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## Ten-year Development of China's Science and Technology Talent Policies and Optimizing Approach for Sci-tech Self-reliance and Self-improvement

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# Ten-year Development of China's Science and Technology Talent Policies and Optimizing Approach for Sci-tech Self-reliance and Self-improvement

## Abstract

Since the 18th National Congress of the Communist Party of China, the science and technology (S&T) talent policies in China have been continuously optimized and developed. Consequently, a multi-layered policy system with vertical and horizontal linkages has been formed. The education and training policies have been improved, the utilization and development policies of talents have been enhanced, and the evaluation and incentive policies have become more rational, which effectively guaranteed the high-quality development of China's S&T talents. However, there are still several problems with the current S&T talent policy system, such as incomplete system, low precision, low integration of technological and educational policy, and insufficient incentives for young S&T talents and basic research talents (hereafter "young-basic talents"), which cannot meet the urgent need under the strategy of sci-tech self-reliance and self-improvement. Therefore, it is vital to consolidate the core position and leading role of the S&T talents development in the construction of the national innovation system under the new situation. Facing the sci-tech self-reliance and self-improvement strategy, the future S&T talent policies need to strengthen selfcultivating, serve national strategy, and focus on industry needs to promote the deep integration of the education chain, talent chain, innovation chain, and industry chain and promote the implementation of policies for young S&T talents, basic research talents and strategic scientists, and outstanding engineers. It is also necessary to promote talent education, training and development policies to meet the needs of sci-tech development by deepening the integration of science and education and establishing a postgraduate education system that follows the laws of scientific research activities. Furthermore, it needs to systematically think about the policy system optimization for the S&T talents evaluation and incentives, to promote the effective implementation of the life security policy of S&T talents. In addition, efforts should be made to promote the establishment of a talent mechanism in line with international standards and to accelerate the construction of the world's important talent centers and innovations highlands.

## Keywords

S&T talent policy; policy development; sci-tech self-reliance and self-improvement; talent cultivation; talent chain; innovation chain

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## Ten-year Development of China's S&T Talent Policies and Optimizing Approach for Sci-tech Self-reliance and Self-improvement

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**Abstract:** Since the 18th National Congress of the Communist Party of China, the science and technology (S&T) talent policies in China have been continuously optimized and developed. Consequently, a multi-layered policy system with vertical and horizontal linkages has been formed. The education and training policies and the utilization and development policies of talents have been enhanced, and the evaluation and incentive policies have become more rational, which effectively guaranteed the high-quality development of China's S&T talents. However, there are still several problems with the current S&T talent policy system, such as incomplete system, low precision, low integration of technological and educational policy, and insufficient incentives for young S&T talents and basic research talents (hereinafter referred to as young-basic talents), which cannot meet the urgent need under the strategy of sci-tech self-reliance and self-improvement. Therefore, it is vital to consolidate the core position and leading role of the S&T talent development in the construction of the national innovation system under the new situation. Facing the strategy of sci-tech self-reliance and self-improvement, future S&T talent policies need to strengthen self-cultivating, serve national strategy and focus on industry needs to promote the deep integration of education chain, talent chain, innovation chain, and industry chain and promote the implementation of policies for young S&T talents, basic research talents, strategic scientists and outstanding engineers. It is also necessary to build policy systems for S&T talent education, training and development to meet the needs of sci-tech development by deepening the integration of science and education and establishing a postgraduate education system that follows the laws of scientific research activities. Furthermore, it needs to systematically think about and optimize the policy system for the S&T talent evaluation and incentives, to facilitate the effective implementation of the living security policy of S&T talents. In addition, efforts should be made to set up a talent mechanism in line with international standards and construct the world-level important talent centers and innovation highlands. **DOI:** 10.16418/j.issn.1000-3045.20220411001-en

**Keywords:** S&T talent policy; policy development; sci-tech self-reliance and self-improvement; talent cultivation; talent chain; innovation chain

