics, maintain the honor of the academician group, and strive to learn to be excellent teachers and act as exemplary models.

(ii) Strengthen Consultation and Evaluation Work

We will systematically analyze the country's decision-making needs and development strategy issues, adapt to the new situation and new requirements of China's modernization of its governance system and governance capacity, improve the pertinence and influence of consulting work, focus on solving problems in reform and development, focus on researching major issues that are global challenges, focus on reflecting the significance and characteristics of S&T, strive to innovate institutions and mechanisms, strive to strengthen top-level design, strive to consolidate research foundations, strive to achieve open cooperation and exchanges, ensure the scientific nature and high-quality of consulting work, and provide a scientific basis and consulting opinions and advice for national macro-level decision-making.

(iii) Strengthen Academic Leadership Work

We will take the continuous research on academic discipline development strategies as our starting point to monitor and predict the directions and trends of S&T development, accurately grasp the layout and foci of S&T development, strengthen research on S&T development strategies in emerging, interdisciplinary, and cutting-edge fields, lead some fields to achieve leapfrog development, and guide Chinese scientists to develop new scientific and technological development directions. We will use high-level academic activities and high-quality academic journals as a platform to create a good academic environment, carry out academic exchanges based on rationality, truth, equality, and freedom, and further enhance the influence of the academic work of the academic departments.

(iv) Strengthen Construction of a Scientific Culture

We will hold high the banner of science, advocate patriotic dedication, promote academic democracy, insist on pursuing truth and seeking truth from facts, persist in serving the country and benefiting the people, persist in letting a hundred schools of thought contend and seeking common ground while maintaining differences, focus on exploring and carrying forward the fine traditions of academic departments, and promote the construction of a scientific culture and science education and popularization work.

II. Strategic Research and Consulting System Construction

(i) Carry Out Pilot Projects for the Construction of a National High-End Think Tank

According to the requirements of the national high-end think tank pilot project, we will give full play to the comprehensive advantages of the "three in one" model, give full play to the leading role of academic departments and the guiding role of the Scientific Think Tank Construction Committee (科学思想库建设委员会), bring together and integrate the relevant advantages of the whole CAS, absorb high-end intellectual resources from China and abroad, build a national high-level S&T think tank, and provide a scientific basis and advice for national and local government decision-making. We will accelerate the construction of the Institutes of Science and Development (科技战略咨询研究院), carry out strategic research on the promotion of S&T development and S&T-promoted development, and continue to launch high-influence and authoritative annual reports, consulting reports, and other brand products oriented by major outputs.

(ii) Construct a Strategic Research and Consulting System for Collaboration in CAS

We will strengthen overall planning and coordination, improve working mechanisms, give full play to the positivity of the two aspects of CAS, and organize high-level expert teams inside and outside CAS to carry out multi-level strategic research activities through institutional arrangement, task-driven, and platform cohesion methods. We will give play to the role of the CAS Development Consultation Committee (发展咨询委员会) and the Academic Committee and its special committees and strengthen the research, consultation, and evaluation of the development strategies for important S&T fields and disciplines. We will encourage and promote CAS in establishing strategic research organizations, allow the CAS Academic Committee to play its role, and continue to carry out strategic research activities.

(iii) Strengthen Strategic Research Platform Construction

We will continuously and steadily support the construction of academic department research support institutions and S&T roadmap strategic research organizations for important fields. Focusing on the laws of S&T innovation activities, the monitoring of S&T development trends, and the reform of S&T innovation and development institutions and mechanisms, we will build a number of strategic research teams that continue to carry out related work. We will give full play to the respective advantages of S&T experts, soft science (软科学) experts, management experts, and intelligence (情报) experts and build research platforms featuring mutual intersections and deep integration.

(iv) Drive Strategic Research with State-Entrusted Tasks

We will organize a team of high-level experts across institutes and disciplines, actively undertake and complete with high quality the strategic research, major decision-making research, third-party evaluation, and decision-making consultation tasks entrusted to us by the state and relevant departments, and promote the improvement of strategic research, consultation, and evaluation capabilities and levels.

Chapter Five: Construction of a World-Class Scientific Research Institution

To build CAS into a world-class scientific research institution, we must focus on innovation teams, innovation capacity building, and the optimization of the S&T layout. We will strive to build a modern scientific research institute governance system that meets the requirements of national development and conforms to the laws of S&T innovation, strive to build high-efficiency, open, and shared S&T infrastructure and innovation platforms with high-level support services, strive to build an open cooperation and collaborative innovation network oriented to the world, and strive to build an innovation ecosystem that pursues excellence and is inclusive, clean, and full of vitality.

