2.1.6 R&D Expenditures in Japan by Sector

The following section gives R&D expenditures in Japan by sector[12] on the basis of the Survey of Research and Development (2001) conducted by the Ministry of Internal Affairs and Communications.

2.1.6.1 Business Enterprises[13]

According to the survey, the business enterprises that engaged in research in FY2003 numbered 25,000 companies, with the manufacturing industry accounting for the vast majority of these, at almost 81.3% of all industry types. Within the manufacturing sector, the food, machinery, and precision equipment industries held the largest shares.

Also, the total of R&D expenses incurred by companies in FY2003 rose by 1.6% from the previous fiscal year to 11.7589 trillion yen, accounting for about 70.0% of Japan's total R&D expenditures.

By source of funding for R&D expenditures, companies accounted for almost all of the total, dwarfing the government funding of about 1.4% of the total. Moreover, for R&D expenses incurred by companies excluding public corporations and incurporated administrative agencies, classified by company capitalization, those with a capitalization of 10 billion yen or more accounted for about 70% of the total, a result that showed R&D expenditures were concentrated in larger corporations. Furthermore, growth rates since FY2002 show that companies with a capitalization of 10 billion yen or more have experienced declines while companies with a capitalization of less than 100 million yen have witnessed year-on-year increases (Table 2-1-24).

Table 2-1-24 R&D expense growth rates and component ratio, by size of company capitalization

Capitalization	R&D expenditures (Million yen)	Growth rate over the previous year	Component ratio (%)
Less than 100 million yen	658,964	124.0	5.6
100 million to 1 billion yen	776,679	19.1	6.6
1 billion to 10 billion yen	2,028,920	2.6	17.3
10 billion yen or more	8,240,106	-3.9	70.4
Total	11,704,669	1.8	100.0

Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.1.6.2 Non-profit Institutions[14]

In FY 2003, the government and the private sector were sources for nearly equal shares of funding for non-profit institutions. The total R&D expenditures at non-profit institutions were 322 billion yen, accounting for about 2% of Japan's total R&D expenditures (Figure 2-1-25).

2.1.6.3 Public Organizations[15]

The government was the source for nearly all R&D expenditures at public organizations in FY2003, with private sector funding accounting for only about 2%.Total R&D expenditures at government research institutions decreased by 1.6% over the pr-

12 Research Performing Sector: Research activities in Japan in this paper are provided by business enterprises, public organizations, non-profit institutions, and universities and colleges. These classifications are based on the "Report on the Survey of Research and Development" compiled by the Statistics Bureau. The following defines some of these organizations.

13 Business enterprises: Corporate companies (Capital: 1 million or more yen (FY1974 or before), Capital: 300 million yen or more (between FY1975 and FY1978), Capital: 5 million yen or more (between FY1979 and FY1993), Capital: 10 million yen or more (FY1994 and after)), profit-oriented public corporations and independent administrative institutions. The public corporations and independent administrative institutions specializing in research are excluded, and are included in the research institutions defined below.

14 Non-profit institutions: Corporations, groups, etc. such as incorporated foundations or incorporated bodies that carry out research and do not seek private profit.

15 Public organizations: National and local government-owned research institutions and public corporations and independent administrative institutions whose primary business is research and development.

evious fiscal year to 1.4601 trillion yen, representing about 9% of Japan's total R&D expenditures.

When looking at expenditures by type of institution, pu- blicly-owned research institutions, and public cor- porations and incorporated administrative agencies witnessed year-on-year declines despite increases at national government-owned institutions (Figure 2-1-25).

