Chapter 2 Science, Technology, and Innovation Policies of Japan

This chapter gives an overview of recent science, technology and innovation policies and discusses the future direction of science, technology and innovation policies.

Section 1 Basic Act on Science, Technology and Innovation and Science, Technology, and Innovation Basic Plan

1 Basic Act on Science, Technology and Innovation

In 1995, Japan enacted the Basic Act on Science and Technology, establishing the basic framework for science and technology policy. The purpose of the Act is to position the promotion of science and technology as one of the most important policy issues and to actively promote science and technology based on the recognition that Japan will move away from a policy of following Europe and the U.S. and take on the challenges of untapped science and technology fields ourselves as a member of the global front-runners.

The first substantial amendments since the enactment were made to the Act in June 2020 to include the “innovation creation” as one of the pillars of the growth strategy, and the humanities and social sciences (referred to as the “humanities” in the Act), which had not been covered by the Act, were included in the scope subject to the Act. The name of the law was also changed to the Basic Act on Science, Technology and Innovation.

2 Science, Technology, and Innovation Basic Plan

Japan formulates the Science, Technology, and Innovation Basic Plan based on the Basic Act on Science, Technology and Innovation (The Science and Technology Basic Plan up to the 5th Basic Plan) every 5 years. These are the main points of each plan.

○ 1st Basic Plan (1996 to 2000)
- Expanding government investment in R&D
- 10,000 Postdoctoral Fellows Plan

○ 2nd Basic Plan (2001 to 2005), 3rd Basic Plan (2006 to 2010)
- Focus on fields of specialization of high importance (four priority fields to be promoted: Life Science, Information and Communication, Environment, Nanotechnology and Materials)
- Doubling of competitive funding and introduction of indirect costs (30%) (2nd Basic Plan)

○ 4th Basic Plan (2011 to 2015)
- Emphasis on innovation policy
- A shift from area-focused prioritization to issue-oriented prioritization

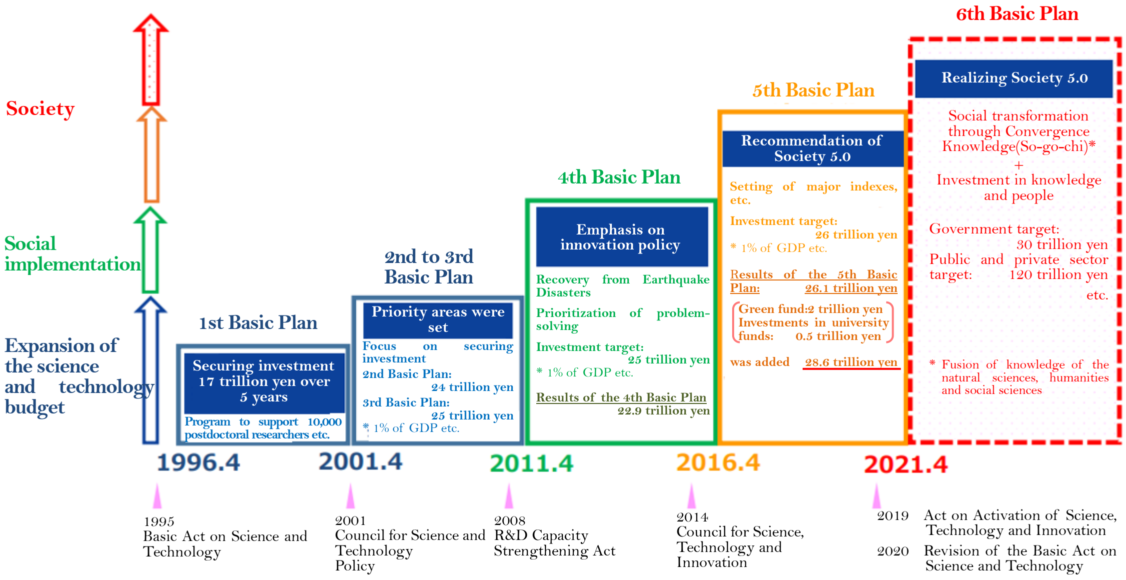
○ 5th Basic Plan (2016 to 2020)
- Society 5.0 was proposed as a future society for which Japan should aim

○ 6th Basic Plan (2021 to 2025)
- Realization of Society 5.0, social transformation through the Convergence Knowledge (So-Go-Chi), and investment in knowledge and people