I. Build a Modern Scientific Research Institute Governance System

(i) Improve the CAS Governance Structure

As a national scientific research institution, we will carry out S&T innovation and management activities in accordance with the law and under the leadership of the Party Central Committee and the State Council and play an important role in national strategic S&T strength. We will establish and improve the three-in-one macro management and operation system of scientific research institutes, academic departments, and educational institutions, which will have clear functions, coordinated operations, and organic unity. We will give full play to the role of the CAS Development Consultation Committee, Academic Committee, Education Committee,

and Scientific Think Tank Construction Committee and improve the strategic, scientific, and coordinated nature of major decisions concerning the reform, innovation, and development of CAS.

(ii) Build a Scientific and Efficient Research Institute Governance System

We will improve the institute director (所长) responsibility system, give full play to the political core of the party committee and ensure its supervisory role, give full play to the advisory, review, and academic supervision functions of the Academic Committee in terms of scientific research layout, resource allocation, and S&T evaluation, and give full play to the democratic management and democratic supervisory role of the workers' congress (职代会). We will explore the establishment of a council and advisory committee system composed of high-level external experts and representatives of relevant national ministries, industries, enterprises, and users, innovate governance models and methods, and improve the scientific nature of CAS's development strategies, development plans, and major decisions. We will promote the open cooperation of scientific research institutions, promote talent exchange and resource sharing, and play an irreplaceable and important role in the national innovation system. We will promote categorization reform of public institutions in accordance with relevant national requirements and actively explore the de-administration (去行政化) of institutions affiliated with CAS.

(iii) Improve the Policy and Institutional System with the CAS Charter as the Core

In accordance with the principles of science, democracy, standardization, and openness, we will strengthen policy research and institutional system construction for CAS. We will amend and improve the *Charter of the Chinese Academy of Sciences* and the *Regulations on the Comprehensive Management of the Institutes of the Chinese Academy of Sciences* to further clarify the development orientation of the CAS. We will clean up and standardize the system of rules and regulations, improve the procedures for establishing, amending, abolishing, and interpreting policies and systems of rules and regulations, and improve the effectiveness and execution of policies and systems. We will promote the formulation of charters by research institutions affiliated with the CAS in an orderly manner, expand their autonomy, and improve their self-development, self-management, and self-discipline capabilities. We will implement the relevant requirements of the central government on the reforms of "delegating power, streamlining administration, and optimizing government services" (“放管服”) in the field of scientific research. According to the reform situation and development requirements, we will adjust and improve the two-level power management of CAS, and build an institutional system with clear rights and

responsibilities, standardization and order, coordination and efficiency. In terms of scientific research project establishment, achievement handling, position setup, employment management, professional title evaluation, salary distribution, budget adjustment, capital construction, and equipment purchasing, we will delegate a batch of management permissions to the research institutes, prompt the research institutes to delegate power to grassroots innovation units and R&D teams, give leading S&T experts greater decision-making power concerning technical routes, greater power to allocate funding, and greater resource mobilization power, and fully mobilize the enthusiasm and creativity of scientific researchers. We will promote the transformation of the functions of CAS from management-oriented to service-oriented and strengthen the macro guidance and coordination services for the institutions affiliated with CAS.

(iv) Optimize the Two-level Planning and Management System of CAS

Guided by the CAS [five-year] plan outline, supported by the key plans and special plans of CAS, and based on the "one-three-five" plans for CAS-affiliated units, we will construct a two-level and three-category planning system for CAS. We will clarify the division of responsibilities, strengthen process management and dynamic adjustment, and do a good job in the implementation of plans. We will establish an institute-level planning management system centered on the "one-three-five" mission statement for research institutes, incorporate the "three majors" deployments at the CAS level and categorization reform of institutes, and push the institutes to further clarify their positioning, focus on key points, promote major outputs, and cultivate and develop core competitiveness. We will strengthen the organization and coordination for the formulation of "one-three-five" plans, avoid low-level duplication, homogenization, and fragmentation, and improve scientificity (科学性) and feasibility. We will strengthen the macro-guidance, supervision, and inspection of the implementation of the "one-three-five" plans.

