Chapter 4 Enhancement of Basic Research and Human Resource Development

Section 1 Radical Enhancement of Basic Research

Academic and basic research has become increasingly significant and meaningful, fostering diversity by producing technological seeds that may grow into innovations. Academic and basic research helps create knowledge and foster culture in various fields, and directly and indirectly contributes to the development of society. In FY 2015, the high quality of Japan's academic and basic research was demonstrated again when Nobel Prizes in Physiology or Medicine and in Physics were awarded or co-awarded to Japanese researchers, and when researchers in Japan became the first in Asia to be given the right to name an element, the 113th element, which was discovered by a Japanese team. In its efforts to vigorously promote ingenious, varied academic research and the top basic research in the world under national projects, Japan must establish a firm foundation for innovative scientific technologies. The Japanese government has been promoting efforts towards fostering the nation's ability to implement fundamental academic and basic research.

1 Enhancement of Diverse and Creative Basic Research

Academic research is rooted in the researcher's intellectual curiosity, originality and spontaneity. It is important in terms of building knowledge and generating intellectual property. The promotion of strategic basic research plays a significant role in linking the large amounts of knowledge that are generated by academic research to the economy, society and the public.

(1) Grants-in-Aid for Scientific Research

Ministry of Education, Culture, Sports and Science (MEXT) and the Japan Society for the Promotion of Science (JSPS) have been implementing the Grants-in-Aid for Scientific Research (KAKENHI). KAKENHI, which are available through MEXT and the JSPS, are the only competitive funds provided for all academic research in any field, from the humanities/social sciences to the natural sciences. KAKENHI grants have been supporting diverse, creative research, broadening the base of various research activities, continually advancing research, and generating profound knowledge. In FY 2015, around 26,000 research applications were newly selected by peer review screening (assessment of the research proposal by at least two reviewers whose specialization is close to that of the applicant) from about 100,000 applications in major research categories. About 73,000 projects, including those continuing for the past fiscal years, were funded. (The KAKENHI budget for FY 2015 is 231.8 billion yen, and in FY 2015, 227.3 billion yen was disbursed as grants-in-aid.)

The KAKENHI system has been reviewed continuously for improvements and fundamental reforms, such as the introduction of a foundation in FY 2015 for promoting high-quality scientific research and generating excellent knowledge. In FY 2015, the KAKENHI grant program implemented several reforms so as to ensure that these grants would maximize research results by providing researchers with funds that can be used for multi-year periods. These funds include the Fund for Promotion International Joint Research, which was established to promote such research and the formation of international research networks, and the Fund for Generative Research Fields, which was established to realize implementation of advanced pilot programs for fund granting assessments.

In September 2015, the Policy for Implementing Reforms in the KAKENHI System was formulated in order to clarify the basic ideas and processes of this reform. The following items were to be promoted under new measures for the comprehensive promotion of plans during the 5th Science and Technology Basic Plan starting in FY 2016: 1) a review of the screening system, 2) a review of research categories and frameworks, and 3) the promotion of the flexible and appropriate use of research funds. Preparations have been under way for the introduction of a new screening system in FY 2018, in which a new screening method will be introduced and in which the current 400 segmentalized screening research fields will be integrated into fewer but larger categories.

Through these measures, we will implement reforms and the strengthening of the KAKENHI system to appropriately address the trends of new requirements and innovations in the academic world.

(2) Strategic Basic Research Programs

The Strategic Basic Research Programs (Creating the Seeds for New Technology) operated by the Japan Science and Technology Agency (JST) and the Advanced Research and Development Programs for Medical Innovation (see Table 2-2-8 in Chapter 2, Section 3, Paragraph 2) launched by the Japan Agency for Medical Research and Development (AMED) invite applications from researchers at universities and other institutions. These programs are carried under the strategic objectives set by the national government. The research is conducted through a fixed-term consortium that is connected over institutional boundaries. The important results generated by the research are being accelerated and deepened.

MEXT established the following six objectives for FY 2015.

(Strategic Basic Research Programs (Creating the Seeds for New Technology))

- Pioneering next-generation photonics through the discovery and application of novel optical functions and properties.
- Clarification of basic principles for innovative energy conversion, and synthesis of new materials, development of new energy harvesting devices, and other core technologies, that will contribute to the high-efficiency conversion of ambient microenergy into electricity and their new advanced applications.
- Creation of innovative catalysts by utilizing various natural carbon resources.
- Establish a system for engineering environmentally adaptive plants, which will realize a stable food supply in an age of drastic climate change.

(Advanced Research and Development Programs for Medical Innovation)

- Clarification of mechanobiological mechanisms leading to the development of innovative medical instruments and technologies.
- Comprehensive clarification of functional lipids which contribute to breakthrough medicines.

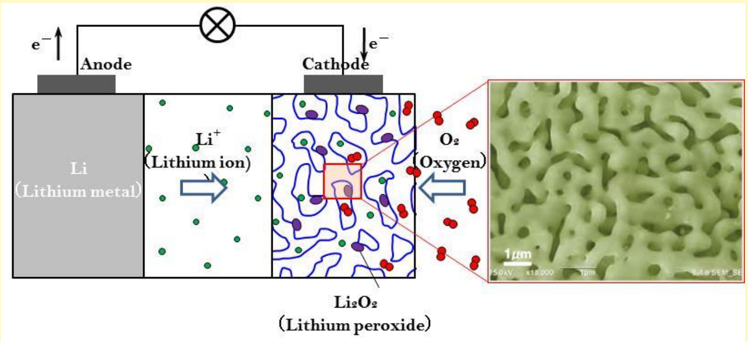
MEXT reformed the method of setting the strategic objectives in order that the method is based on objective evidence, taking the Guidelines for Setting Strategic Objectives set by the Strategic Basic

Research WG of the Council for Science and Technology into account.

Column 2-5 Development of electrode materials for lithium-air batteries that have a long cycle life and a large capacity

Rechargeable batteries are used for various products, including electric vehicles. However, currently available batteries have a small capacity, and this problem needs to be overcome. A fully charged electric vehicle runs less than half the distance a conventional gasoline vehicle can run. Lithium-air batteries, which theoretically can have a large capacity, are thought to be promising next-generation batteries. However, performance deteriorations after repeated use and low recharging efficiency have been problems. Competitions for development and improvement to solve these problems have been under way around the world.

The team of M.W. Chen, a professor at the Advanced Institute for Material Research, Tohoku University, has improved the capacity, cycle life, and recharging efficiency of lithium-air batteries by developing an innovative electrode material: improved nanoporous graphene. R&D on this innovative electrode material was done under the JST Strategic Basic Research Programs. If lithium-air batteries that use the results of this research are put into practical use, it is expected that electric vehicles will run as far on a single charge as conventional gasoline vehicles now run. This development will be able to accelerate the reformation of energy systems in society.



Lithium-air battery and nanoporous graphene

Source: Tohoku University

Column 2-6 Development of fundamental technology that enables the mass production of influenza vaccines

The team of Yoshihiro Kawaoka, a professor at the Institute of Medical Science, the University of Tokyo, has developed a fundamental technology that enables the mass production of influenza vaccines. This development was realized as part of the Advanced Research & Development Programs of AMED.

In the conventional production of the seasonal influenza vaccine, virus cultivation is done using eggs, and in some cases, the vaccine efficacy has become low from mutations in the antigen. In a new vaccine production technology, viruses are propagated in cultivated cells. This technology has been put into practical use, and it greatly suppresses mutations in the antigen. However, the method has other problems, such as a low propagation rate for virus and small vaccine production quantities.

An even newer technology developed by the Kawaoka team, which uses the team's original technique of synthesizing influenza viruses from genes, has enabled the production of a highly proliferative virus.

By giving the produced virus the antigens of seasonal influenza viruses, it has become possible to produce any influenza virus in large quantities by using cultured cells. This technology is expected to realize the production of vaccines that are more effective than those produced in conventional egg-based methods. The timely provision of vaccines in sufficient quantities at times of global flu pandemics is also expected.