■ Figure 1-2-1/ The 6th Science, Technology, and Innovation Basic Plan

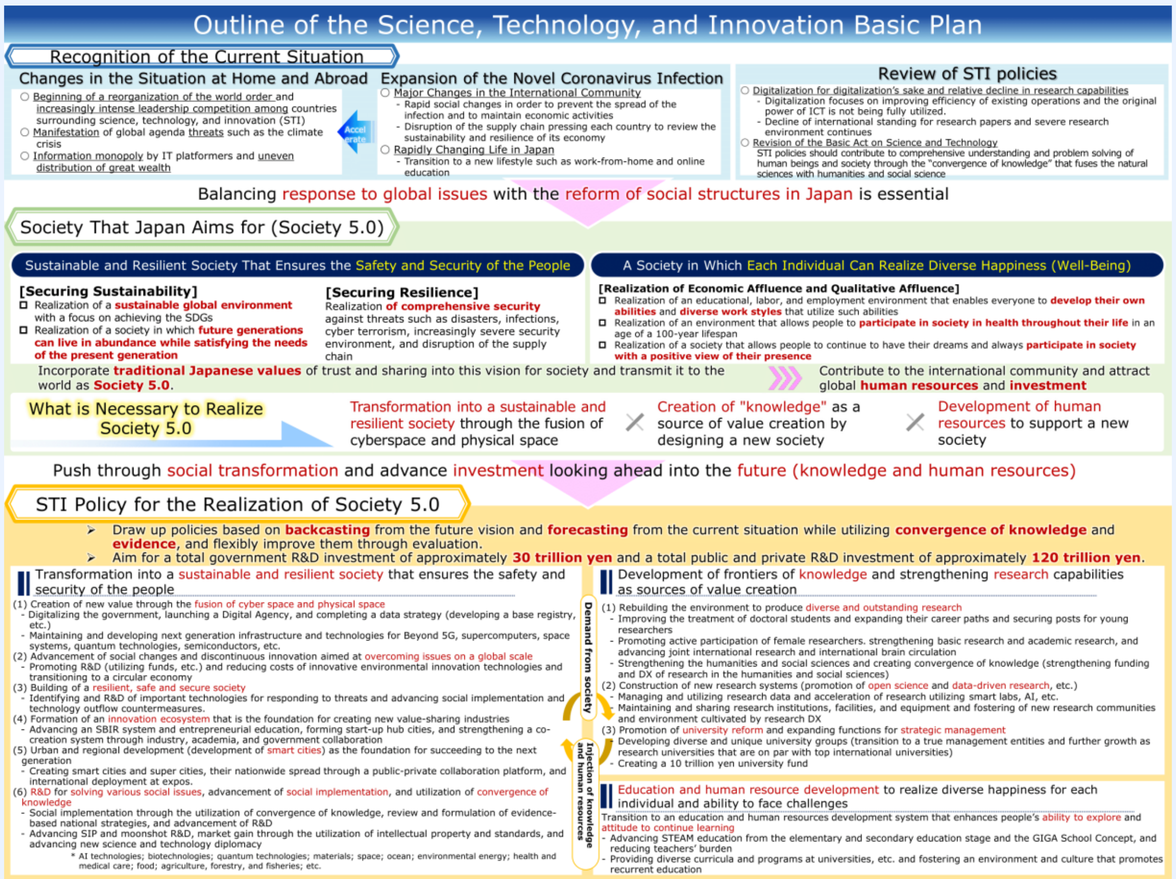
The Science, Technology, and Innovation Basic Plan

- The Basic Plan is formulated every five years based on the Basic Act on Science and Technology enacted in 1995
- The 1st to 3rd Basic Plan placed emphasis on expanding the science and technology budget, the 4th Basic Plan focused on social implementation, the 5th Basic Plan proposed "Society 5.0"
- In the 6th Basic Plan (2020), the Basic Act was amended, and "promotion of humanities and social sciences" and "innovation creation" were included in the scope of the Basic Plan, were added. Embarked on full-scale social transformation



Source: Cabinet office data

■ Figure 1-2-2/ The 6th Science, Technology, and Innovation Basic Plan (Overview)



Source: Cabinet Office "The 6th Science, Technology, and Innovation Basic Plan (Overview)"
URL: https://www8.cao.go.jp/cstp/kihonkeikaku/6gaiyo.pdf

3 Government R&D Investment

The Basic Plan sets a five-year target for government investment in R&D, which was approximately 17 trillion yen for the 1st Basic Plan, approximately 24 trillion yen for the 2nd Basic Plan, approximately 25 trillion yen for the 3rd and 4th Basic Plans, and approximately 26 trillion yen for the 5th Basic Plan. The investments in the 1st and 5th Basic Plans exceeded the target. In the current 6th Basic Plan, the target is set at approximately 30 trillion yen, with the following target: "While other countries are planning large-scale R&D investment in anticipation of the post-coronavirus era, Japan will secure bold-scale government R&D investment in order to win the fierce competition among countries."