(v) Establish a Resource Allocation System that is Conducive to Major Outputs

We will explore the establishment of a new overall allocation model for resources, strengthen the links between resource allocation and innovation performance, development trends, and funding utilization efficiency, promote the adjustment and optimization of the scientific research layout and the output of major achievements, and improve the return on investment (ROI) benefits. We will implement and improve the management and other policies for scientific research project funds, strengthen budget management, process management, and performance management, introduce third-party and public supervision mechanisms, and improve the efficiency and transparency of scientific research funds. We will

implement and improve the management system for the indirect expenses of scientific research projects and increase the proportion of performance expenditures used for personnel incentives. We will establish a financial assistant system for scientific research. We will improve the inspection, audit, and other systems for scientific research projects and funds and strengthen the supervision mechanisms. In accordance with the requirements of S&T innovation and the development of undertakings, we will strengthen the construction of a resource assurance system for sustainable development.

(vi) Establish and Improve Categorized Evaluation Systems Oriented by S&T Innovation Quality, Contributions, and Performance

We will deepen the reform of the S&T evaluation system, cooperate with research institute categorization reform and national laboratory construction, and explore, establish, and improve the indicator systems and evaluation methods for categorized evaluation. We will organize pilot acceptance work for the four types of institutions and implement dynamic adjustment and merit-based support policies. Incorporating the S&T reporting system, innovation investigation, and performance management pilot work, based on the basic data monitoring system of the institutes, and focusing on the diagnostic evaluation of the institutes and acceptance upon the completion of the "one-three-five" mission statements, we will further improve the construction of the evaluation system for research institutes guided by major outputs. We will promote and improve the international evaluation system for research institutes and carry out mid-term evaluation and acceptance of major S&T projects. We will streamline evaluation procedures, reduce unnecessary evaluations, and give researchers more time to devote to research. We will guide and push research institutes to reform their S&T evaluation systems.

II. S&T Resource Prerequisites and Capital Construction

(i) Strengthen the Construction and Operation Management of Major S&T Infrastructure and Scientific Research Instruments and Equipment

We will complete major S&T infrastructure construction tasks with high quality and as planned and actively strive to win and undertake a number of new construction tasks during the "13th Five-Year Plan" period, such as high-energy synchrotron radiation light sources. We will strengthen preliminary research on future major S&T infrastructure and provide technical and engineering reserves for the construction of facilities. Incorporating national laboratory construction and the construction of comprehensive national science centers (国家综合性科学中心) and CAS big science research centers, we will achieve cluster development (集群化发展). We will upgrade

and transform some operating facilities, improve their technical indicators and comprehensive performance, and give full play to their scientific benefits. We will build high-level public platforms for experimental research and observation and monitoring, strengthen the construction of professional technical support service teams, strengthen innovation in management systems and operating mechanisms, and build a shared service system for major S&T infrastructure and scientific research equipment. We will focus on building a two-level public technical service support system for CAS, improve user participation mechanisms, and develop and improve large-scale regional instrument centers such as Beijing, Shanghai, and Hefei.

Box 15: Major S&T Infrastructure Operated or Under Construction by CAS	
Facilities in Operation	**Facilities Under Construction**
Beijing Electron Positron Collider (BEPC) The Heavy Ion Research Facility in Lanzhou (HIRFL) Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST) Hefei Light Source Experimental Advanced Superconducting Tokamak (EAST) Remote sensing aircraft China Remote Sensing Satellite Ground Station (中国遥感卫星地面站) Long and short wave timing systems Shenguang High-Power Laser Experimental Facility (神光高功率激光实验装置) The Germplasm Bank of Wild Species in Southwest China (中国西南野生生物种质资源库) Shanghai Synchrotron Radiation Facility (SSRF) "Shi Yan 1" Research Vessel (“实验 1”号科学考察船) Meridian Space Weather Monitoring Project Daya Bay Reactor Neutrino Experiment (大亚湾反应堆中微子实验) Multipurpose oceanographic research vessels National Facility for Protein Science Shanghai (NFPSS)	Five-hundred-meter Aperture Spherical radio Telescope (FAST) Steady High Magnetic Field Facility (SHMFF) National network of ground-based receiving stations for observation satellite data Wuhan National Biosafety Laboratory (武汉国家生物安全实验室) Chinese Aeronautic Remote Sensing System (CARSS) Spallation Neutron Source (SNS) X-Ray Free Electron Laser Test Facility (X 射线自由电子激光试验装置)