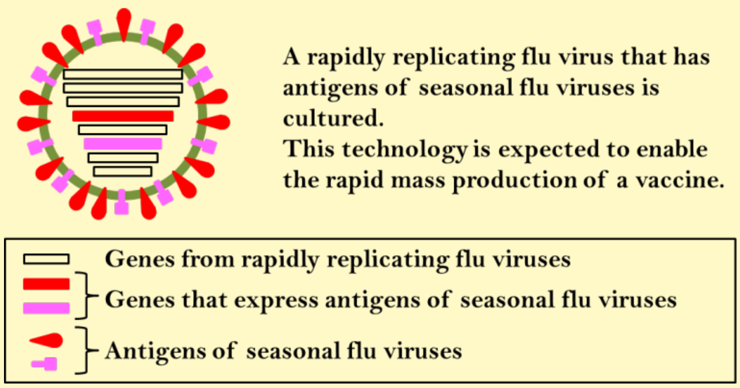


Diagram of the use of the technology for vaccine production

Source: Created by MEXT under the supervision of the University of Tokyo

(3) Promotion of shared use and joint research at universities and inter-university research institutes

MEXT has been promoting a Joint Usage/Research system in which researchers share facilities and equipment, as well as valuable documents and data, at inter-university research institutes and collaborative research centers[1] of national and private universities. This allows researchers to conduct their research beyond organizational boundaries.

In particular, regarding large-scale scientific research projects, in which many researchers from home and abroad participate, MEXT launched the Promoting Large Scientific Frontier Projects to support such projects by funding the installation and operation of large research facilities for outcomes that may lead global scientific research, by formulating a research center that attracts outstanding domestic and foreign research and by fostering young researchers in an international environment.

In FY 2015, 10 projects (Figure 2-4-1) were promoted from which world-leading research results are expected. For example, results from the B-factory high-energy accelerator and the Super-Kamiokande neutrino detector directly contributed to research by three winners of the Nobel Prize in Physics: Makoko Kobayashi, Special Professor Emeritus of the High Energy Accelerator Research Organization, and Hidetoshi Masukawa, Professor Emeritus of Kyoto University in 2008; and Takaaki Kajita, Director of the University of Tokyo's Institute for Cosmic Ray Research in 2015. From FY 2015, improvements to SINET were newly promoted as a full-fledged project. SINET is an academic information infrastructure that is indispensable to Japan's academic research and educational activities and that connects more than 800 universities and research institutes throughout Japan and research institutions overseas. To improve the research and education environment in Japan, communications lines were developed that can carry 100 gigabits per second of data to all areas of Japan, international communications lines were strengthened, and support for cloud computing was started. All these new developments have been further and widely contributing to research and educational activities at universities and other institutions of advanced research.

1 In FY 2015, the Minister of Education, Culture, Sports, Science and Technology approved three centers and reapproved an additional center As of April 2015: 99 centers in 49 universities

■ Figure 2-4-1 / Large-scale projects that will be implemented under the Large-Scale Academic Frontier Promotion Project

Source: MEXT

2 Strengthening World-Leading Basic Research

In an environment of increasing globalization in recent years, competition to secure top researchers has intensified. To further raise scientific and technological standards in Japan, it is necessary to improve the research environment to attract top human resources from around the world. In addition, support is necessary for the establishment of groups of universities that conduct world-class research.

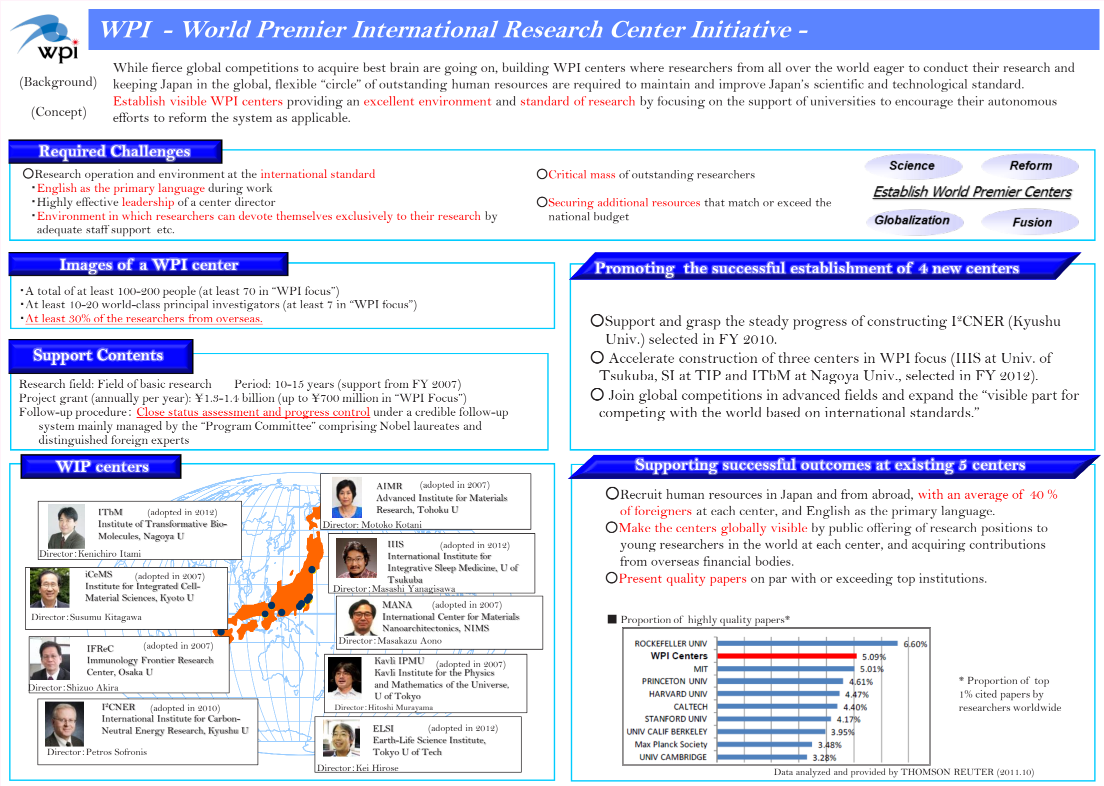
(1) Creation of world-leading international research centers

MEXT has been promoting the World Premier International Research Center Initiative (WPI) program. Each research center selected for this initiative receives 1.3 -1.4 billion yen annually for 10 years. Research centers that produce outstanding results are supported for more than 15 years, and the research centers that were selected in FY2012 have been provided with up to 0.7 billion yen annually. As of FY 2015, 9 centers are supported under this initiative. (Figure 2-4-2) Under this initiative, the WPI Program Committee, chaired by Hiroo Imura, an ex-president of Kyoto University, is playing a central role in verifying the progress of research at the nine research centers and taking annual follow-up measures strictly and to meticulously ensure that these centers develop into globally prominent research centers.

(2) Program for promoting the enhancement of research universities

With the aim of increasing world-class universities and also of enhancing universities' research capabilities, support is provided to prospective world-class universities based on quantitative indicators or evidence. Specifically, the government promotes intensive reform of research environments by helping these universities to employ research management personnel, including research administrators, so that the research capacity of Japanese universities will increase. In FY2015, 22 universities and inter-university research institutes selected in FY 2013 were supported, with funding of 200-400 million yen provided to each of them.

■ Figure 2-4-2 / World Premier International Research Center Initiative (WPI)



Source: MEXT

Section 2 Development of Human Resources Capable of Active Roles in Science and Technology Research

MEXT has been implementing the systematic development of human resources specializing in science and technology through education at elementary, junior high, high schools, and universities, as well as through programs for postdoctoral researchers. Various measures have been taken to ensure that young researchers, female researchers and research administrators are able to assume more active roles. All these efforts are aimed at increasing the number of people who can contribute to science and technology in Japan, and at fostering high-quality researchers.

Based on the Strategy for Developing Science and Engineering Human Resources, which was formulated on March 13, 2015, MEXT and METI held the Round Table Conference Concerning the Development of Science and Engineering Human Resources on May 15, 2015. The conference had been planned to substantiate and enrich the formulated strategy, and to provide a venue for exchange of opinions among industry, academia and the government. Ways of developing human resources who are needed in industry and of encouraging such human resources to assume active roles in industry have been examined at the strategy conference, as have the roles of industry, academia, and government.

1 Development of Human Resources Capable of Leadership in Diverse Fields

(1) Radical enhancement of graduate school education

As a result of the Graduate School Education in the Globalized Society (a report issued by the Central Council for Education on January 31, 2011), MEXT formulated the Second Platform for the Promotion of Graduate School Education (approved by the Minister of MEXT on August 5, 2011) to implement measures for improving and ensuring the quality of graduate school education.