Since the 18th National Congress of the Communist Party of China (CPC), the CPC Central Committee, the State Council and other relevant departments have successively issued S&T (S&T) talent policies covering talent education and training, talent use and development, and talent evaluation and incentive. As a result, the system has been constantly improved, and remarkable achievements have been made. At present, the world is experiencing great unprecedented changes, and the S&T competition is focusing on the competition of high-end S&T talents. In order to effectively deal with the international S&T competition, break through the "bottleneck" dilemma of technologies, realize sci-tech self-reliance and self-improvement, and build a world-level S&T power, China shall cultivate and develop high-quality innovative S&T talents. General Secretary XI Jinping pointed out that, "The sci-tech self-reliance and self-improvement shall rely on high-quality innovative talents". In the speech at the Central Talent Work Conference on September 27, 2021, Xi emphasized that "Talents form the key to independent

innovation and top talents are irreplaceable. National development and rejuvenation depend on talents" [1]. Under the new situation, in view of the strategic needs of sci-tech self-reliance and self-improvement, it is urgent for China to implement the strategy of strengthening the country with talents in the new era, and further improve and optimize China's S&T talent policy system. China shall also explore and establish a S&T talent policy system following the laws of S&T development, and talent cultivation and use, consolidate the core position of the S&T talent development in the construction of the national innovation system, promote the deep integration and coordinated development of education chain, talent chain, and innovation chain, and stimulate the innovation vitality and potential of the S&T talents, so as to accelerate the breakthroughs in key and core technologies and deal with the increasingly fierce international competition. On the basis of reviewing the development process of China's S&T talent policies after the 18th National Congress of the CPC, this study analyzes their achievements and the

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unsolved problems. In addition, the paper proposes suggestions on systematic optimization of China's S&T talent policy system from five aspects, namely strengthening policy integration and improving the systemic development and implementation of talent policies, strengthening self-cultivation and realizing internationalization and self-cultivation of talents, strengthening young-basic talents (young S&T talents and basic research talents) and consolidating the basis of sci-tech self-reliance and self-improvement, strengthening multi-chain integration and promoting coordination in education, talents, research activities and strengthening demand orientation and improving the precision of development policies for S&T talents".

## **1 China's S&T talent policies have been continuously optimized, gradually forming a multi-layered policy system**

China has always attached great importance to talents, deepened and expanded the S&T talent policies, and strengthened their development in depth and breadth. Therefore, a multi-layered policy system with vertical and horizontal linkages has been formed between government departments and the central and local governments, effectively stimulating the vitality of S&T talents in terms of innovation and creativity.

### **1.1 Improved and optimized S&T talent policy system**

Since the 18th National Congress of the CPC, China has continuously improved the S&T talent policy system through stimulating the vitality of S&T talents and building S&T talent teams conforming to the development of the times as well as economic and social demands. (1) More abundant policy supply. From 2013 to 2021, the central and local governments issued more than 220 policies regarding S&T talents, in which, 76 were issued by the CPC Central Committee and the State Council, accounting for 34.5% <sup>[2]</sup>, indicating enhanced central and local policy supply capacity and linkage. (2) More diversified policy subjects. Governments and departments at all levels have issued relevant support policies for S&T talents, and formed a multi-tiered and multi-sectoral supply structure to promote their growth and career development. (3) More comprehensive policy receivers. The current S&T talent policies cover S&T talents in various fields, at various levels and in different phases of career development. For example, the National Natural Science Foundation of China (NSFC) has established a funding pattern involving full life circle of the career of innovative S&T talents, such as Youth Science Foundation Program, Excellent Young Scientists Fund Program, Program of National Science Fund for Distinguished Young Scholars, and Innovative Research Group Program. (4) Increasingly focused policy priorities. China's S&T talent policies are gradually

deepening, and reflect the concept of innovation-driven strategic talents. China has paid attention to the construction of hierarchical structure of strategic S&T talents, leading S&T talents, young S&T talents and innovation team talents, the introduction and flow of talents and the reform in their classification and evaluation.