(ii) Improve the Key Laboratory System

Focusing on the adjustment and optimization of the S&T layout and the construction of four types of institutions, we will improve the layout of key laboratories, appropriately adjust the directions of some key laboratories, build a small number of CAS key laboratories in the interdisciplinary and emerging disciplines, and

eliminate key laboratories with insignificant unique advantages and weak achievement output capabilities. Based on key laboratories, we will integrate other innovation resources, promote the combination of key laboratories with curricula construction and major S&T tasks, steadily improve the innovation capabilities of key laboratories, and promote the production of major achievements.

(iii) Strengthen Informatization Construction

Through new generation information technology (IT), we will deeply integrate relevant S&T resources, build a "China Science and Technology Cloud" (“中国科技云”) service platform based on S&T resources such as infrastructure, experimental conditions, software platforms, data, and documents, create data and computing platforms, and provide comprehensive resources and information services for CAS and national S&T innovation. We will build the "Smart CAS" (“智慧中科院”) basic service platform, build a new generation Academia Resource Planning (新一代 ARP), form an open application environment that is deeply integrated with various scientific research activities, and provide intelligentized services for scientists, managers, and decision-makers. We will build a scientific big data center and accelerate the construction of an authoritative and comprehensive scientific data sharing infrastructure. We will significantly improve the level of scientific research informatization at CAS and we will lead the development of national scientific research informatization. We will strengthen cybersecurity infrastructure and environmental assurance construction. We will promote the establishment of a major national scientific research informatization infrastructure project (the Jinke Project [金科工程]).

(vi) Strengthen the Construction of a Strategic Biological Resources Service Network

We will continue to carry out the baseline surveys of resources and the environment, the census and collection of germplasm resources, and the mining of beneficial genes of wild animal and plant resources and achieve the collection, preservation, analysis, evaluation, and utilization of biological resources to the greatest extent. We will strengthen the collection and preservation of wild and special habitats and other biological resources, build a DNA barcode voucher specimen and sample platform, research and develop new models and animal models, and improve the national strategic biological resource protection system. We will cooperate with relevant state ministries to establish a biodiversity monitoring network featuring a reasonable layout and comprehensive support and regularly publish dynamic change data and monitoring and evaluation reports. We will implement a strategic biological resource evaluation and transformation plan, systematically carry out research on the functional evaluation, exploration, and utilization of strategic biological resources,

improve the strategic biological resources information service platform, improve the China Union of Botanical Gardens, establish the National Specimen Center System (国家标本馆体系), Nationwide Microbial and Cell Repository Alliance (全国微生物和细胞资源库联盟), Biological Genetic Resources Research Network (生物遗传资源研究网络), Characteristic Animal Resource Bank Alliance (特色动物资源库联盟), Mainland China Biodiversity Monitoring Network (中国大陆生物多样性监测网络) and their evaluation systems, and build a national strategic biological resource industrialization service system.

(v) Strengthen Field Station Network and Agricultural Base System Construction

We will strengthen the construction of field control experimental platforms and physical simulation experimental devices, build a system of field research bases and agricultural bases that are interlinked and interdisciplinary, and improve the scientific research level of field stations and agricultural bases. We will promote the construction of field station network informatization capabilities, achieve integration and remote online services for information collection, integrated management, data sharing, and system simulation, and achieve a transformation in field station network observation and research modes. We will continue to advance the work of the Field Observation and Research Network (野外观测研究网络) and the Field Station Alliance, explore the establishment of a cross-ministerial collaborative innovation mechanism, formulate a unified field monitoring technical standards and normative indicator system, promote online observation and research, and provide S&T support for the major needs of the industry. Incorporating the regional distribution of CAS agricultural platform bases, we will build animal and plant breeding bases for rice, wheat, corn, pigs, fish, and other animals and plants, research and develop new agricultural fertilizer and pesticide formulations, develop characteristic high-value economic crop resources, provide special equipment and facilities for breeding, form a breeding base network system featuring intelligent information collection and data sharing and networking, and improve support capabilities for basic agricultural research and technology integration.