Specifically, the Program for Leading Graduate Schools was started in FY2011 to assist in efforts to develop leading graduate schools at which interdisciplinary doctoral programs are provided consistently from both terms in order to foster leaders who can play active roles in industry, academia and government globally. As of FY 2015, 62 projects have been supported. In anticipation of the new Platform for the Promotion of Graduate School Education that will be formulated from FY 2016, MEXT proposed a future direction for Japan's graduate education reform. The ministry compiled the *Report on deliberations by the Central Council for Education held on September 15, 2015* and published the Graduate Education Reforms Leading the Future: Advanced Knowledge Professionals Development through Collaborations with Society in September 2015.

At the request of MEXT, the Science Council of Japan (SCJ) began deliberations on quality assurance for university education in each academic field in October 2014, issued a response about Guideline for Curriculum Formation that focuses on the basic education given to all graduates, and announced reference standards for 22 academic fields[1] as of FY 2015. The SCJ will continue to explore other fields.

(2) Support for students pursuing doctoral studies and the diversification of career options

① Support for students pursuing doctoral studies

As part of its efforts to financially support graduate students, MEXT has been increasing the amounts of competitive research funds available to universities for the employment of graduate students. In consideration of the educational benefits accruing to students, these competitive funds are used to hire graduate students as Teaching Assistants (TA) or Research Assistants (RA).

The Japan Student Services Organization (JASSO) provides scholarship loan programs to financially support to students who excel academically but who have difficulty pursuing their studies due to financial constraints. Interest-free loan recipients who are recognized by JASSO as having achieved particularly outstanding results in their studies may be partially or completely exempt from repaying their loans.

To foster top level researchers who will play major roles in future scientific research, the JSPS offers a

1 Business administration, linguistics/literature, law, home economics, mechanical engineering, mathematical science, biology, civil engineering/architecture, history, regional research, politics, economics, material engineering, anthropology, psychology, geography, sociology, earth and planetary science, social welfare science, electrical and electronic engineering, agriculture and statistics

special program under which fellowships are granted to doctoral students.

② Diversification of career options

MEXT has been making efforts to develop leaders who can play active roles globally in industry, academia and government (Chapter 4 Section 1, (1).)

To increase career options for postdocs[1], the Career Development Program for Postdoctoral Fellow supports universities that offer internship programs of three months or longer to postdocs. As of FY 2015, 15 organizations are being supported.

In addition, MEXT has been encouraging the development and employment of research administrators in order to improve research environments; for example to provide for more active research, strengthen R&D management at universities and increase career options for scientists/engineers.

Under a JST program for supporting the use of career information, the Japan Research Career Information Network Portal site (JREC-IN Portal) is operated, through industry-university-government cooperation, to provide useful information for career development and to support the efficient use of such information. The provided information covers job offers available to researchers and research administrators and applications by them.

In a project to build a medium- to long-term interexchange system for researchers, METI is supporting development of a framework and an environment for implementing medium- to long-term, two months or longer, research internships for students in master's/doctoral courses in the sciences at corporate laboratories. The aim of this project is the development of highly-skilled professionals in the sciences who have expertise, a broad view of society and the capability for project management. Creation of innovations through enhanced mobility between industry and academia is also a goal. This system has started working effectively.

(3) Development of engineers and their capabilities

Industries and engineers that underpin industrial activities assume a pivotal role in the promotion of science, technology and innovation. Increasingly advanced and integrated technologies require engineers to improve their qualifications and abilities. MEXT and related agencies have been making efforts to foster engineers who can keep pace with these changing requirements and to increase their capabilities.

MEXT is promoting efforts for practical education in engineering at universities and universities that are improving their educational content and methodologies. For example, students are provided opportunities to learn through hands-on experience, group exercises, presentations, debates and problem-solving. At national colleges of technology, practical training in engineering is given to students shortly after they graduate from junior high school. In response to changes in the industrial structure and accelerated socioeconomic globalization, these colleges are improving their education such as to foster practical, creative engineers who can satisfy regional or industrial needs and the colleges are also developing engineers who are capable of creating innovations and playing active roles globally.

1 Qualified postdocs are defined as Ph.D. holders who have been researching at universities or research institutions for a fixed term, or persons who have earned the required credits and left a Ph.D. course after studying for at least as many years as the normal duration (excluding professors, senior associate professors, associate professors, assistant professors, research instructors, leaders of research groups, and chief researchers).

Engineers who have a high level of applied skill in areas such as S&T and who can engage in planning and designing are qualified as professional engineers under the Professional Engineer Qualification System. The Professional Engineer Examination is divided into the First-Step Examination, which is given to determine whether the examinee has the expertise expected of a university graduate in science or engineering, and the Second-Step Examination, which is given to determine whether the examinee has the high level of applied skill required of a professional engineer. In FY2015, 8,693 candidates passed the First-Step Examination and 3,649 candidates passed the Second-Step Examination. Data on candidates who passed the Second-Step Examination in each technical discipline are shown in Table 2-4-3.

■ Table 2-4-3 / Breakdown of successful candidates of the Second-Step Professional Engineer Examination by Technical Discipline (FY 2015)

Technical Discipline	No. of candidates (people)	No. of successful candidates (people)	Pass rate (%)	Technical Discipline	No. of candidates (people)	No. of successful candidates (people)	Pass rate (%)
Mechanical engineering	1,050	217	20.7	Agriculture	769	113	14.7
Marine & ocean	11	2	18.2	Forestry	333	77	23.1
Aerospace	38	9	23.7	Fisheries	134	24	17.9
Electrical & electronics engineering	1,345	213	15.8	Industrial engineering	201	52	25.9
Chemistry	140	39	27.9	Information engineering	449	79	17.6
Textiles	37	10	27.0	Applied science	587	87	14.8
Metals	103	47	45.6	Biotechnology & bioengineering	30	12	40.0
Mining	21	6	28.6	Environment	587	94	16.0
Civil engineering	13,635	1,623	11.9	Nuclear & radiation	77	19	24.7
Water supply & sewerage	1,427	189	13.2	Compressive technical management	3,293	664	20.2
Environmental engineering	611	73	11.9				

Source: MEXT

To aid engineers in acquiring a broader range of basic knowledge about science and technology, the JST provides online self-study materials[1] on common science and technology topics and specific science and technology disciplines.

1 https://jrecin.jst.go.jp/

2 Development of Creative, Top-Level Researchers

(1) Establishment of fair and transparent assessment systems

In order to develop top-level and creative researchers, positions for which young researchers can challenge need to be increased to provide them with opportunities to conduct research autonomously, to play active roles and present career options.

MEXT has been making efforts to establish the Tenure Tracking System[1] at more universities and public research institutions. It is a fair and transparent personnel system for employing high quality researchers (See Chapter 4, Section 2 (2).)

(2) Career options for researchers

So that excellent young researchers can be fostered and employed, it is necessary to secure positions for them and to encourage mobility for their career progress, in order to guarantee them opportunities to obtain research funds and improve their research environments so they can concentrate on their research and produce results.

For the purpose of securing research environments in which young researchers can concentrate on independent research and obtain secure positions, MEXT has been implementing the Program to Disseminate the Tenure Tracking System, which provides support to universities that have newly adopt that system. As of FY 2015 this program is supporting 54 organizations[2].

The Building of Consortia for the Development of Human Resources in Science and Technology has started to ensure the stable employment of young researchers while encouraging mobility for their career progression and promoting the diversification of career paths. MEXT is supporting10 centers, including universities, through this program as of FY 2015.

The Act for the Amendment of the Act on Enhancement of Research and Development Capacity and Efficient Promotion of Research and Development by Advancement of Research and Development System Reform and of the Act on term of Office of University Teachers, etc.[3] (Act No. 99 of 2013), enforced in December 2015, is expected to make it easier for researchers to achieve research results during the employment contract period and to receive fair evaluations of their achievements so that they can obtain stable positions.

Under KAKENHI grant programs, Grants-in-Aid for Young Scientists (A & B) are provided to support independent research arising from the original ideas of young researchers, who are potential future leaders (See Chapter 4, Section 1(1).)

The JSPS launched the Special Fellowship Program for young scientists, in which fellowships are granted to outstanding young doctoral students and postdoctoral researchers who will play leading roles in Japan's future scientific research.