### **1.2 Improved S&T talents education and training policies**

Since the 18th National Congress of the CPC, governments and departments at all levels have issued a series of improved education and training policies for S&T talents, which have constantly advanced the policy system in the following two aspects. (1) Strengthening the education and training of talents in basic disciplines, and comprehensively promoting the reform of the discipline system and teaching system. For example, the Ministry of Education has introduced several policies supporting basic disciplines such as the Pilot Enrollment Reform Program for Strengthening Basic Disciplines. Since 2012, it has approved and established 1,189 first-class majors in basic disciplines <sup>[3]</sup> for vigorously cultivating potential young talents in basic disciplines. Under the background of new S&T development, the Ministry of Education has also promoted the construction of new engineering, new medical sciences, new agricultural sciences and new liberal arts, and the reform in the interdisciplinary training system <sup>[4]</sup>; in addition, it has also focused on cultivating basic research talents urgently needed for industrial and regional development. (2) Establishing a S&T demand-oriented talent cultivation mechanism, and deepening the integration of science and education as well as industry and education. For example, the Chinese Academy of Sciences has given full play to its advantages as a "trinity" of a research institute, department and educational institution to strengthen the identification and training of compound and applied S&T talents. The Several Opinions of the General Office of the State Council on Deepening the Integration of Industry into Education issued in 2017 further emphasized promoting the integration of discipline building and industrial transformation and upgrading.

### **1.3 Improved utilization and development policies of S&T talents**

Since the 18th National Congress of the CPC, governments and departments at all levels have improved the utilization and development policies of S&T talents based on the scientific research platform and business platform, involving the following two aspects. (1) Promoting the reform in management of S&T programs, optimizing the organization and implementation of S&T programs, and encouraging S&T talents to devote themselves to scientific research activities. Governments and departments have implemented the overall rationing system of funds for talent scientific research, to give the right of allocating research funds to individuals, and free S&T talents from the formalism and bureaucracy of scientific

research management <sup>[1]</sup>. They have also promoted the growth of young S&T talents through S&T projects, and supported and encouraged them to undertake major S&T tasks <sup>[5]</sup>. (2) Reforming scientific research institutes while focusing on expanding the autonomy of employers, and providing S&T talents with favorable environment for development. Governments and departments have improved the corporate governance structure of research institutes, and expanded the autonomy of post management, decentralized the management of performance-based pay structure, assessment method and distribution method, as well as the autonomy of staffing and HR management <sup>[2]</sup>, and established a diversified income distribution mechanism involving performance-based pay and the annual salary system, so as to practically increase the income of researchers.

#### **1.4 Enriched evaluation and incentive policies of S&T talents**

Since the 18th National Congress of the CPC, China has constantly reformed the evaluation and incentive system for S&T talents, to develop the system and increase its vitality with reform. The policy system has been more abundant, which is mainly reflected in the following two aspects. (1) Constantly optimizing the evaluation mechanism of S&T talents guided by the creation of value of knowledge. China has improved an evaluation system for S&T talents based on innovation ability, quality, contribution and performance focusing on the creation of value of knowledge, and resolutely abolished the thesis, title, education, and award-oriented principle, to advance the methods for classification and evaluation of talents in basic research, applied research and technological development in terms of scientific value, technological value and industrial value. (2) Continuously optimizing the funding management of S&T projects, to stimulate the innovative vitality of S&T talents. China has implemented various competition systems, and promoted the establishment of a goal-oriented “military order” system, to encourage the leading S&T talents to take charge <sup>[1]</sup>.

## **2 China's S&T talent policies have made significant achievements, promoting high-quality development of S&T talents**

Since the 18th National Congress of the CPC, under the systematic policies for S&T talents, the scale of S&T talents has been expanded, with increasingly rational structure and significantly enhanced innovation ability, laying a foundation for sci-tech self-reliance and self-improvement.

### **2.1 Expanded scale of S&T talents**

In recent years, the number of S&T talents in China has remarkably increased. At the end of 2020, the total number of S&T talents in China reached 112.34 million, increasing by 45.29 million as compared with that in 2012 and ranked the

first in the world for many consecutive years <sup>[6]</sup>. Among them, the scale of postgraduate students (as the reserved S&T talents) has also expanded year by year. In 2020, the number of postgraduate students and that of doctoral students in China were 2,673,000 and 466,500, respectively, increasing by 1,237,000 and 182,700, respectively as compared with those in 2012. China also takes a lead in the scale of research and development (R&D) personnel. In 2020, the quantity of R&D personnel was 5,234,500, increasing by 1,987,700 as compared with that in 2012, with an average annual growth rate of 6.15%. The intensity of R&D personnel investment has also been increasing year by year. In 2020, the number of R&D personnel per 10,000 workers reached 70, showing a narrowing gap with western developed countries.