(vi) Strengthen Document Intelligence Construction

We will build basic capabilities for document intelligence (文献情报) systems and services for all of CAS, build a distributed big data technology knowledge resource system, develop new theories, new methods, and new tools for knowledge discovery, integration, analysis, and services, carry out knowledge service application demonstrations, and basically achieve active, accurate, and ubiquitous knowledge services. We will improve coordinated knowledge resource assurance and intelligence

service mechanisms of CAS, realize the diffusion and transfer of existing capabilities to research institutes, and develop inclusive document information services covering the innovative value chain oriented toward the development needs of research institutes, fields, and disciplines. We will expand the significance of new types of document intelligence services, create S&T consulting services for industrial and regional innovation, and become a comprehensive knowledge service center supporting national innovation and development. We will strengthen the construction of archive resources, expand their development, utilization, and services, and improve the level of informatization in archival work.

(vii) Establish and Improve the "Big Logistics" Assurance Service System

We will adapt to the requirements of the development of undertakings, strengthen the construction of scientific research and innovation platforms, give priority to guaranteeing urgently needed conditions for major S&T tasks, assure that the rigid demand for scientific and educational housing is met, and improve the assurance level for scientific and educational infrastructure. We will implement infrastructure upgrading and renovation and housing renovation projects, expand functions, improve conditions, and improve utilization efficiency and benefits. We will adjust and optimize the layout of science education campuses and build first-class campuses with complete functions, supporting facilities, and pleasant environments. We will deeply implement the "Housing, Home, and Health" project (“3H”工程), solve the problem of housing for young backbone personnel through construction, renovation, purchase, and rental, and basically achieve full coverage. We will strengthen cooperation and co-construction with local high-quality educational resources and basically achieve full assurance that the children of key scientific research talents can enroll in schools so as to relieve the worries of scientific research personnel. We will strengthen security and confidentiality work and ensure S&T innovation and the development of undertakings.

III. International Collaboration and Opening Up to the Outside

(i) Strengthen Cooperation with First-Class Institutions in Developed Countries and Form a Scientific Research Institution Cooperation Network

We will implement the "International Partnership Program" (“国际伙伴计划”) focus on major tasks, highlight key areas, cooperate with first-class scientific research institutions, research universities, innovative enterprises, and international S&T organizations overseas and in Hong Kong and Macau, jointly establish new scientific research support mechanisms, explore the establishment of scientific and educational cooperation units and institutions, develop multi-level partnerships through joint research, scientific research networks, and other formats, and deepen and expand

substantive and strategic S&T cooperation. We will start the establishment of offices outside of mainland China at the appropriate times, steadily expand the international cooperation network of CAS, and enhance the international influence of CAS.

(ii) Focus on the National BRI Strategy and Accelerate the Pace of "Going Global" in Science and Education

We will continue to promote the "Expanding Science and Education Cooperation with Developing Countries Project" (“发展中国家科教合作拓展工程”), adhere to the combination of bringing in (引进来) and going global (走出去), make full use of the TWAS platform, and build overseas science and education institutions and CAS-TWAS centers of excellence. We will start the implementation of the BRI international S&T cooperation program, build the BRI international scientist alliance and information network platform, fulfill the important role of CAS in China's S&T foreign aid, and promote the common prosperity and sustainable development of China and the BRI countries and regions.

(iii) Participate in Global S&T Governance and Lead the Initiation of International S&T Programs

We will accelerate the improvement of CAS's ability to deeply participate in global S&T governance. Focusing on the core well-positioned disciplines and major S&T infrastructure of CAS, we will actively cultivate major international science programs. At the same time, focusing on global common challenges and hot-button issues, we will actively participate in International and regional research programs such as the International Thermonuclear Experimental Reactor (ITER) program, Large Hadron Collider (LHC), the Square Kilometer Array (SKA), the Group on Earth Observations (GEO), and the International Ocean Discovery Program (IODP) and take the lead in launching major international science programs. We will continue to allow CAS scientists to play the backbone and leading role in international S&T organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), TWAS, the International Council for Science (ICSU), and the Organization for Women in Science for the Developing World (OWSDW). We will support scientists as they serve in international scientific organizations and further expand their numbers and influence.

(iv) Fully Implement the Internationalization Promotion Strategy and Create an Environment for International Innovation

We will further strengthen the international philosophy and awareness of all of CAS, focus on promoting the research and formulation of policies related to the international development of China and CAS, continue to strengthen the capacity

building of international cooperation teams throughout CAS, expand and cultivate the international vision of scientific research and management teams, strengthen the coordination and cooperation of various departments in CAS, explore new modes and mechanisms of internationalization, and promote the construction of a culture of international innovation in line with the needs of CAS's innovative development.