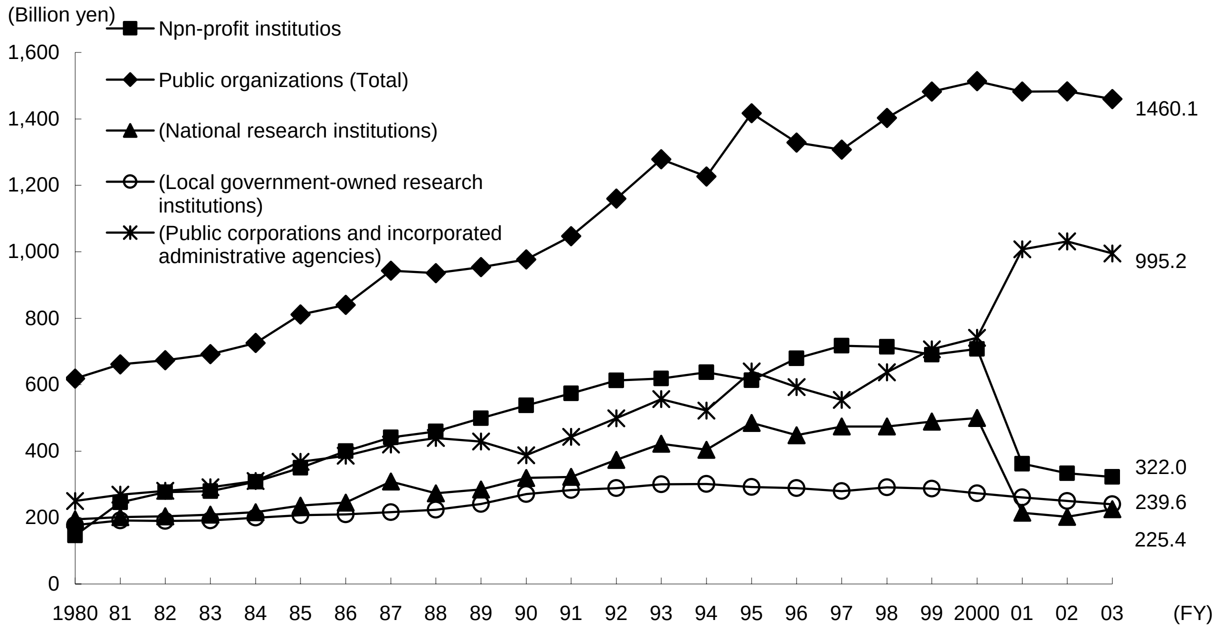


Figure 2-1-25 Trends in R&D expenditures for non-profit institutions and public organizations

Note: Survey coverage categories were changed in FY2001; figures up to FY2000 use values for the following organizations:
Non-profit intstitutions: Private research institutions
Public organizations: Government research institutions (within which, "Public corporations and independent administrative institutions" uses the values for "Public corporations" up to FY2000)

Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.1.6.4 Universities and Colleges[16]

By source of funding for R&D expenditures at universities and colleges in FY2002, the government accounted for about 50% of the total. The total R&D expenditures at universities and colleges increased by 1.5% over the previous fiscal year to 3.2823 trillion yen, accounting for about 20% of Japan's total R&D expenditures .

For trends in R&D expenditures by type of university, national and private universities registered year-on-year increases. Likewise, all fields of study within the natural sciences registered year-on-year increases (Figure 2-1-26).

16 Universities and colleges: Departments of universities and colleges (including graduate schools), junior colleges, colleges of technology, research institutions attached to the universities and colleges and inter-university research institutes, National Institution for Academic Degrees and University Evaluation, Center for National University Finance and Management, and National Institute of Multimedia Education.