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1 Under this system, young researchers who are selected through a fair process are provided with opportunities to gain experience as independent researchers in limited-term employment before obtaining more permanent positions.

2 Excluding organizations that are supported by the Promotion of Environmental Improvement to Enhance Young Researchers' Independence (the former Special Coordination Funds for Promoting Science and Technology)

3 The Special Provisions of the Labor Contract Act were implemented on April 1, 2014. These special provisions target researchers, engineers, and professionals who are in charge of operating and managing R&D (e.g., persons who are in charge of planning, securing funds, and obtaining and using intellectual property) at universities, inter-university research institutes and R&D corporations; and teaching staff at universities and inter-university research institutes.

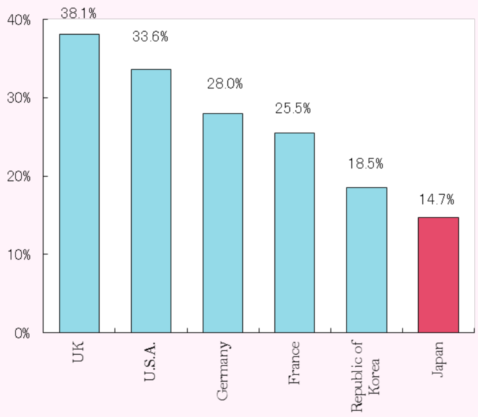
Under the Basic Research Programs, the JST also launched various promotional programs, such as Sakigake, which attracts many young researchers (See Chapter 4, Section 1(2).)

(3) Promoting the employment of female researchers

Encouraging female researchers to fulfill their potential promotes socioeconomic revitalization and gender equality.

The 4th Basic Plan sought the early accomplishment of the numerical target set in the 3rd Basic Plan regarding the share of female researchers (25% in natural sciences) and an increase in the share to 30%. The 5th Basic Plan that starts in FY 2016 aims at the early achievement of these targets. In view of this, the government has been promoting employment and increasing the roles of female researchers, and the share of female researchers has been increasing every year. However, woman still accounted for only 15% of researchers as of March 2015, which is lower than in other advanced countries (Figure 2-4-4).

■ Figure 2-4-4 / Percentage of female researchers by country



Note: 1. The data are as of 2010 for the U.S., 2013 for Germany, the UK and France, 2014 for the Republic of Korea and 2015 for Japan.
2. For the U.S.A., data on scientific professionals (i.e., bachelor's/ master's/ doctoral degree holders in science or engineering who engage in a science-related profession) are used instead of data on researchers. "Science" includes the social sciences.

Source: Adapted by MEXT based on *Survey on Research and Development* (MIC), *Main Science and Technology Indicators* (OECD) and Science and Engineering Indicators (NSF)

To improve the situation, MEXT has implemented the Initiative for Realizing Diversity in the Research Environment, under which universities set targets and plans for such diversity, such as for improving the workplace environment to help researchers balance their research with maternity, childcare and nursing care and to help female researchers improve their research capabilities. MEXT is supporting 41 universities as of FY 2015.

The JSPS has implemented the Restart Postdoctoral Fellowship (RPD) Program to provide research incentives to male/female researchers who have temporarily discontinued their research due to maternity/childcare responsibilities.

The National Institute of Advanced Industrial Science and Technology (AIST) organized the Diversity Support Office (DSO), a consortium of 21 universities and research institutions nationwide. The DSO promotes information-sharing and exchanges of opinions on gender equality among member institutions, towards achieving work-life balance, career development and a raised awareness of research careers.

The JST has implemented the "project to encourage female students of lower/upper secondary schools to follow scientific career paths." Under this program, female students in lower/upper secondary schools are given opportunities to communicate with female science and technology researchers, engineers and university students, as well as to take part in experimental classes and school visit programs.

The Cabinet Office's website Science/Engineering Challenge: The choice by female high-school and university students to major in science[1] provides information on efforts by universities and companies to encourage such challenges and provides communications from female workers in science and technology.

To encourage female students to choose careers in science and engineering, the Cabinet Office, together with the Japan Business Federation, held an event entitled Summer Science/Engineering Challenge: Encounter Science/Engineering Jobs from July to August 2015. This event was integrated with activities and symposia held by individual universities and businesses.

(4) Support for unique human resource development

The Ministry of Internal Affairs and Communications (MIC) launched the *Innou-vation* program. (*Innou* is Japanese for "unusual talent.") The program, which is under the Strategic Information and Communications R&D Promotion Program (SCOPE), supports R&D on ambitious technological themes by researchers with unusual talents. These efforts have great potential to generate global values that may have destructive effects on globally unpredictable areas of ICT, where new technologies and ideas emerge daily.

3 Development of Human Resources for Next-Generation Science and Technology

The JST conducts a Science Leaders Camp to support science and mathematics teachers and provide effective skills for the teaching of talented students and the promotion of inter-regional networks between teachers at a training camp, and the JST holds the event Establishing Training Centers for Core Science Teachers, supporting efforts to nurture elementary and lower secondary school teachers who take leading roles in science and mathematics education in schools and regions.

The JST has also developed digital materials for use in science education, which it offers online to provide children and students with opportunities to learn science topics interesting to them. Other programs promoted by the JST to foster future scientists include the following: 1) the Future Scientist Program, a systematic education program for talented, motivated children and students, which supports universities in implementing issue-specific research, and 2) the Program for Promoting the Science Club Activities of Junior/Senior High-Schoolers, which helps students to identify issues by themselves and to conduct activities constantly and independently while applying scientific methods. This is done in collaboration with schools, boards of education and universities.

The National Institution for Youth Education set up the Children's Dream Fund to assist private organizations in their various activities, such as their programs for hands-on scientific experiences by children.

The Japan Patent Office (JPO) has been collaborating with the National Center for Industrial Property Information and Training (INPIT) in spreading knowledge about intellectual property, as well as in providing support to senior high schools and colleges of technology that utilize intellectual property in practical education for human resources development.

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1 http://www.gender.go.jp/c-challenge/

In addition, assistants for science observations and experiments have been deployed in order to further improve observations and experiments in science education while reducing the burden on teachers involved in preparing science experiments. Improving facilities and equipment for scientific observations and experiments at schools has also been implemented, pursuant to the Science Education Promotion Act (Act No. 186, 1953). In these ways, MEXT provides comprehensive support for the enhancement of science and mathematics education.

MEXT designates high schools that provide advanced science and mathematics education as Super Science High Schools (SSH), to which the JST provides support. This initiative aims to develop human resources for science and technology who will play important roles globally in the future. Specifically, efforts are made to promote the development and use of curricula that are not based on the National Curriculum Standards, to promote project studies, to foster human resources for science and technology in the future and to share the results of these efforts among multiple schools. In FY 2015, 203 high schools throughout the country provide such advanced and specialized education. Universities that develop and provide educational programs for motivated and capable students are supported as Global Science Campuses (GSCs) to develop international human resources for science and technology in the future.

MEXT sponsored the 5th Science Intercollegiate (March 5 and 6, 2016) in Hyogo Prefecture as a venue for undergraduate students in natural science courses to present their own research in a friendly nationwide competition. They also have opportunities to meet with researchers and business people. Of a total of 279 applications, 176 who had passed a documentary examination were presented.

The JST has sponsored preliminary domestic contests for international science and technology contents, such as the International Science Olympiads for mathematics, physics, chemistry, biology, informatics, geography and earth science, and the Intel International Science and Engineering Fair (Intel ISEF), as well as supporting Japanese students' participation in competitions abroad and international competitions held in Japan (Figure 2-4-5). In FY 2015, the 5th Japan High School Science Championship was held from March 18 to 21, 2016 in Ibaraki Prefecture. In this nationwide competition of schools and teams, comprehensive strengths are determined based on paper tests and practical skills in science and mathematics. The Aichi Prefecture team won first place (Figure 2-4-6). The 3rd Japan Junior High School Science Championship was held on December 4-6, 2015 in Koto Ward. Toyama Prefecture team won first place in this nationwide competition of schools and teams (Figure 2-4-7).

MEXT, the JPO, the Japan Patent Attorneys Association and INPIT jointly host patent contests and patent design contests for students at high schools, colleges of technology and universities. The aim is to enhance public understanding of intellectual property and to encourage interest in it.