### **2.2 Optimized structure of S&T talents**

With the improvement of China's S&T talent policies, the structure of innovative S&T talents has been continuously optimized. (1) The proportion of basic researchers in R&D personnel has been increasing day by day. In 2020, the number of basic researchers in China reached 426,800, accounting for 8.15% of the R&D personnel, which was significantly higher than that in 2012 (212,200, 6.54%). (2) The age structure of S&T talents has been continuously optimized. There are more young S&T talents and more supporting policies. For example, according to the statistics of the National Office for Science & Technology Awards, the average age of newly elected academicians was 55.7 years in 2019, and that of the winners of the National Natural Science Awards in 2019 was 44.6 years. The personnel undertaking the projects funded by the NSFC has also been younger. According to the statistics of the NSFC, taking general projects of the NSFC as examples, the proportion of project leaders under 40 was steadily increased from 36.64% in 2012 to 47.71% in 2019. (3) The education structure of S&T talents has been continuously optimized. The proportion of R&D personnel with bachelor's degree or above increased from 50.27% in 2012 to 63.58% in 2020, among which the proportion of R&D personnel with master's or doctor's degree increased from 19.55% in 2012 to 23.13% in 2020. (4) The gender structure of S&T talents has been more balanced. The number of female researchers has increased markedly. The male-female ratio of S&T talents decreased from 3.00 in 2012 to 2.81 in 2020, being more balanced, and the role of female S&T talents has been further released.

### **2.3 Enhanced innovation ability of S&T talents**

With the continuous implementation of S&T talent policies, the global competitiveness of China's S&T talents has been gradually enhanced, and a large number of leading S&T individuals and teams have emerged, constantly updating the level of S&T innovation. (1) The comprehensive competitiveness of China's S&T talents has been steadily increased. In recent years, the ranking of global talent competitiveness composite index of China has risen in fluctuations. In 2021,

China ranked the 37th, increasing by 10 as compared with that in 2013<sup>[7]</sup>. (2) More leading S&T talents with global influence have emerged in China. Many leading talents have obtained major international S&T awards. For example, TU Youyou won the 2015 Nobel Prize in Physiology or Medicine, WU Meirong won the Theodore von Kármán Prize in 2013, and XUE Qikun won the Fritz London Memorial Prize in 2020. (3) The S&T talents in China have made great innovation achievements. In terms of innovation achievements, the number of papers per 10,000 researchers in China was 1,181 in 2019, an increase of 326 compared with that in 2012. The number of patent cooperation treaty (PCT) applications per 10,000 corporate researchers increased from 40.32 in 2012 to 91.04 in 2020, narrowing the gap between the US and other developed countries. In addition to papers and patents, China's scientists have made important breakthroughs in basic research, involving topological quantum computer, magnetic confinement fusion device, and spallation neutron source, as well as strategic high-tech fields, such as Chang'e-4 Lunar Probe, Beidou-3 Global Navigation Satellite System, "Crust 1" 10k Driller, and "Tiankun" Cutter Suction Dredger.

### **3 There are still many challenges in systematization and accuracy of China's S&T talent policies**

In the face of increasingly fierce global competition for S&T talents, there are still several problems with the current S&T talent policy system, such as incomplete system, low precision, low integration of technological and educational policy, and insufficient incentives for young S&T talents and basic research talents, which cannot meet the urgent need under the strategy of sci-tech self-reliance and self-improvement. Thus it is urgent to perform refined development.

#### **3.1 Incomplete system of S&T talent policies**

The current China's S&T talent policies are incomplete in systematization. The linkage of policies S&T talent policies between departments should be further strengthened, and the discontinuity of policy time limitation in different regions should be further improved. (1) From the perspective of policy formulation. In China, the formulation of S&T talent policies may be usually dominated by multiple departments, which would inevitably lead to policy conflicts<sup>[8]</sup>. Moreover, the system supporting the S&T talent policies is still incomplete. For example, some regions focus on introduction rather than utilization, with no supporting policy implementation measures and policies for scientific research service personnel. Due to the excessive and frequent formulation of policies, the continuity and compatibility between some old and new policies are insufficient, demonstrating the fragmented policy system. Therefore, it is urgent to strengthen the

systematization of policy content. (2) From the perspective of policy implementation. There is neither a communication and coordination mechanism between governments and departments, nor a reasonable talent planning system and coordinated management system between the central and local governments and departments, making the S&T talent policy system in China low in overall efficiency. For example, under the existing policy system, although China has built the largest innovative talent teams in the world, there are still several problems such as inadequate high-level talents, unreasonable structure and imperfect incentive mechanism<sup>[9]</sup>.