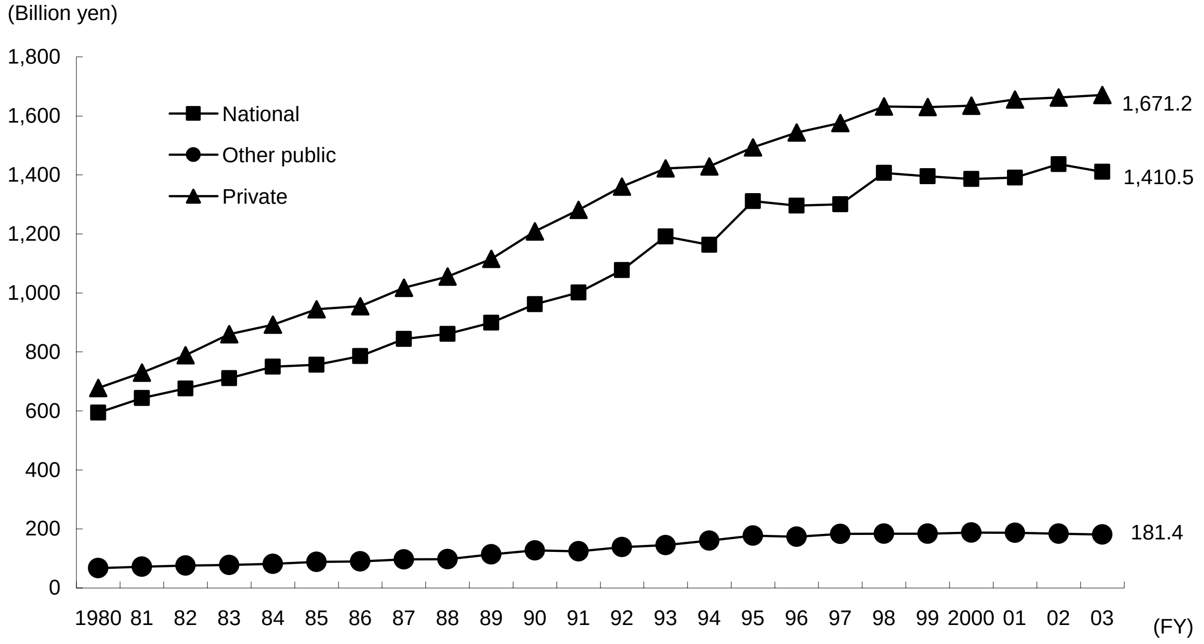


Figure 2-1-26 (1) Trends in R&D expenditures at universities and colleges, by type of university

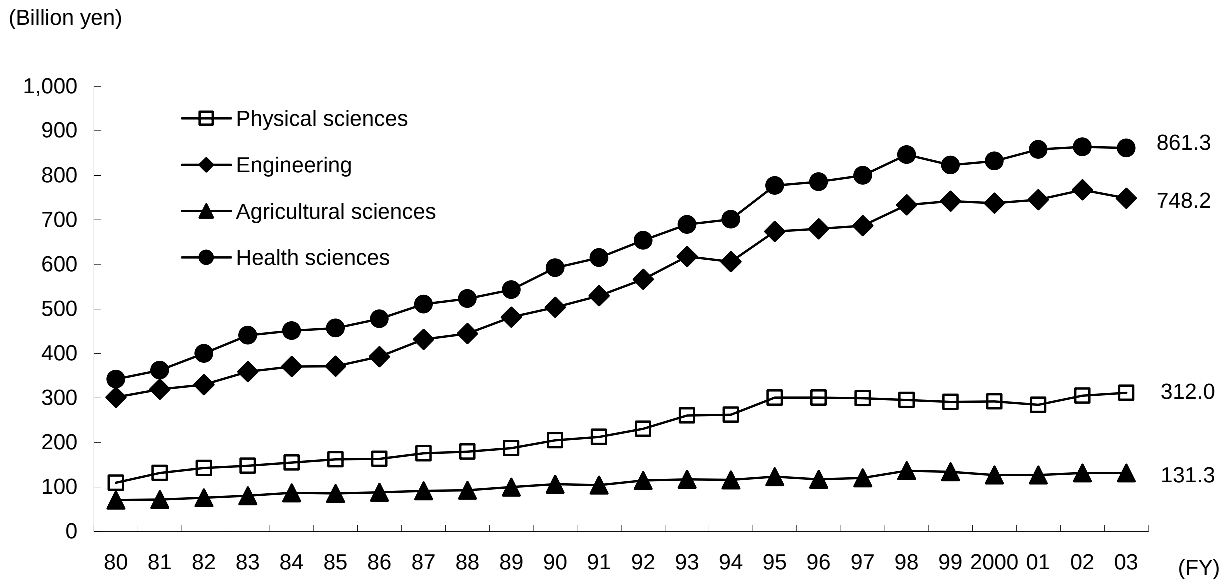


Figure 2-1-26 (2) Trends in R&D expenditures at universities and colleges, by field

Note: The figures by type of university include the humanities and social sciences.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.1.7 R&D Expenditures in Japan by Type

R&D expenditures break down into labor costs, materials, expenditures on tangible fixed assets (land and buildings, machinery, instruments, equipment and others), and lease fees (separated from ‘Other expenses’ in FY2001) and other expenses.

An examination of Japan’s R&D expenditures by type reveals that total labor costs increased by 3.1% over the previous fiscal year to 7.6314 trillion yen. The total expenditures for materials increased by 1.3% over the previous fiscal year to 2.7856 trillion yen. The total expenditures for tangible fixed asset purchases decreased, registering a 0.9% decrease over the previous fiscal year to 1.7376 trillion yen. On the other hand, the total expenditures for lease fees increased by 2.0% over the previous fiscal year to 180.8 billion yen. The share of other expenses required for research, such as books and journals, utilities, travel, and telecommunications, etc., decreased by 2.8 % over the previous fiscal year to 4.4688 trillion yen (Figure 2-1-27).