■ Figure 1-2-3/ Overview of the STI Policy

Overview of the STI Policy

1990	Collapse of the bubble economy		
1991	End of the Cold War	1991	University Council Report "Quantitative Improvement of Graduate Schools" (emphasis on graduate schools)
1993	Inauguration of the European Union		
1995	Great Hanshin-Awaji Earthquake	1995	Basic Act on Science and Technology (Emphasis on Basic Research)
		1996	Expansion of government R&D investment under The 1st Science and Technology Basic Plan, Total government investment of 17 trillion yen, Expansion of competitive research funds, and a program to support 10,000 postdoctoral researchers
1997	Kyoto Protocol *1		
1999	Budapest Declaration *2	1999	Act on General Rules for Incorporated Administrative Agencies
	JOC accident	2001	Reorganization of central ministries and agencies (Council for Science and Technology Policy, MEXT)
2001	September 11 terrorist attacks		The 2nd Science and Technology Basic Plan, Total government investment of 24 trillion yen Four priority fields to be promoted, Doubling of competitive research funds, etc.
2004	Valmisar Boat*3	2004	Corporatization of national universities
		2005	Reform of total personnel expenses (Reduction in personnel expenses)
2006	Successful creation of iPS cells	2006	The 3rd Science and Technology Basic Plan, Total government investment of 25 trillion yen, 4 priority fields to be promoted and 4 fields to be promoted, Education Rebuilding Council was set up
2008	Lehman shock Peaking of the Japanese population	2008	R&D Capacity Strengthening Act (Innovation legislation, Exemption concerning reduction in personnel expenses)
2009	Change of government	2009	Government revitalization unit (reviewing of government programs)
2010	China's GDP ranked 2nd		
2011	2011 Great East Japan Earthquake	2011	The 4th Science and Technology Basic Plan, Government investment target of 25 trillion yen, Issue-oriented prioritization, Emphasis on innovation policies
2012	Change of government	2013	Council for Science and Technology (CST) deliberative motion (general review of the science, technology and innovation policies in light of the earthquake disaster) R&D Capacity Strengthening Act amended (Special Provision for Labor Contracts Act, URA (Research Administrators) legislation, Investment)
		2014	Reorganized as the Council for Science, Technology and Innovation
2015	SDGs were adopted Paris Agreement was adopted	2015	National Research and Development Agency - National Research and Development Agency System
		2016	The 5th Science and Technology Basic Plan, Society 5.0 was proposed, Government investment target of 26 trillion yen
2018	Inauguration of the International Science Council (ISC)*4	2019	Law on the Revitalization of Science, Technology and Innovation Creation (Swift establishment of funds)
		2020	Basic Act on Science, Technology and Innovation (Humanities and innovation creation were included in the scope subject to the Act)
2020	2020 COVID-19 Pandemic U.K. exit from the E.U.	2021	The 6th Science, Technology, and Innovation Basic Plan, Realization of Society 5.0 Social transformation through Convergence Knowledge(So-Go-chi)+ Investment in knowledge and people, Government target of 30 trillion yen and public and private sector target of 120 trillion yen

Source: Prepared by MEXT based on materials from the 66th General Meeting of the Council for Science and Technology

*1 The Kyoto Protocol was adopted at the Third Session of the Conference of the Parties (COP3) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Kyoto in December 1997, in which legally binding numerical targets for the reduction of greenhouse gas emissions in developed countries were decided.

*2 "Declaration on Science and the Use of Scientific Knowledge," proclaimed at the World Conference on Science jointly organized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Council for Science (ICSU) in 1996

*3 A report prepared by the Council on Competitiveness (COC) in 2004 to strengthen U.S. competitiveness. The report considered innovation the source of U.S. competitiveness and considered the necessity to strengthen the three major areas, namely, human resources, investment capital, and infrastructure, to create innovation.

*4 The International Council for Science (ICSU) and the International Social Science Council (ISSC) merged in July 2018 to form a non-governmental and non-profit international academic organization.

<The Council for Science and Technology, 2013: Proposal in the Wake of Earthquake Disaster>

Recognizing that those engaged in science and technology did not always adequately meet the expectations of the public in the wake of the Great East Japan Earthquake, the Council for Science and Technology examined the issues in the Science and Technology Policy that emerged as a result of the earthquake and compiled the "future science and technology and science policy based on the Great East Japan Earthquake" (proposal) (January 2013). The proposal points out that those engaged in science and technology need to be fully aware of the demands of society by proactively learning from society and also points out the following.

- Japan's R&D tends to be biased toward acquiring new knowledge and developing elemental technologies, and the results of R&D may not lead to the resolution of actual issues or social implementation; therefore, systemization comprehensively considers the actual social implementation is necessary.
- Although the resolution of issues requires the integration of diverse expertise, Japan is not actively engaged in initiatives such as collaboration, fusion, and interdisciplinary research among different fields; therefore, it is necessary to establish a framework for the creation of science, technology, and innovation through all stages from fundamental research to practical application and social implementation using a collaboration system that transcends organizations and fields.

The government is pursuing R&D, promoting social implementation, and utilizing Convergence Knowledge (So-Go-Chi) to resolve social issues introduced in Chapter 4.

Section 2 Review of Major Policies

1 Creation of Incorporated Administrative Agencies and National Research and Development Agency System, and Corporatization of National Universities

An incorporated administrative agency is a legal entity established to effectively and efficiently perform tasks necessary from a public viewpoint, which need not be performed directly by the government but might not be performed if left to the private sector. Since 2001, major national research and development organizations have been converted to Incorporated Administrative Agencies. Meanwhile, because of the negative effects of imposing common and uniform regulations on various Incorporated Administrative Agencies performing diverse tasks, including research and development, the system was revised in 2014, the agencies were classified into Agencies Managed under the Medium-term Objectives, National Research and Development Agencies, and Agencies Engaged in Administrative Execution, according to the characteristics of their administration and business. National Research and Development Agencies are established to ensure the maximization of results of research and development and to contribute to the sound development of the national economy and other public interests through the improvement of the standard of science and technology in Japan. It was set forth in the goals set by the government that matters concerning the maximization of research and development results should be prescribed and that the target period should be extended. In addition, among these agencies, the agencies that are expected to produce world-class R&D results to a considerable degree were positioned as "Designated National Research and Development Agencies" by the "Act on Special Measures Concerning the Promotion of Research and Development by Designated National Research and Development Agencies" (Act No. 43 of 2016), under which three agencies (the National Institute for Materials Science, RIKEN, and the National Institute of Advanced Industrial Science and Technology) were designated.