IV. Innovation Culture Construction and Science Communication

(i) Strengthen the Construction of a Culture of Innovation and Create a Cultural Atmosphere Conducive to Accelerating Reform, Innovation, and Development

1. Carry forward the scientific spirit and fine traditions

We will guide the staff of CAS to consciously practice the socialist core values concept (社会主义核心价值观), firmly establish the S&T values of "innovating technology, serving the country, and benefiting the people," and strengthen the sense of responsibility, urgency, and self-confidence in accelerating reforms, innovation, and development and achieving the "Four Take the Leads" goals. We will strengthen the construction of academic ethics, scientific research integrity, and scientific ethics, advocate free imagination, bold conjectures, and earnest verification, encourage teamwork and collaborative innovation, and create a good atmosphere for bold innovation, encouragement of success, and tolerance of failure. We will carry forward the spirit of pursuing truth and boldly summiting high peaks and the academic style of seeking truth from facts and scientific rigor, imbue the entire process of our S&T innovation practices with the tradition of "science, democracy, patriotism, and dedication" and the institutional spirit of "realism, truth-seeking, cooperation, and innovation," and enhance the attractiveness and cohesion of our culture of innovation.

2. Wide range of innovative culture vehicles

We will extensively and deeply carry out spiritual civilization (精神文明) construction work at the three levels of "this unit - provincial and ministerial level - nationwide" and promote the construction of a culture of innovation in an all-round way. We will set up "Innovation Culture Construction Special Projects," select recipients for "Innovation Culture Outstanding Achievement Awards," and strengthen the theoretical and practical work of innovation culture construction and innovation ecosystem construction. With the Ideological and Political Work Research Association of CAS as the core, we will build a research platform for innovation culture. We will promote the construction of innovation culture dissemination bases, support the construction of innovation cultural squares in base-type branches (基地型分院), and

continuously enrich the effective vehicles of innovation culture construction.

(ii) Strengthen Science Communication and Enhance the Ability of Science Popularization Work to Serve Society and Promote "Popular Entrepreneurship and Mass Innovation"

1. Promote the construction of scientific communication efficiency

We will organize the implementation of CAS key work tracking and propaganda plans and strengthen dynamic publicity. Targeting different audiences, we will implement the "Precise Communication" (“精准传播”) plan. We will implement the strategy of "High-Quality Communication" (“精品传播”), strengthen brand building for activities such as "Visiting the Chinese Academy of Sciences" and "Public Science Day," and create a number of high-quality scientific communication products such as "70 Years of Innovation for the Country" (“创新报国 70 年”) reports. We will further exert the scientific decision-making role of government information services, improve public opinion judgment and response capabilities, establish and improve information disclosure mechanisms, deepen foreign S&T propaganda and international cooperation, and vigorously promote the construction of news media and publishing houses affiliated with CAS. We will fully mobilize the positivity of online propaganda at the CAS top level and at the institute level and steadily promote the networkized new media strategy. We will build an image asset construction and management system and improve the value of CAS image assets.

2. Promote the construction of core capacities for science popularization

We will continue to implement the "High-End Scientific Research Resource Science Popularization" (“高端科研资源科普化”) program, give full play to the science popularization function of scientific research facilities, strengthen the construction of science popularization teams and the R&D of science popularization products, and strengthen the informatization construction of science popularization resources. We will actively undertake national science popularization tasks such as Science and Technology Week and Science Popularization Day, organize and implement the "Science and China" science education program, and support CAS-affiliated units as they carry out distinctive science popularization activities. We will promote the construction of a scientific culture communication base with the CAS History Museum as the core. We will explore the establishment of an emergency mechanism for science popularization work for hot-button issues and emergencies. We will actively build a new media platform for science popularization, expand channels for scientific communication and popularization, provide S&T services for "Popular Entrepreneurship and Mass Innovation," promote the formation of a good atmosphere

in which people talk about science, love science, study science, and apply science throughout the whole society, and improve the scientific spirit and scientific literacy of the public.

3. Implement the S&T journal promotion plan

Promote the reform of journal institutions and mechanisms, implement the entities responsible for running journals, explore the intensive and multi-mode centralized running of journals, develop open access (OA) and other new journal models, start the construction of a journal academic dissemination knowledge service platform, enhance the competitiveness of journals, create a group of S&T journals with international influence, and enhance the ability of CAS journals to support and serve S&T innovation.