#### **3.2 Low precision of S&T talent policies**

The current S&T talent policies in China fail to fully consider the differences in development demands between different research categories, S&T talent levels, fields, units, and regions. In addition, China also fails to fully consider the trends and demands of industrial and social development, leading to low precision and refinement of S&T talent policies. (1) The differences in the development demand of different research categories have not been fully considered. Different types of research require different supporting policies due to the demand of different funding methods, assessment methods, development environments and development conditions. In practice, however, the S&T talents in basic research, applied research and experimental development are generally evaluated and funded in the same manner, making S&T talent policies fail to effectively motivate and support these three types of talents. (2) The differences in the development demand of different levels of S&T talents have not been fully considered. Strategic S&T talents, leading S&T talents, distinguished engineers and young S&T talents require different policy conditions for development. However, the current S&T talent policies have not effectively established a supporting system for different demands of each level of S&T talents. (3) The differences in the development demand of different regions have not been fully considered. Regions at different stages of development differ in the demand for talents, which means that targeted policy supporting systems shall be established. However, some regions fail to comprehensively take into account the characteristics of their own industrial development and the diversified demands for S&T talents, thereby resulting in inaccurate and inefficient allocation of S&T talents. (4) The trends and demands of industrial and social development have not been fully considered. For building a high-level power of sci-tech self-reliance and self-improvement, it is necessary to perform frontier exploration and forward-looking layout, and cultivate leading S&T talents. However, the cultivation and development policies for S&T talents in China are low in forward looking about S&T and industry development. Therefore, the supply of high-level S&T talents has not been precisely matched with the demand for talents, and cannot fully meet the future development demand of the industry and society.

### 3.3 Low integration of technological and educational policy

China's higher education and scientific research management policies are not closely linked, and there are mainly two problems restricting the deep integration of science and education in the systems and mechanisms such as postgraduate enrollment system, discipline setting mechanism, discipline evaluation mechanism, scientific research evaluation mechanism and professional title evaluation orientation. (1) The policy system for cultivating S&T talents relying on scientific research platforms and activities has not been effectively established. The complete policy system for cultivating postgraduate talents in accordance with the rules of scientific research, and the full-circle funding system for postgraduate talents to advanced S&T talents have not been established. Furthermore, the quota of postgraduate students in China is mainly plan-oriented, and the allocation mechanism underlying the postgraduate enrollment quota based on scientific research tasks has not been effectively set up. (2) The policies for the development of reserved S&T talents and those for the development of scientific research activities have not been strongly correlated. According to the Statistical Bulletin of China's National Education Development, the proportion of doctoral student enrollment in the number of regular undergraduates has been maintained at about 2% in China in the past 20 years. From 2012 to 2020, the number of doctoral student enrolment and that of doctoral student recruitment increased by 64.38% and 69.60%, respectively. During this period, China's R&D expenditure increased by 136.86%, and the growth rate of the scale of talents could not fully meet the demands of scientific research activities in China.

### 3.4 Incomplete policy system for young-basic talents

Young S&T talents are the main talents for basic research and also the core forces making basic research achievements. At present, the absence of complete supporting systems, such as the incentive policies for young-basic talents, and the problems in the implementation of such policies result in an incomplete system of cultivating the reserved S&T talents with self-reliance and self-improvement in the new era, which were mainly reflected in the following two aspects. (1) The multi-layered and multi-category incentive system for young-basic talents has not been effectively established. Internationally, scientific research funding organizations generally take young S&T talents as the targets, and provide them with various forms of funding. For example, the US National Science Foundation (NSF) created a Young Scientist Development Program for young S&T talents in 1994. Japan successively issued the documents such as the Comprehensive Measures to Strengthen Research Capacity and Support Young Researchers. However, China's current incentive policies for young-basic talents fail to fully consider

the growth laws of S&T talents in different scientific research activities<sup>[10]</sup>. For example, there is not a long-term and stable supporting mechanism for young talents in the field of basic science that can encourage them to engage in research; while for young talents in the field of engineering application, there is not a complete mechanism for promoting their growth and development through undertaking important S&T tasks. (2) Under the current S&T system in China, it is hard to implement the policies for young-basic talents, and provide them with sufficient extent and intensity of funding. For example, the funding of the NSFC for young talents has been slowly increased. Compared with those in 2012, the number of applications for the Young Scientists Fund of the NSFC increased by 53,000 in 2020, whereas the number of projects funded only increased by 70,000, with the funding rate decreasing from 23.45% in 2012 to 16.22% in 2020. These indicate that the young scientist's fund was not dynamically optimized according to the development status of S&T talents in the new era.