National universities were incorporated in 2004 under the National University Corporation System. This system takes into consideration the independence and autonomy of universities while utilizing the framework of the Incorporated Administrative Agency System. This system aims to make universities more unique and appealing by enabling each university to devise ways for excellent education and distinctive research.

2 Promotion of Dual Support System

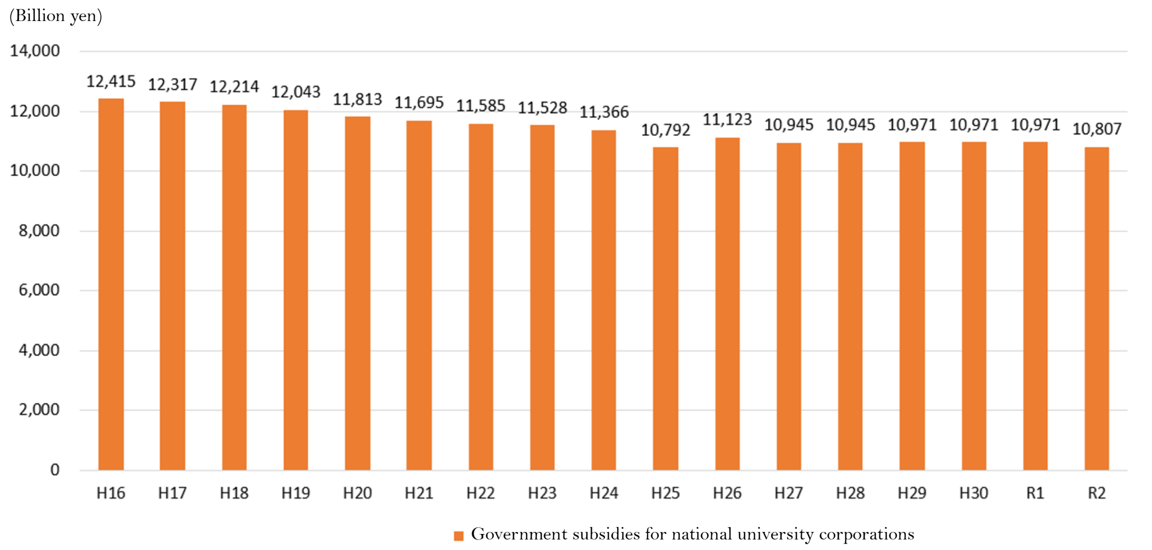
Education and research activities at universities, etc. are promoted through a dual support system in which basic research funds are used to ensure an education and research infrastructure based on a long-term perspective, and competitive funds are used to promote innovation and sophistication in education and research activities and establish centers for such activities.

The 2nd Basic Plan (FY2001-2005) aimed to double the amount of competitive funds, and during the period of the plan, national universities were incorporated. Since the incorporation, basic research funds have been trending downward but have remained nearly the same since FY2015. Competitive funds have generally increased except for a period, and the Grants-in-Aid for Scientific Research, as described below, has expanded, and the adoption rate has also improved. Such support has contributed to Japanese researchers' winning the Nobel Prize.

In addition, universities with many papers tend to have a larger share of government-funded R&D expenditures in the university and college sectors. For example, the top 4 universities with the largest share of papers have increased by 5 percentage points from FY2001 to FY2017 (see Figure 1-2-6). And, the number of papers attracting attention in the university and college sector, including the top-tier universities, has trended downward (see Figure 1-1-7). The dual support system should maximize the research results while considering such analysis and domestic and international trends.

In addition, the 2nd Basic Plan stipulated the introduction of indirect costs for competitive funds. Indirect costs are allocated, at a certain ratio to direct costs, to the research institutions to which the researchers who have obtained competitive funds belong. The efficient and flexible use of the funds by research institutions will help improve the research environment and strengthen the functions of the research institutions. Since FY2022, competitive funds and other public research funds have been unified as "competitive research funds" to which indirect costs are allocated. Research organizations are expected to make strategic use of government subsidies for national university corporations and indirect costs that are highly flexible, such as ensuring an environment in which young researchers, including those holding permanent positions, can focus on their research.