■ Figure 2-4-5 / Participants in the International Student Contests in Science and Technology (FY 2015)

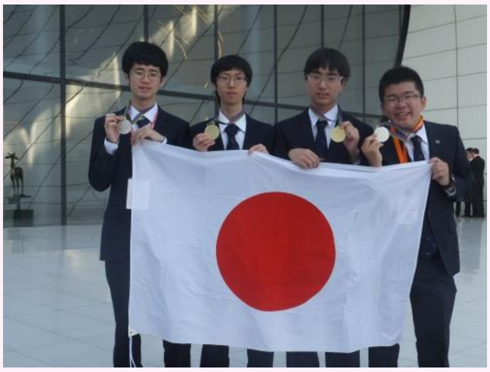
International Mathematical Olympiad (Thailand) Participants

From left
Ko AOKI, 2nd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)
Kazuki MATOYA, 3rd grade, Senior High School at Komaba, University of Tsukuba (bronze medalist)
Yuta TAKAYA, 1st grade, Kaisei High School (silver medalist)
Takuya INOUE, 2nd grade, Kaisei High School (bronze medalist)
Yuki SAEKI, 3rd grade, Kaisei Senior High School (silver medalist)
Hirotomo SHINOKI, 3rd grade, Nada Senior High School (bronze medalist

International Physics Olympiad (India) Participants

From left
Akihiro WATANABE, 1st grade, Todaiji Gakuen Senior High School (gold medalist)
Satoshi YOSHIDA, 2nd grade, Osaka Seiko Gakuin Senior High school(silver medalist)
Hiroto TAKAHASHI, 6th grade, Metropolitan Tokyo Okishigawa Middle School (bronze medalist)
Hideharu KASHU, 3rd grade, Nada Senior High School (silver medalist)
Hajime UEDA, 1st grade, Nada Senior High School (bronze medalist)

International Chemistry Olympiad (Azerbaijan) Participants



From left
Yu NAKATSUKA, 3rd grade, Musashi Senior High School (silver medalist)
Haruki MATSUMOTO, 3rd grade, High School Attached to Osaka Kyoiku University (Tennoji Campus).(gold medalist)
Kohei YOSHIMURA, 3rd grade, Asabu Senior High School (gold medalist)
Aoi TAKEUCHI, 3rd grade, Kochi Gakugei Senior High School (silver medalist)

International Biology Olympiad (Denmark) Participants

From left
Ryota TAKEMOTO, 3rd grade, Hiroshima Gakuin Senior High School (bronze medalist)
Haruki ISHIDA, 3rd grade, Nada Senior High School (silver medalist)
Kazuki MIYATA, 2nd grade, Aichi Prefectural Okazaki Senior High School (silver medalist)
Yotaro SUEOKA, 3rd grade, Senior High School at Komaba, University of Tsukuba (gold medalist)

International Olympiad in Informatics (Kazakhstan) Participants

From left
Takahiro MASUDA, 2nd grade, Senior High School at Komaba, University of Tsukuba (gold medalist)
Akio MATSUZAKI, 3rd grade, National Institute of Technology, Akashi College (bronze medalist)
Yuta TAKAYA, 1st grade, Kaisei High School (gold medalist)
Takuya INOUE, 2nd grade, Kaisei High School (gold medalist)

International Earth Science Olympiad (Brazil) Participants

From left
Takanobu MOGI, 3rd grade, Senior High School at Komaba, University of Tsukuba (bronze medalist)
Haruyuki OKINAKA, 3rd grade, Hiroshima Gakuin Senior High School (bronze medalist)
Aritsune TSUJI, 3rd grade, Nada Senior High School (gold medalist)
Kiyoaki DOI, 3rd grade, Hiroshima Gakuin Senior High School (bronze medalist)

International Geography Olympiad (Russia) Participants

From left
Kosuke SAITO, 3rd grade, Kaisei Senior High School (silver medalist)
Aritsune TSUJI, 3rd grade, Nada Senior High School (bronze medalist)
Yuta KIKUCHI, 2nd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)
Go SATO, 2nd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)

Source: MEXT

■ Figure 2-4-6 / The 5th Japan High School Science Championship

Shuho KANDA (1st grade)
Rei KUBOTA (1st grade)
Noshinari TAKEMOTO (1st grade)
Kotaro MURAMATSU (1st grade)
Takuto MISTUNOBU (2nd grade)
Note: The grades are as of when the award was won.
Source: MEXT

■ Figure 2-4-7 / The 3rd Japan Junior High School Science Championship

Sosuke NAGAI, 2rd grade, Attached Junior High School to the Faculty of Human Development, University of Toyama
Ryunosuke UENO, 2rd grade, Attached Junior High School to the Faculty of Human Development, University of Toyama
Shimon AKINO, 2rd grade, Takaoka City Goi Junior High School
Mikuto TAKAE, 2rd grade, Toyama City Shinjo Junior High School
Akira SANTO, 2rd grade, Attached Junior High School to the Faculty of Human Development, University of Toyama
Maho SASAKI, 2rd grade, Kurobe City Koshino Junior High School
Note: The grades are as of when the award was won.

Source: MEXT

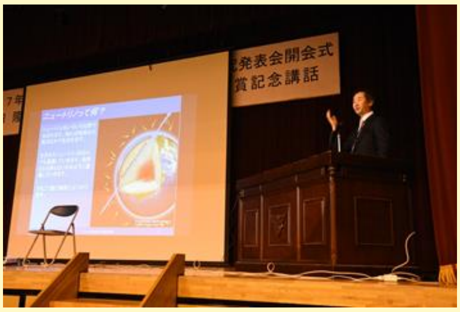
Column 2-7 A spirit of autonomy and independence that has been handed down to younger generations -- Mr. Kajita and Saitama Prefectural Kawagoe Senior High School

A spirit of autonomy and independence that has been handed down to younger generations -- Mr. Kajita and Saitama Prefectural Kawagoe Senior High School

Takaaki Kajita, Director of the University of Tokyo's Institute for Cosmic Ray Research and winner of the 2015 Nobel Prize in Physics, was born in Higashimatsuyama City, Saitama Prefecture. He was in the 29th graduating class of Saitama Prefectural Kawagoe Senior High School (hereinafter: Kawagoe SHS).

The ties between Mr. Kajita and Kawagoe SHS restrengthened when Mr. Kajita delivered the lecture Neutrinos, the Universe and Elementary Particles at a school-wide lecture for the SSH at Kawagoe SHS in 2010. Mr. Kajita has been working as the operation guidance commissioner for Kawagoe High School since 2013. Mr. Kajita gave advice for the SSH's inter-disciplinary classes such as Global Environment and Energy, Life and Matters, Matters and Technologies, and Mathematics classes, and gave guidance on the students' project studies, saying "To become a researcher, it's very important to get to the core of whatever you're studying."

At the 2015 Saitama Prefectural Kawagoe Senior High School SSH Student Research Presentation and Project Reporting Meeting held in February 2016, Mr. Kajita delivered a keynote lecture titled Discovery of the Neutrino's Small Mass.



Memorial Lecture on Winning the Nobel Prize in Physics

Source: Saitama Prefectural Kawagoe Senior High School

In his lecture, Mr. Kajita inspired the students by saying, "the driving force behind research depends on the quality of the idea and the people who conduct the research. I've been blessed with excellent teachers, fine peers, and wonderful meeting with the research themes. I hope you all open your eyes and minds wide in preparation for the time when you'll meet whatever will become very important to you."

One student who joined the lecture said, "After I heard that Mr. Kajita investigated something which had only slightly drew his attention, which eventually led him to win Nobel Prize, I decided to value something about which I have even a slight question and investigate it in details."

The Students Research Presentation Meeting was held immediately after the opening ceremony and was followed by the keynote lecture.

The student presentations included those on polarimetry of the Crab Nebula, which was also studied by Mr. Kajita, and on the relationship between solar radio emissions, sunspots and the surface temperature of the sun, which are based on data from a BS antenna.

The students who had the opportunity to receive guidance from Mr. Kajita at the previous year's presentation meeting said, "I delivered my presentation on gravitational acceleration in English. Mr. Kajita told me it was great to deliver a presentation in English while I was still young. Now, I'm interested in research in robotics. I'm determined to actively study an area that interests me."

There were many students who had been actively engaging in diverse research. The schools founding principle of "autonomous, independent youth education" has been successfully handed down to the younger generation.