## 4 We should systematically promote the optimization of the policy system for S&T talents and improve the efficiency of the talent policy system

In the era of sci-tech self-reliance and self-improvement, China shall significantly enhance the ability of self-cultivating of high-level innovative S&T talents, strengthen the planning of S&T talent policies for cutting-edge technologies in the future, and support S&T talents to make original breakthroughs in the fields such as basic research. Therefore, it is urgent to systematically optimize the S&T talent policy system in China, promote high-quality transformation of China's S&T talent management, and improve the overall efficiency of the S&T talent system.

### 4.1 Strengthening policy linkage and improving the systematization of talent policy formulation and implementation

Based on the national goal and demands of S&T talents, China shall strengthen the coordination and cooperation between governments and relevant departments at all levels in policy formulation and implementation, and optimize the policy system covering the whole chain of education and training, utilization and development, evaluation and incentive of S&T talents. (1) Strengthening top-level design and departmental coordination to improve inter-departmental synergy and inter-policy linkage<sup>[11]</sup>. The policies shall be formulated according to the demands of economic and social development and industrial structure, and combined with the functions of talents of different types and in different development phases, so as to systematically design the S&T talent policy system. According to different tasks of S&T talent

policies in different departments and regions, it is necessary to establish and improve the information exchange mechanism and platform, and guide departments and regions to communicate with each other in a timely manner, so as to avoid the policy conflicts. (2) Establishing a reasonable coordination and overall management system for S&T talents between governments at all levels and different departments. It is necessary to emphasize the concept of “market leading, and government service supervision”, strengthen the authorization relaxation of government departments, give full play to the subjective initiative of employers, and create a mechanism for multiple subjects to participate in talent development [2]. All departments shall strengthen cooperation, study and identify the systemic reasons behind the alienation of S&T talent policies, eliminate the superficialness, and form a policy management system that can adapt to the healthy development of S&T talents in the new era [12].

#### **4.2 Strengthening self cultivating and realizing internationalization and independent training of talents**

In the new era, the construction of S&T talent team shall promote the internationalization of S&T talents from the perspective of mutual benefit and global network construction, and shall also establish a policy system for self cultivating of talents serving sci-tech self-reliance and self-improvement, so as to create a sound institutional ecosystem with Chinese characteristics suitable for the growth of multi-echelon talents in the world. (1) Optimizing the structure of disciplines and specialties based on the national strategy, and forming a diversified and classified system of talent self cultivating policies. In view of the demands of upgrading industrial structure and making breakthroughs in basic research, it is necessary to adjust the discipline and specialty setting for the reserved S&T talents, and match the supply of young scientific research talents with actual problems faced by the industry and society in the current and future development. (2) Constantly promoting the internationalization of S&T talents, optimizing and adjusting the thinking of the internationalization of innovative S&T talents and making overall planning from the perspective of communication, mutual benefit, and talent cultivating, so as to accelerate the implementation of global scientific research funds. It is necessary to establish and improve the two-way development pattern of introduction and going global, advance the management methods for the introduction of innovative talents and the internationalization of their training, and create a talent mechanism being geared to international standards, thus elevating the internationalization level of S&T talents [13]. According to the regional S&T development level and the demands of economic and social construction, the pattern of special talent zone shall be promoted, and outstanding innovative S&T talents shall be introduced from all over the world. Special talent policies shall be implemented for specific fields relying on major S&T platforms and innovation platforms.