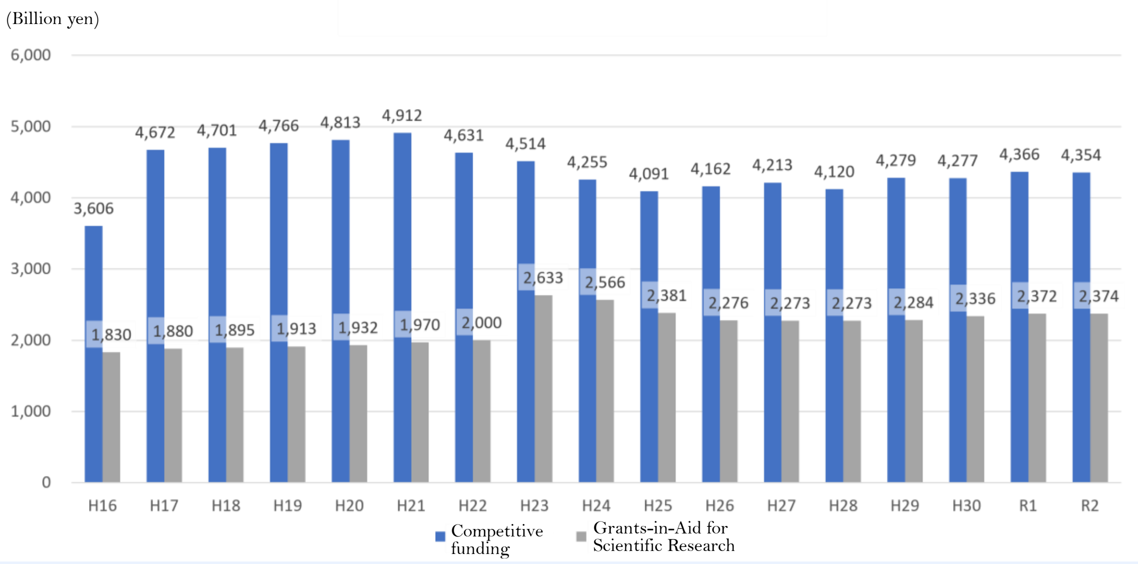
■ Figure 1-2-4/ Changes in government subsidies for national university corporations



* From the FY2020 budget, tuition fee reductions and exemptions under the New Higher Education Support System are allocated to the Cabinet Office.

Source: Prepared by MEXT based on materials from the 67th General Meeting of the Council for Science and Technology.

■ Figure 1-2-5/ Changes in competitive funding

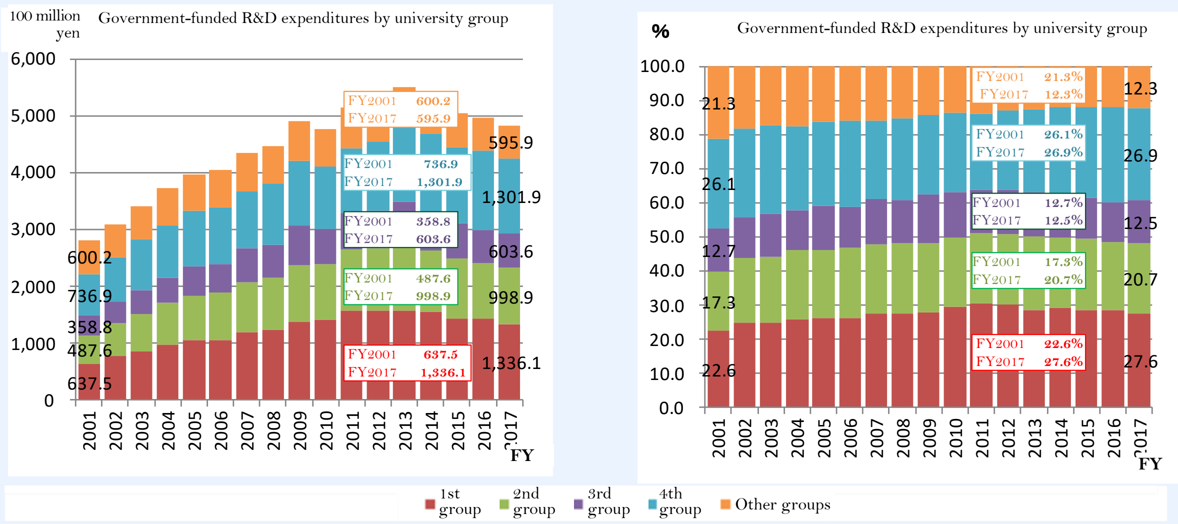


* The figures for competitive funds and Grants-in-Aid for Scientific Research include those allocated to national and private universities, etc.

* Grants-in-Aid for Scientific Research are included in competitive funds.

Source: Prepared by MEXT based on materials from the 67th General Meeting of the Council for Science and Technology.