V. Party Building Work

(i) Strengthen the Party's Ideological Construction

We will fully implement the spirit of the 18th Party Congress and the Third, Fourth, and Fifth Plenums of the 18th Central Committee, make an in-depth study of the theory system of socialism with Chinese characteristics, carry out in-depth study and education on the "Two Studies and One Be,"[17] especially studying and implementing General Secretary Xi Jinping's important remarks on comprehensively governing the Party strictly and on S&T innovation, adhere to a problem-oriented approach, take ideal and belief education as the core, and focus on strict political life within the Party, strengthen theoretical education and political guidance for Party-member cadres and S&T personnel, educate and guide the majority of Party members to stay true to their original intentions and strengthen their beliefs, establish the "Four Confidences,"[18] strengthen the "Four Consciousnesses,"[19] and enhance political consciousness, consciousness of the big picture, consciousness of the core leadership, and consciousness of falling in line with Party directives.

(ii) Strengthen the Construction of Grassroots Party Organizations

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[17] Translator's note: The "Two Studies and One Be" (“两学一做”) is short for "study the Party Charter and Party regulations, study [Xi Jinping's] series of speeches, and be a qualified Party member" (学党章党规、学系列讲话、做合格党员).

[18] Translator's note: The "Four Confidences" (“四个自信”) are: Confidence in the (1) path, (2) theory, (3) system, and (4) culture of socialism with Chinese characteristics (中国特色社会主义道路自信、理论自信、制度自信、文化自信).

[19] Translator's note: The "Four Consciousnesses" (“四个意识”) are: (1) political consciousness, (2) consciousness of the big picture, (3) consciousness of the core leadership, and (4) consciousness of falling in line with Party directives (政治意识、大局意识、核心意识、看齐意识).

We will strengthen the political functions and service functions of grassroots Party organizations, conscientiously do a good job in the development of Party members and education management, strengthen the work of developing Party members among scientific research backbone personnel, academic leaders, and returnees from overseas studies, continue to do a good job in the evaluation and appraisal of Party building work, and further allow grassroots Party organizations to play their role as fighting fortresses (战斗堡垒) and Party members to play their vanguard and exemplary role. We will strengthen the Party's leadership over united front work and group (群团) work and strengthen construction of non-Party representative teams throughout CAS. We will strengthen retired cadre work and continue to implement political and lifestyle treatment (政治生活待遇) for retired comrades.

(iii) Strengthen the Construction of Leadership and Cadre Teams

We will adhere to the principle of the Party's management of cadres and the standards for good cadres in the new era, improve the selection and appointment procedures and evaluation systems of leaders, and build a team of leaders who are politically firm, have both ability and integrity, are determined to make reforms, have the courage to take responsibility, are dedicated to their jobs, and are honest and free from corruption. We will expand the vision of the selection and use of personnel, explore the global selection of academic leaders for research institutes, strengthen the selection and training of reserve leaders (后备领导人员), further optimize the structure of the leadership team, and enhance the overall functions of the team. We will improve the mechanisms for the exchange of leaders between institutions within CAS and with institutions outside CAS and strengthen the education and training of Party-member cadres. We will implement the relevant regulations of the central government on the strict management of cadres and strengthen the management and supervision of leaders.

(vi) Deeply Promote Party Style and Clean Government Construction

We will adhere to the principles that the Party must manage the Party and of governing the Party strictly, implement the *Chinese Communist Party Standards on Integrity and Self Discipline* and *Regulations of the Chinese Communist Party on Disciplinary Measures*, implement the main responsibilities and supervisory responsibilities for the construction of Party style and clean government, establish and improve the accountability system, and force the implementation of responsibilities. We will consolidate the Party's mass line education and practice activities and the

achievements of "Three Stricts and Three Honests"[20] special-topic education and continue to deepen and strengthen work style construction. We will adapt to the reform and adjustment of the forward-deployed (派驻) institutions of the Central Commission for Discipline Inspection, strengthen the construction of discipline supervision and review institutions and teams, consolidate and improve the working systems and mechanisms for effective linkages at the three levels—top level, branch level, and research institute level—of CAS, and the effective combination of discipline supervision, review, and inspection, and deeply promote construction to combat corruption and uphold integrity. We will strengthen prevention and supervision in key areas, further promote the construction of a risk prevention and control system for honest practitioners, and establish and improve our system for punishing and preventing corruption.