Research Presentation Meeting of SSH students at Kawagoe SHS

Source: Saitama Prefectural Kawagoe Senior High School

Chapter 4

Section 3 Establishment of a World-Class Research Environment and Infrastructure

1 Improvement of R&D Environments at Universities and Public Research Institutions

(1) Improvement of facilities and equipment at universities

① Facilities and equipment at national universities

Facilities at national universities play the important role of hubs for various activities, such as creative, advanced scientific research, the development of excellent creative human resources and the promotion of advanced medical treatment.

With this in mind, MEXT formulated the 3rd Five-Year Program for Facilities at National Universities (FY 2011-FY 2015) (Hereinafter: the 3rd Five-Year Program) in August 2011, based on the 4th Basic Plan to promote the systematic and prioritized improvement of university facilities.

The 3rd Five-Year Program prioritizes the following projects covering a total of 5.5 million m^2 of facilities: 1) the improvement of outdated facilities (approx. 4 million m^2 of facilities), 2) the improvement of cramped facilities (approx. 800,000 m^2), and 3) the improvement of university hospitals (approx. 700,000 m^2). Improvements completed as of FY 2015, the final year of the 3rd Five-Year Program, were 1) improvement of outdated facilities: approx. 2.51 million m^2 (63%), 2) improvement of cramped facilities: approx. 870,000 m^2 (109%), and 3) improvement of university hospitals: approx. 770,000 m^2 (109%).

With this in mind, MEXT formulated the 4th Five-Year Program for Facilities at National Universities (FY 2016 - FY 2020) (Hereinafter: the 4th Five-Year Program) in March 2016 based on the 5th Basic Plan. The 4th Five-Year Program prioritizes the following projects: 1) the improvement of infrastructure for safe and secure educational environments (approx. 4.75 million m^2), 2) responding to changes such as the functional enhancement of national universities through the construction of new buildings and extension (400,000 m^2) and improvement of university hospital facilities (700,000 m^2)(a total of 585 million m^2) and 3) promoting lowering energy consumption and initiatives to serve as leading models for society towards creating sustainable campuses.

Based on their long-term vision, national universities will create and improve their campus master plan, and will strive to implement systematic, more effective and efficient facility development based on this plan in accordance with their basic principles, academic plan and management strategy. Furthermore, strategic facility management and facility development utilizing diverse sources of finance will be further promoted.

Regarding facility management, in order to achieve university visions and academic plans, MEXT started to hold expert meetings[1] in November 2013 to promote the facility management of all university facilities from a management perspective. The expert meeting published a report[2] in March 2015 targeting the administration of national universities. This report introduces the basics and detailed procedures for

1 Examination Committee for the Comprehensive Management of Facilities at National Universities
2 Strategies for the Management of University Facilities: Facility Management Strengthens Educational and Research Infrastructure

facility management, and examples of advanced practices.

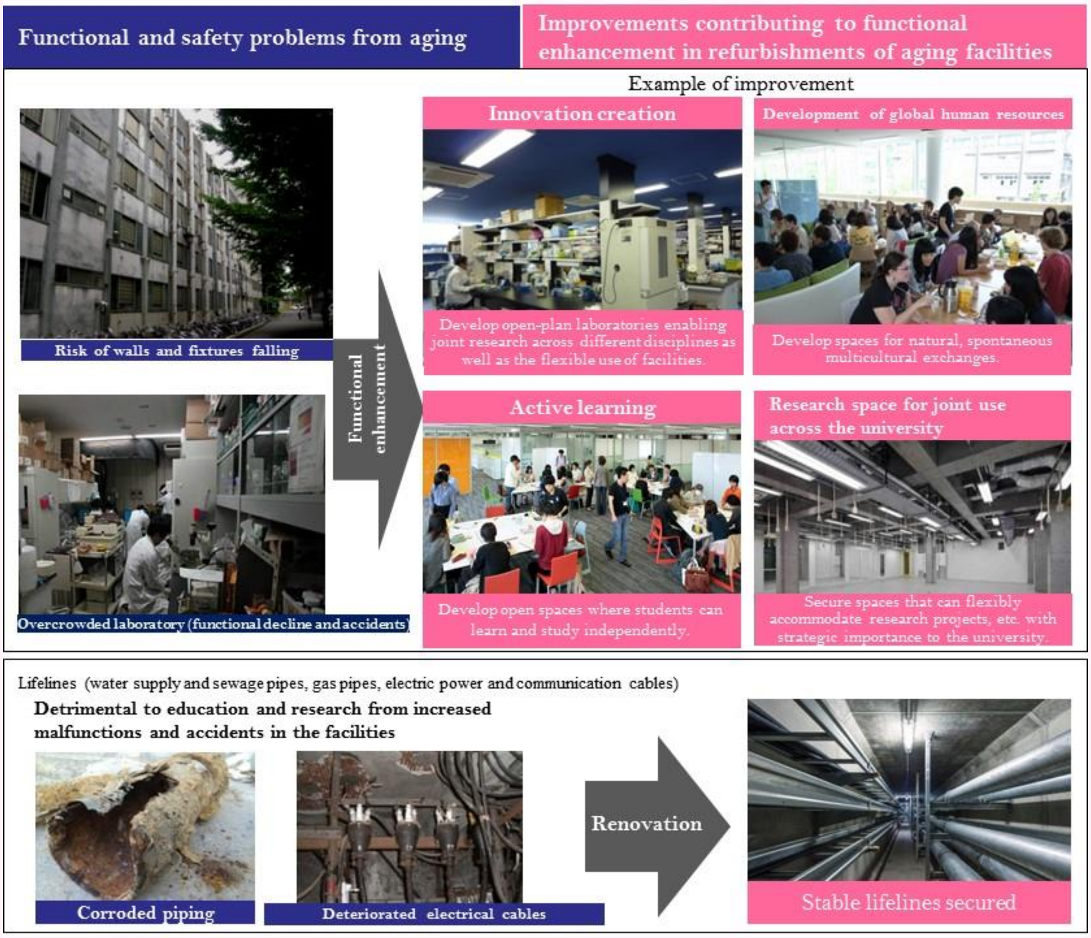
It is crucial to improve facilities at national universities, as they are infrastructure that supports advanced research and quality education.

Thus, MEXT financially supports these universities on the basis of a mid- to long-term master plan that each university has formulated for the systematic, continuous improvement of their equipment. Additionally, under a program for supporting the effective use of research equipment at national universities, MEXT supports the efforts of universities to promote effective and shared use of their equipment. Currently, national universities lack personnel qualified to implement the efficient and effective use of equipment and to manage aging or obsolescent equipment.

Under its Large-scale Academic Frontier Promotion Program, MEXT also provided support for the management of the world's most advanced research equipment developed based on the creative ideas of Japanese scientists. (e.g., the Large-scale Cryogenic Gravitational Wave Telescope Project (KAGRA)) (See Chapter 4, Section 1, Paragraph 1.)

MEXT provided costs for disaster mitigation facilities of universities under the revised budget in FY 2015 in order to support the construction and improvement of infrastructure for education and research.

■ Figure 2-4-8 / Example of the redevelopment of an aging facility



Source: MEXT

② Facilities and equipment at private universities

MEXT is working to improve private universities' research infrastructure by implementing the MEXT-Supported Program for the Strategic Research Foundation at Private Universities, a project to provide private universities with comprehensive support that enables them to improve their research facilities and equipment for excellent research projects.

(2) Promotion of the shared use and improvement of advanced research facilities and equipment

Regarding advanced research facilities and equipment requiring significant expenses for improvement and operation and suitable for shared use in multiple science and technology areas, public research institutions have been playing a leading role in their improvement and operation. However, because public financial support for public research institutions has been decreasing, the maintenance and management of advanced research facilities and equipment has become difficult.

Thus, the government has been taking measures to ensure that public research institutions can continue to improve and operate advanced research facilities and equipment, and can promote the extensive shared use of these (See Chapter 3, Section 1, Paragraph 5(2).)

The utilization of company-owned external advanced research facilities and equipment was investigated by the National Institute of Science and Technology Policy in its Survey on Research Activities of Private Corporations.

Of the 431 companies engaged in advanced R&D for their major products and services in FY 2013, about half (46.6%) reported using external advanced research facilities and equipment.