■ Figure 1-2-6/ Government-funded R&D expenditures by university group



University group	Share of Papers	Number of Universities	Name of University
1st group	More than 1% (top 4 universities)	4 (4, 0, 0)	Osaka University, Kyoto University, The University of Tokyo, Tohoku University
2nd group	More than 1% ~ (excluding the top 4 universities)	13 (10, 0, 3)	Okayama University, Kanazawa University, Kyushu University, Kobe University, Chiba University, University of Tsukuba, Tokyo Institute of Technology, Nagoya University, Hiroshima University, Hokkaido University, Keio University, Nihon University, Waseda University
3rd group	More than 0.5% ~ less than 1%	27 (18, 3 6)	Ehime University, Kagoshima University, Gifu University, Kumamoto University, Gunma University, Shizuoka University, Shinshu University, Tokyo Medical and Dental University, Tokyo University of Agriculture and Technology, Tokushima University, Tottori University, University of Toyama, Nagasaki University, Nagoya Institute of Technology, Niigata University, Mie University, Yamagata University, Yamaguchi University, Osaka City University, Osaka Prefecture University, Yokohama City University, Kitasato University, Kindai University, Juntendo University, Tokai University, Tokyo Women's Medical University, Tokyo University of Science
4th group	More than 0.05% ~ less than 0.5%	140 (36, 19, 85)	State: Akita University, Asahikawa Medical University, Ibaraki University, Iwate University, Utsunomiya University, etc. Public: University of Aizu, Akita Prefectural University, University of Kitakyushu, Gifu Pharmaceutical University, Kyushu Dental University, etc. Private: Aichi Medical University, Aichi Gakuin University, Aichi University of Technology, Aoyama Gakuin University, Azabu University, etc.
Other groups	less than 0.05%	-	Universities other than above, inter-university research institute and technical colleges

Note 1: The classification is based on the share of the number of papers in natural sciences. The share of the number of papers here implies the share in the total number of papers (fractional counting) of national, public and private universities in Japan. The top 4 universities in the First Group account for more than 4.5% of the total number of papers.

Note 2: The number in parentheses for the number of universities indicates the applicable number of national universities, public universities, and private universities.

Note 3: The university names for First Group to Third Group are listed in alphabetical order of national universities, public universities, and private universities. The names of the universities in the Fourth Group are displayed in alphabetical order up to five for each of the national universities, public universities, and private universities.

Source: Prepared by MEXT based on the NISTEP "How to Break the Sense of Blockage among Researchers: Towards Sharing of Prerequisites for Evidence-based Policy Planning - NISTEP TEITEN Survey Workshop 2019"

3 Grants-in-Aid for Scientific Research

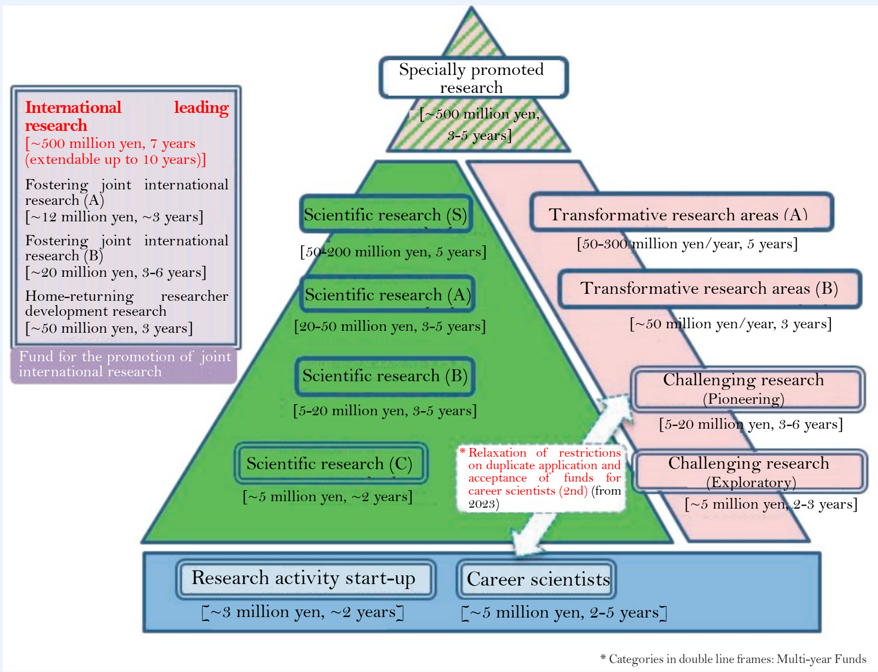
Research is primarily conducted either as academic research based on the intrinsic motivation of individual researchers or as strategic research based on policy demands. A typical example of competitive research funds provided for all academic research in any field is the Grants-in-Aid for Scientific Research (hereinafter referred to as "KAKENHI"). KAKENHI plays a major role in the development of science by supporting a wide range of academic research based on the researchers' imagination and creativity. Many Japanese Nobel laureates also make use of KAKENHI.

The KAKENHI system has been reviewed continuously for improvements, including introducing a Multi-year Fund, reviewing its screening system and enhancing the "KAKENHI Young Support Plan." In FY2021, "International Leading Research" was newly established to vigorously promote international joint research by outstanding research teams led by top-level researchers.

The KAKENHI budget for FY2022 (237.7 billion yen) has increased by about 30% compared to FY2004 (183.0 billion yen), and the adoption rate (for new research projects) has increased by 5.4 percentage points for FY2021 (27.9%) compared to FY2004 (22.5%).

The 6th Basic Plan stipulates “aiming at a new adoption rate of 30%, while continuously promoting system improvements such as support for young researchers, further promotion of emerging and fusion research and internationalization, and review of examination categories.”