Chapter Six Plan Organization and Implementation

The "13th Five-Year Plan" development planning system of CAS consists of plans divided into two levels and three categories, including the CAS plan outline, the CAS key and special plans, and the "one-three-five" plans of CAS-affiliated units. It is necessary to strengthen organizational leadership, strengthen overall coordination, and strengthen process management to ensure the smooth and effective implementation of the plans, complete the tasks set out in the plans with high quality, and achieve the development goals specified in the plans on schedule.

I. Strengthen Organizational Leadership and Responsibility Implementation

The organization and implementation of CAS's "13th Five-Year Plan" shall be under the unified leadership of the CAS Party Group. For the CAS "Take the Lead Initiative" plan, the Leading Group for Comprehensively Deepening Reform (全面深化改革领导小组) shall be responsible for deploying, guiding, promoting, and supervising the implementation of the plan.

The organization and implementation of the CAS [Five-Year] Plan Outline shall be led by the departments of CAS according to their division of functions. The organization and implementation of CAS key plans and special plans shall be led by staff departments (编制部门). All units affiliated with CAS shall conscientiously implement the relevant goals and tasks determined by the CAS Plan Outline, key

[20] Translator's note: Xi Jinping advised Chinese Communist Party members to uphold the "Three Stricts and Three Honests" (“三严三实”) to maintain "Party style" (党风) and avoid corruption. The "Three Stricts and Three Honests" are: Be strict in cultivating your moral character, in using your political power, and in disciplining yourselves; be honest when making plans, when carrying out your undertakings, and in your interpersonal relations (严以修身、严以用权、严以律己；又谋事要实、创业要实、做人要实).

plans, and special plans while taking account of the actual situation.

The "one-three-five" plans of CAS-affiliated units shall be organized and implemented by the respective units. All units shall strengthen organizational leadership, strengthen resource assurance and policy support, clarify the division of responsibilities, do a good job in work implementation, and ensure the smooth and effective implementation of the plans.

II. Strengthen Overall Coordination and Form a Combined Force for Implementation

We will strengthen overall management and coordination, establish mechanisms for the effective linkage between the development planning system of CAS and the relevant national plans, and establish effective mechanisms for coordinating and aligning the key plans and special plans of CAS, the "one-three-five" plans of CAS-affiliated units, and the CAS Plan Outline.

All CAS departments and affiliated units shall establish and improve the communication and contact mechanisms for plan organization and implementation and jointly promote smooth plan implementation. In the key S&T layout areas in the plans, it is necessary to strengthen the overall organization of disciplines, platforms, cadre building, and deployment of major tasks, ensure the achievement of major breakthroughs, and promote the production of major achievements. We must strengthen the overall coordination and policy support of major reform measures such as research institute categorization reform and national laboratory construction, scientifically and rationally allocate human, financial, and material resources, and form a combined force to ensure the smooth and effective implementation of the plans. We must coordinate the comprehensive and coordinated development of various undertakings throughout CAS and promote the coordinated development of CAS-affiliated institutions in different regions.

The relevant CAS departments should strengthen their guidance, supervision, coordination, and services for the implementation of the "one-three-five" plans of CAS-affiliated units. We must give play to the role of branches in coordinating and supervising the implementation of the "one-three-five" plans of CAS-affiliated units within the system and strengthen linkages with regional development plans.

III. Strengthen Process Management and Perform Strict Evaluation and Acceptance

We must improve dynamic plan implementation status monitoring mechanisms. Incorporating annual work summaries and exchanges, we must monitor the progress

of plan goals, task deployment, and implementation of policy measures at the top and subordinate levels of CAS and keep abreast of plan implementation conditions. Research institutes can revise and dynamically adjust the content of their "one-three-five" plans based on S&T progress and changes in the development environment and in accordance with the relevant regulations and procedures of CAS.

We must conduct summary evaluations at the end of the plan implementation period. We must adopt a method combining self-assessment and external assessment, conduct acceptance assessment and conversational evaluation on the completion of the objectives in the "one-three-five" plan mission statement of each institute, and strengthen merit-based support. We must summarize the implementation of CAS top-level plans. The acceptance evaluation and summary results serve as an important basis for formulating a new round of plans for the two levels of CAS.