Of the 189 companies that gave responses concerning the results of R&D using their external advanced research facilities and equipment, 82.5% reported having obtained research achievements that lead to commercialization and 40.7% reported R&D that resulted in joint research with external organizations (other companies, universities). In effect, 88.8% of the companies that responded to the questionnaire were found to have recognized some effects from using external advanced research facilities and equipment (Table 2-4-9).

■ Table 2-4-9 / Effects of using external advanced research facilities and equipment (cross tabulation)

		Results tied to joint research with external organization?		
		Yes	No	Total
Results tied to commercialization	Yes	34.4%	48.1%	82.5%
	No	6.3%	11.1%	17.5%
	Total	40.7%	59.3%	100.0%

Source: Survey on Research Activities of Private Corporations 2014, *NISTEP Report, No.163* (June 2015)

Column 2-8 The universe as seen through gravitational waves: Elucidating black holes and beyond

Gravitational waves were predicted by Dr. Albert Einstein in his General Theory of Relativity in 1916.

For example, when a very massive celestial body moves, the space around it distorts. This distortion is transmitted like waves through the universe. It is said that gravitational waves are generated by a supernova, when a star at least ten times the mass of the sun ends its life in a great explosion.

In February 2016, the scientists at the Laser Interferometer Gravitational-wave Observatory (LIGO) detectors in the US announced that the observatory had detected gravitational waves, the world's first such result.

This discovery of gravitational waves has added a new observation technique to those used in astronomy, a field that aims at elucidating phenomena of the universe through the observation of electromagnetic waves (visible light, electric waves) and radiation (X rays, gamma rays)

In Japan, the introduction of a laser interferometer gravitational-wave detector has been examined by the University of Tokyo and the National Astronomical Observatory of Japan since the latter half of the 1980s. The development of prototype detectors for observing gravitational waves has been promoted.

To observe gravitational waves on the earth, the capabilities of laser interferometers must be improved. The development of a detector larger than those already examined was considered, and the construction of a larger detector was initiated in 2010.

The detector being constructed is KAGRA, a large-scale cryogenic gravitational wave telescope.

The construction of KAGRA has been carried out under a 7-year plan from FY 2010 to FY 2016. A pair of orthogonally oriented laser interferometers, each of which is 3 km in length, are being constructed at a depth of 200m at Kaguraoka Mine (Kaguraoka Town, Hida City, Gifu Prefecture).

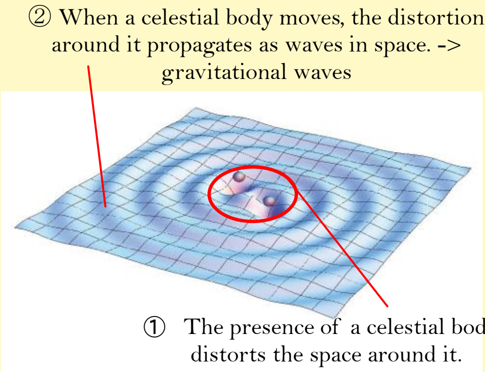
The main features of KAGRA will be 1) its placement underground, where ground surface vibrations will be low, and 2) the possibility of cooling the reflectors to an ultra-low temperature (-253 °C). The detector will enable high-resolution observation.

For example, much remains unknown about how black holes are born. It is anticipated that the observation of gravitational waves using KAGRA will greatly contribute to knowledge of black holes.

Test operation of KAGRA started in the spring of 2016, and preparations for full-fledged observations from FY 2019 have been steadily progressing.

MEXT will continue to lend its support to the development of gravitational wave astronomy, a budding academic field. Our plan will be realized when KAGRA is completed as planned, observations start and research through observations of gravitational waves progress.

In the observation of gravitational waves, international collaboration and cooperation will be important.



Concept of gravitational waves

Source: The University of Tokyo's Institute for Cosmic Ray Research

For example, to accurately determine the source of gravitational waves, it is necessary to observe the waves at multiple, distant locations on the earth's surface. The start of observations using KAGRA has been anticipated by many countries of the world.

KAGRA has two major features that LIGO detectors do not. KAGRA is installed underground and has low-temperature mirrors. These innovative aspects of KAGRA were employed in considering advanced research in the future.

When the observation of gravitational waves was found to be possible, this finding added a new technique for investigating unknown cosmic phenomena. The realm of inquiry, which arises from the intellectual curiosity of humans, has further widened towards the elucidation of the moment black holes are born and various other cosmic mysteries through observations of phenomena on unknown celestial bodies.

In the gravitational wave phenomenon of merging binary black holes, mass equivalent to about three of our suns was converted into gravitational waves and released into space.

This cosmic phenomenon is observable only through the observation of gravitational waves. This development of gravitational wave observation has made it possible to observe things that humans had not been able to know.

Ultimately, when the horizon of human knowledge has expanded further, the observation of the early universe through observations of gravitational waves may become possible.

KAGRA

Source: The University of Tokyo's Institute for Cosmic Ray Research

2 Enhancement of Intellectual Infrastructure

For the effective and efficient promotion of R&D, intellectual infrastructure needs to be improved to ensure its safety, reliability and qualitative/quantitative stability, because intellectual infrastructure supports basic research activities such as experiments, measurement, analyses and evaluations and should be available to many researchers. Thus, the systematization of intellectual property, such as research results and research materials, is necessary.

To meet the needs of diverse users, the improvement and effective use of intellectual infrastructure is being promoted while the improvement of the quality of intellectual infrastructure is also taken into account. The systematization of research materials, measurement standards and measurement/evaluation methods has been steadily advanced.

Through AMED, MEXT is developing a center of bio-resources under the National Bio-resource Project (NBRP) and the JST is implementing the Project for Promoting Integration of Life Sciences Database. The aim is to support research in the life sciences (See Chapter 2, Section 3, Paragraph 2.)

MEXT has been collaborating with businesses and universities in promoting the development of the most advanced, unique technologies and instruments for measurement and analysis that serve the needs of the world's leading researchers and manufacturers (See Chapter 3, Section 1, Paragraph 5(1).)

MEXT publishes the Japanese Standard Tables of Food Composition, which lists the composition of the Japanese diet.

As high-quality data pooling had been required to address the needs of the modern Japanese diet, the table was revised in 2015, the table was revised in 2015. The new table lists a greater variety of foods, and a new table for composition of carbohydrates was added. In November 2015, METI checked the progress of a plan for the development of intellectual infrastructure in three areas (measurement standards, microbial genetic resources and geological information), checked specific measures for promoting the use of intellectual infrastructure and reviewed the plan.

For the measurement standards, the National Institute of Advanced Industrial Science and Technology

(AIST) conducted precise determinations of the fundamental physical constants (e.g., the Avogadro constant and the Planck constant).

This precise determination of fundamental physical constants is expected to contribute to basic sciences and to the revision of the International System of Units (SI), which is planned for 2018.

As chemical reference materials, the bromate ion standard solution and chlorate ion standard solution were developed. These two standard solutions are planned to be used in an evaluation method that secures the safety of the water supply through SI traceability. Isotopic reference materials (lead, etc.) were developed, and the use of those materials is expected to contribute to precise component analysis and evaluation techniques using mass spectrometry to analyze subterranean resources.

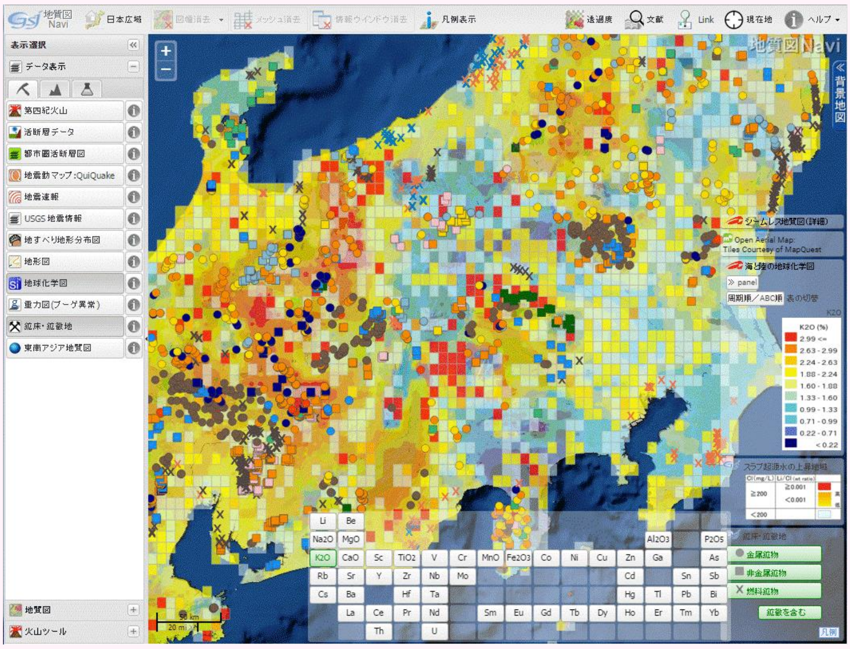
Regarding geological information, AIST produced two 1:50,000 geological maps, one 1:200,000 geological map and three 1:200,000 marine geological maps.