■ Figure 1-2-7/ Overview of Grants-in-Aid for Scientific Research (KAKENHI)



Source: Prepared by MEXT

■ Table 1-2-8/ List of major applications and improvements for Grants-in-Aid for Scientific Research

FY	Item
1999	○ Transfer of screening and grant operations to the Japan Society for the Promotion of Science (JSPS) begins
2001	○ Establishment of Scientific Research (S) ○ Indirect cost measures (Specially Promoted, Basic S/A, etc.) begin ○ Modified to allow labor cost for research assistants to be paid from direct cost
2002	○ Disclosure of review results for non-adopted proposals for Scientific Research, etc., begins ○ Deadline for submitting performance reports to allow for the hiring of research assistants until the end of the fiscal year extended
2003	○ Establishment of the Research Center for Science Systems within JSPS ○ Introduction of carry-over system ○ Introduction of a system for researchers who have temporarily discontinued their research due to maternity/childcare responsibilities to resume their research
2004	○ Reorganization and revision of Grant-in-Aid rules and preparation of a handbook for researchers and research institutions begins ○ Creation of a Review Committee OB in JSPS ○ Computerization of Scientific Research, etc., begins
2005	○ Electronic application system for Scientific Research, etc., begins
2008	○ Modified the age limit for career scientists from 37 years old or younger to 39 years old or younger ○ Modified to allow combined use of funds with other expenses with no restrictions on use
2009	○ Introduction of a limit on the number of times career scientists can receive a grant
2011	○ Funding for Grants-in-Aid for Scientific Research (C), Challenging Research (Exploratory), and Career Scientists (B) begins
2012	○ Modified to allow equipment to be purchased jointly with combined use of multiple Grants-in-Aid for Scientific Research and other expenses
2013	○ Establishment of "Adjustment money" for subsidies
2015	○ Establishment of “Fund for the Promotion of Joint International Research”
2016	○ Establishment of “Challenging Research (Pioneering/Exploratory)”
2017	○ Discontinuation of existing "Discipline Table" and introduction of new screening categories and screening methods (implementation of Grant-in-Aid for Scientific Research Review and Reform 2018) ○ Modified the age limit for career scientists, applications from 39 years old or younger to researchers with less than 8 years after acquisition of Ph.D ○ "Support for Formation of Independent Foundation" in "Career Scientists (B)" begins ○ Delivery procedures made paperless
2018	○ Establishment of “Fostering joint international research (B)”
2019	○ Funding for research activity start-up ○ Introduction of a system to temporarily suspend research funds when a researcher is traveling overseas and resume them upon the researcher’s return
2020	○ Funding for Challenging Research (Pioneering)
2021	○ Advancement of public offering schedule ○ Establishment of "International Leading Research"

Source: Prepared by MEXT

4 Strategic Basic Research Programs

A typical example of competitive research funds for strategic research is Strategic Basic Research Programs (Creating the Seeds for New Technology) (hereinafter referred to as "Strategic Basic Research"). Strategic Basic Research is the strategic promotion of basic research, which is the source of innovation under the strategic objectives set by the national government and has achieved outstanding results to date. For example, about 20% of the papers submitted from Japan to "Cell," "Nature" and "Science," which are regarded among the world's top 3 scientific journals, are submitted through these programs every year.

This project sets about 5 to 8 strategic objectives every year. When setting these strategic objectives, whether they are expected to open up new areas of science and technology, produce creative results, and generate significant social and economic impact in the future is considered. The budget for Strategic Basic Research has been around 42 billion yen over the past 5 years and reached 42.8 billion yen in FY2022.

The 6th Basic Plan includes a new provision for the "Promotion of basic research for the post-coronavirus era by providing priority support for young researchers and seamless support for excellent researchers, and bringing together and merging researchers from a wide range of fields, including the humanities and social sciences. The government will also enhance and improve the program to take on emerging and fusion fields, promote overseas challenges, and strengthen international joint research."

■ Figure 1-2-9/ Strategic Basic Research Programs

A large number of papers are submitted to the top 3 scientific journals in the world

- About 20% of all papers from Japan to **"Cell," "Nature"** and **"Science"** have been submitted through these Programs -

Comparison of the total number of papers submitted from Japan to the top 3 scientific journals with the number of papers submitted through the Strategic Basic Research Programs over the past 12 years

Target	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Japan Overall (Number of papers)	189	193	184	181	162	168	158	170	158	174	217	234	2188
Strategic Basic Research Programs (Number of papers)	43	34	30	32	48	30	40	36	35	38	54	53	437
%	22.8	17.6	16.3	17.7	29.6	17.9	25.3	21.2	22.2	21.8	24.9	22.6	21.6

* The figures for 2015 onward include the achievements of the Advanced Research & Development Programs for Medical Innovation (Source: JST and AMED research)

In the budget, only about 10% of the total amount of competitive research funds is accounted for by this project, but accounts for as much as 20% of the total number of papers

Producing many of Japan's top researchers

- "14 of the 28 Japanese Clarivate Citation Laureates, which is a list of researchers who are considered strong candidates to win the Nobel Prize in natural sciences, made significant strides with this project" -