#### **4.3 Strengthening the cultivation of young-basic talents and consolidating the foundation of sci-tech self-reliance and self-improvement**

Young-basic talents form the foundation of sci-tech self-reliance and self-improvement in the new era. Therefore, their growth environment shall be optimized, and relevant policies shall be implemented. (1) Supporting young S&T talents to play the leading role. It is necessary to improve the implementation level of projects for young scientists under China’s key R&D program, encourage young talents to obtain experience at front-line positions, and promote the growth of young S&T talents through undertaking scientific research projects [14]. (2) Further increasing the funding for young S&T talents. It is necessary to provide long-term and stable support for young S&T talents with outstanding achievements and obvious innovation potential in the field of natural science, shift forward the funding phase for young S&T talents, set up research programs for the postgraduate students, promote young talents to show themselves in early career development, and help young S&T talents to form scientific research teams and build scientific research platforms [12]. Moreover, we should support young R&D personnel to select their own research fields and content, and fully stimulate their vitality of independent innovation. (3) Establishing a long-term policy system to support basic research talents. It is necessary to establish a long-term training, evaluation and funding system for basic S&T talents, to help them devote to basic research, and provide practical support for them to make high-level original achievements. It is also necessary to focus on inheritance and innovation, pay more attention to the guidance and training of young talents engaging in basic research, set up a “mentoring” mechanism between senior, middle-aged and young S&T talents, and foster high-level basic research teams.

#### **4.4 Strengthening multi-chain integration and promoting coordination in education, talents and research activities**

In view of the S&T development demand in the new era, it is necessary to deepen the reform of the postgraduate enrollment system, discipline setting mechanism, scientific research evaluation mechanism and professional title evaluation orientation, promote the integration and linkage of education chain, talent chain and innovation chain policies, and support the education and training of S&T talents from self-reliance to self-improvement. (1) Designing education and training policies for S&T talents according to the industrial innovation chain, to matching the building of disciplines and specialties with industrial transformation and upgrading. Colleges and universities shall establish an interdisciplinary talent training system based on global frontier goals and industrial development in the future to adapt to new technological revolutions such as digital transformation and green transformation, and strengthen the training of S&T talents in



key technical fields. (2) Cultivating and using S&T talents based on the industry-university-research cooperation platform, to promote all-round integration of structural elements at the supply side of S&T talent cultivation and the industrial demand side. It is necessary to speed up the establishment of an effective mechanism for universities and enterprises to jointly cultivate high-quality interdisciplinary talents, encourage enterprises to accept postgraduate students to participate in technology research and development, and support technical experts and R&D personnel in enterprises to serve as part-time postgraduate tutors, so as to promote the interaction between capital market and the academia and industrial circle. Furthermore, we should build postgraduate training bases incorporating industry, universities and research relying on major national innovation platforms, major S&T programs and key disciplines. (3) Establishing a postgraduate training system following the laws of scientific research activities. It is necessary to optimize the postgraduate education system and improve the enrollment quota mechanism based on scientific research tasks and strengthen the postgraduate training relying on scientific research projects and platforms, to consolidate the foundation for cultivating the reserved S&T talents.

#### 4.5 Strengthening demand orientation and improving the precision of the S&T talent policy system

Facing the demand for S&T talents with self-reliance and self-improvement in the new era, China shall promote the reform of the S&T talent policy system, and accelerate the establishment of a development mechanism that can enable S&T talents to show themselves and release the innovative vitality. (1) Demand orientation of the policies on supply of S&T talents. On the one hand, it is necessary to cultivate talents based on the demands of science and industry, and establish a dynamic discipline adjustment mechanism conforming to the demands of science and industry. On the other hand, it is also necessary to consider the difference in development demands of strategic S&T talents, leading S&T talents, outstanding engineers and young S&T talents, as well as the difference in various research categories, so as to optimize the S&T talent policy system in China. (2) Demand orientation of the policies on evaluation of S&T talents. It is necessary to further improve the long-term evaluation mechanism conforming to the law of input-output cycle of scientific research<sup>[12]</sup>, and encourage and guide S&T talents

to perform scientific exploration activities based on long-term goals, so as to cultivate their comprehensive outlook and forward thinking ability. (3) Demand orientation of supporting policies for S&T talents. It is necessary to provide S&T talents with effective public services in the aspects of housing, schooling of children, and medical care, and practically resolve their worries. (4) Demand orientation of evaluation of S&T talent policies. Through examining whether the S&T talent policies meet the needs of national, industrial, scientific and talent development in the new era, we should evaluate the effects and problems of policy implementation, to further promote the policy implementation and improve the systematization and precision of the policy system.

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