AIST updated its 1:200,000 seamless geological map of Japan[1] and made adjustments for the next generation of seamless geological maps.

A selection system that determines and displays the type of rock and its period of origin in an easy-to-understand way on the map was installed in the seamless geological map viewer.

Geomap Navi (Figure 2-4-10), a comprehensive portal for geological information that formally opened in FY 2013, was given data display functions for geochemistry, mineral deposits and deep groundwater.

■ Figure 2-4-10 / Geological Information Integrated Portal Site (GeomapNavi): Display example



The geochemical map (distribution of K_2O concentration), mineral deposits and deep groundwater data are displayed.
Source: AIST

The National Institute of Technology and Evaluation (NITE) has been collecting, preserving and

1 These standardized geological maps cover all of Japan, are based on 1/200,000-scale maps and are browsable on the website.

distributing biological genetic resources and has also been organizing information on these resources in terms of their genes and genetic lineages so as to make the information accessible to researchers and others. (7,103 strains of biological genetic resources had been distributed as of December 2015.)

It also joined a network of 23 organizations from 13 countries that aims for the preservation and sustainable use of microbial resources (the Asia Consortium, founded in 2004) and has actively supported Asian countries in their efforts to preserve biological resources through multilateral interchange programs according to the Convention on Biological Diversity (CBD).

The Ministry of Agriculture, Forestry and Fisheries (MAFF) is developing a database and a system for higher-level analysis of fragmentary genomic information produced by next-generation genome analyzers, for the purpose of providing breeders and researchers at universities and private companies with information on the genes and genomes of agricultural, forestry and fishery products.

In its gene bank project concerning agricultural biological resources, MAFF collects, preserves, assesses and provides biological genetic resources related to agriculture, and preserves and provides genomic resources, including DNA, of rice and other crops.

3 Enhancement of Research Information Infrastructure

(1) Development of networks

The National Institute of Information and Communications Technology (NICT) has been promoting R&D and demonstration tests that use a next-generation communications network test-bed (JGN-X) which NICT has developed and has been operating (See Chapter 3, Section 1, Paragraph 2 (2).)

The National Institute of Informatics (NII) has been operating the Science Information Network (SINET) as a platform for supporting overall scientific research and education at universities.

As of the end of 2015, more than 800 Japanese universities and research institutions were connected to SINET. Through SINET, the distribution of academic information is secured for many people at institutions of education and research.

The international distribution of research information is necessary for internationally advanced research projects. To promote such information distribution, SINET is connected with academic and research networks overseas, including those in the U.S. and Europe.

To address future increases in communication needs in education and research and the further dissemination of cloud computing[1] at universities, the operation of a faster, more convenient new system (SINET5) is planned to start in April 2016.

MAFF has been developing and operating MAFFIN[2] a research network that connects research institutions related to agriculture, forestry and fisheries. As of the end of March 2015, 87 institutions are connected in MAFFIN.

MAFFIN, which is linked to an institution in the Philippines, is serving as part of a network for the distribution of research information overseas. Ministry of Environment (MOE) runs the Network of

1 This is a collective name for the services provided through the network. On this network, software, hardware and diverse resources are available. It will be possible to quickly use necessary computer resources on the basis of “taking what one needs when it’s needed.”
2 The Ministry of Agriculture, Forestry and Fisheries Research Network

Organizations for Research on Nature Conservation (NORNAC), in which 46 research institutions currently participate. The purpose of this organization is to contribute to the promotion of policymaking for nature conservation based on scientific information. National and local governments and research organizations related to nature conservation exchange and share information through this organization.

MOE also serves as the secretariat for the Asia Pacific Biodiversity Observation Network (AP-BON). That network promotes the collection and integration of observation data, including monitoring data, on biodiversity in the Asia Pacific region, towards strengthening the scientific infrastructure that is necessary for the conservation of global-scale biodiversity.

(2) Creation and provision of databases

The National Diet Library keeps a database on the publications, materials and the like. It collects and provides information on the database via its website[1]. To help enhance the efficiency and effectiveness of R&D activities, the NII systematically collects information on science and technology necessary for the creation of innovations, organizes the information into an easy-to-use format and posts it online.

For example, the NII has been creating and providing a database on the whereabouts of information regarding bibliographies of academic books and journals kept by university libraries nationwide and on doctoral and other scientific papers in Japan (CiNii). A common repository system[2] is provided by NII to research institutions and universities to help them to develop their own institutional repository for preserving and disseminating their research/educational results. NII is operating JAIRO[3]. JST is offering an information service, J-GLOBAL. In this service, a database on basic information is created regarding literature, patent, researchers, and research activities and in Japan and overseas and information is provided by linking a specific researcher, for example, to the relevant information. The JST has also been creating a database on abstracts in Japanese available online via the paid bibliographic information retrieval service (JDreamIII[4]).

To respond to progress in open science and to assist in the development of open-access journals published by various academic societies, the JST has been providing a common-use system environment (J-STAGE[5]).

From FY 2015, the JST has been promoting the distribution of electronic content in wider areas and collecting not only reviewed journal articles, but also abstracts.

MAFF has been creating and providing databases on information regarding literature on agriculture, forestry and fisheries as well as on the whereabouts of literature, including the bibliographic database (Japanese Agricultural Sciences Index (JASI)) on papers published in Japanese science journals related to agriculture, forestry and fisheries.

MAFF is also creating and offering databases on digitized full-text information regarding research papers published by independent administrative institutions specializing in R&D, national/public R&D institutions and universities. These cover topics related to agriculture, forestry and fisheries; satellite

1 http://iss.ndl.go.jp/
2 This Internet-based archive stores academic papers generated by educational and research activities at universities and research institutions. The users are able to retrieve academic documents by Internet.
3 Japanese Institutional Repositories Online
4 The JST Document Retrieval System for Academic and Medical Fields III
5 The Japan Science and Technology information Aggregator, Electronic

imagery; and topics of ongoing research conducted at R&D institutions.

MOE is collecting, managing and providing information on natural environments and biodiversity throughout Japan by means of the Japan Integrated Biodiversity Information System (J-IBIS).

■ Table 2-4-11 / Key projects relating to research and information infrastructure (FY2015)

Ministry/ Agency	Implemented by	Project
Diet	National Diet Library	Collection and organization of science and technology-related documents at the National Diet Library
MIC	NICT	Development of an advanced R&D testbed network (JGN-X)
MEXT	JST	The organization of basic S&T information, and promotion of the use of such information (J-GLOBAL, etc.)
		Life Science Database Integration Program (by the NBDC)
	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Operating expenses for information infrastructure
	NII	Development of the Science Information Network (SINET 4)
Ministry of Health, Labour and Welfare (MHLW)	National Institute of Infectious Diseases (NIID)	Infectious Disease Surveillance Center (IDSC) expenses
		Research project expenses for collecting, analyzing and assessing safety data on biological products
MAFF	Secretariat of Agriculture, Forestry and Fisheries Research Council	Operation of Agriculture, Forestry and Fisheries Research Information Technology Center (JASI, MAFFIN, etc.)
Ministry of Land, Infrastructure, Transport and Tourism (MLIT)	Geospatial Information Authority of Japan (GSI)	Promotion of the Global Mapping Project (development of techniques for preparing the 3rd edition of the global geological map)
MOE	Biodiversity Center of Japan	Promotion of the collection, management and provision of information on biodiversity
MEXT JPO	JST INPIT	Improvement of an integrated system for searching patent and literature information
JPO, Relevant ministry/agency	INPIT	Provision of a database on research tool patents (RTDB)

Source: MEXT