Japanese laureates from this project (Example)

(Source: Clarivate Analytics (Japan) Co., Ltd. website)

Shinya Yamanaka (Professor, Kyoto University)

Hideo Hosono (Designated Professor, Tokyo Institute of Technology)

Shizuo Akira (Designated Professor, Osaka University)

Noboru Mizushima (Professor, The University of Tokyo)

Makoto Fujita (Distinguished Professor, The University of Tokyo)

Yoshinori Tokura (Professor, The University of Tokyo)

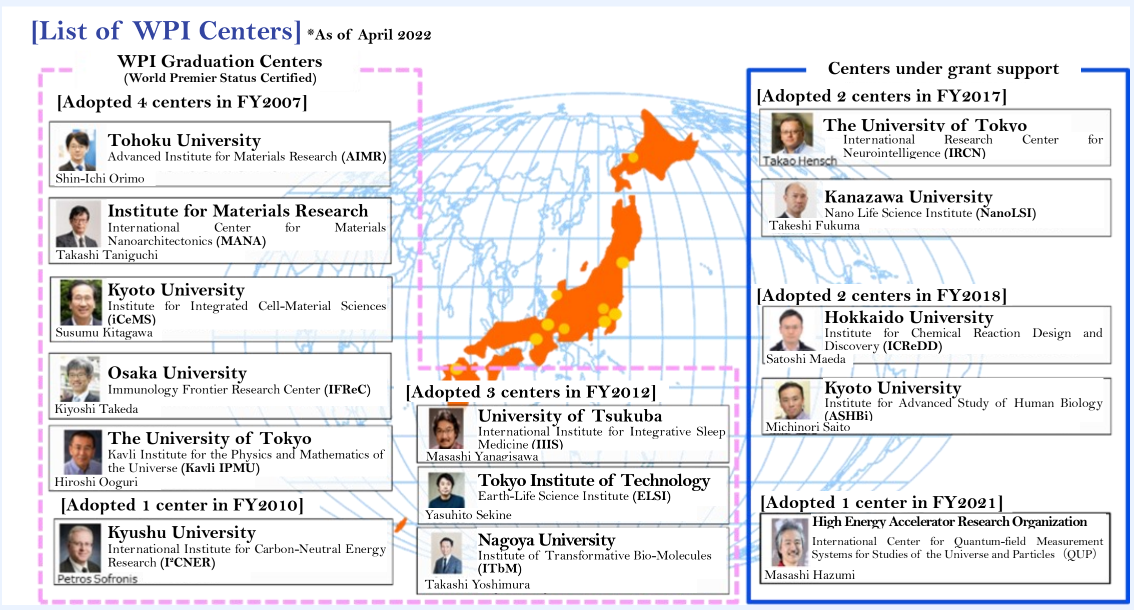
Source: Prepared by MEXT

5 World Premier International Research Center Initiative (WPI)

Since the 2000s, projects aiming to build research centers within Japan have been developed under various policy objectives. The World Premier International Research Center Initiative (hereinafter referred to as "WPI") is a representative project aiming to build research centers. Under the following missions newly formulated in FY2020; (1) World-Leading Scientific Excellence and Recognition, (2) Global Research Environment and System Reform, and (3) Values for the Future, the WPI does not designate research areas at the public recruitment stage, but concentrate support to universities, etc. to establish centers that will serve as "hubs for international brain circulation."

The centers developed under the WPI have achieved excellent results so far, for example, in producing high-quality research papers, which have grown to a level comparable to that of world-class research universities. Some centers have also received large amounts of research funds and donations from private foundations and companies, paving the way for diversifying financial resources to make the centers self-sufficient. In the future, we aim to create a system that reformation of research centers establishment occurs permanently through the WPI formation in a planned and continuous manner.

■ Figure 1-2-10/ List of WPI Centers



Source: Prepared by MEXT

6 Future Issues

For the realization of a nation of science and technology, it is important to maximize research results by optimizing the dual support system, promoting strategic use of funds by research institutions with a high degree of freedom in how they are used, and improving the systems of programs such as the Grants-in-Aid for Scientific Research Program (KAKENHI), the Strategic Basic Research Program and WPI.

At this time, a factor analysis targeting universities (see Figure 1-1-8) concerning the number of papers, which is an important indicator of research capacity, shows that the decreased research time for university faculty members, slow growth in the number of university faculty members, and the number of doctoral students have an impact, and sufficient attention should be paid concerning these points.

For young scientists especially, the number of permanent positions is decreasing while the percentage of limited-term positions is increasing, and the percentage of full-time university faculty members is also decreasing, leading to instability of employment. Therefore, securing an environment where young scientists can settle and engage in research, including permanent positions, is a pressing issue. The number and rate of people advancing from master's to doctor's courses are declining, mainly due to uncertainty about such career paths and a lack of financial prospects while in school. The development of career paths and the improvement in the treatment of doctoral students are also urgent issues to be addressed. The government is promoting initiatives to support young scientists and doctoral students, which will be introduced in Chapter 3.