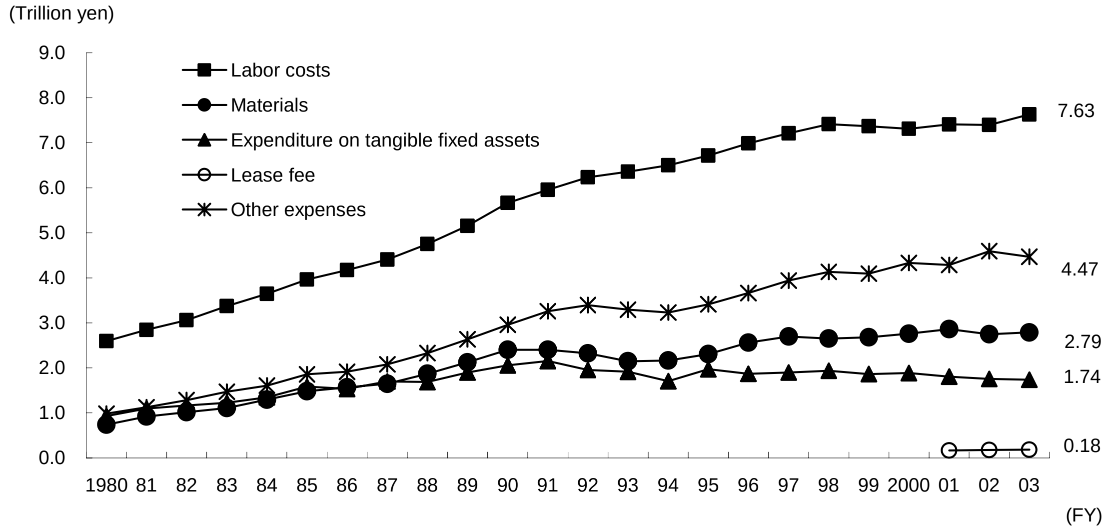


Figure 2-1-27 Trends in R&D expenditures by type

Notes: 1. The humanities and social sciences are included.
2. Lease fee was separated from ‘Other expenses’ in FY2001.
3. Some Industries were added as new survey targets in FY1996 and FY2001.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

Moreover, the trends in the composition of expenditures reveal that while labor cost has long held the largest share of overall expenditures, that share has been declining in recent years. Tangible fixed asset purchase expenditures are also declining. The shares of materials cost and other expenditures have remained almost the same (Figure 2-1-28).

Company R&D expenditures by category rose with the exception of tangible fixed asset purchase expenditures and lease fees (Figure 2-1-29).

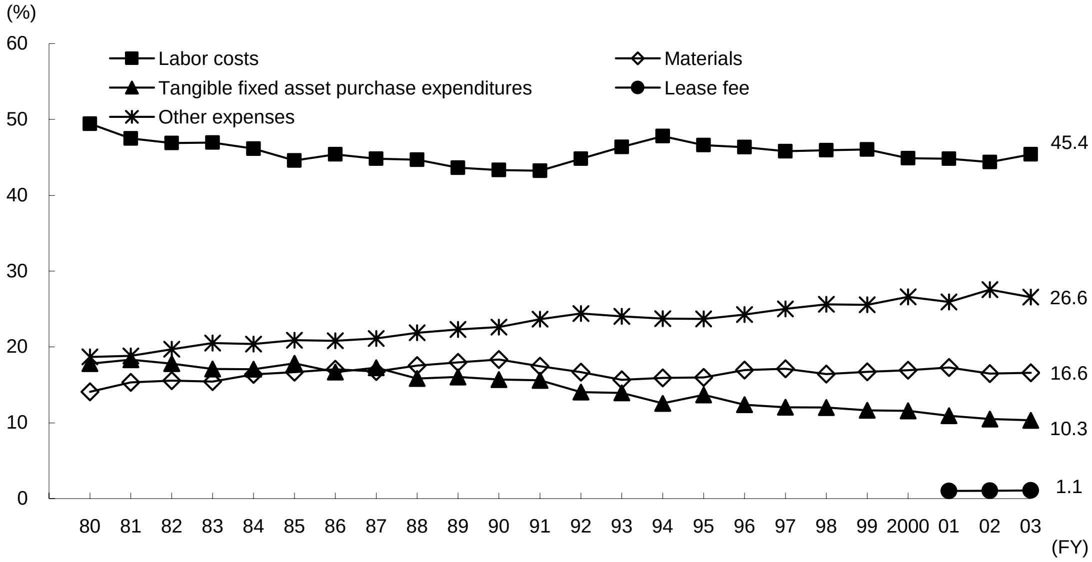


Figure 2-1-28 Trends in R&D expenditures by constituent elements

Notes: 1. The humanities and social sciences are included.
2. Lease fee was separated from 'Other expenses' in FY2001.
3. Some Industries were added as new survey targets in FY1996 and FY2001.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

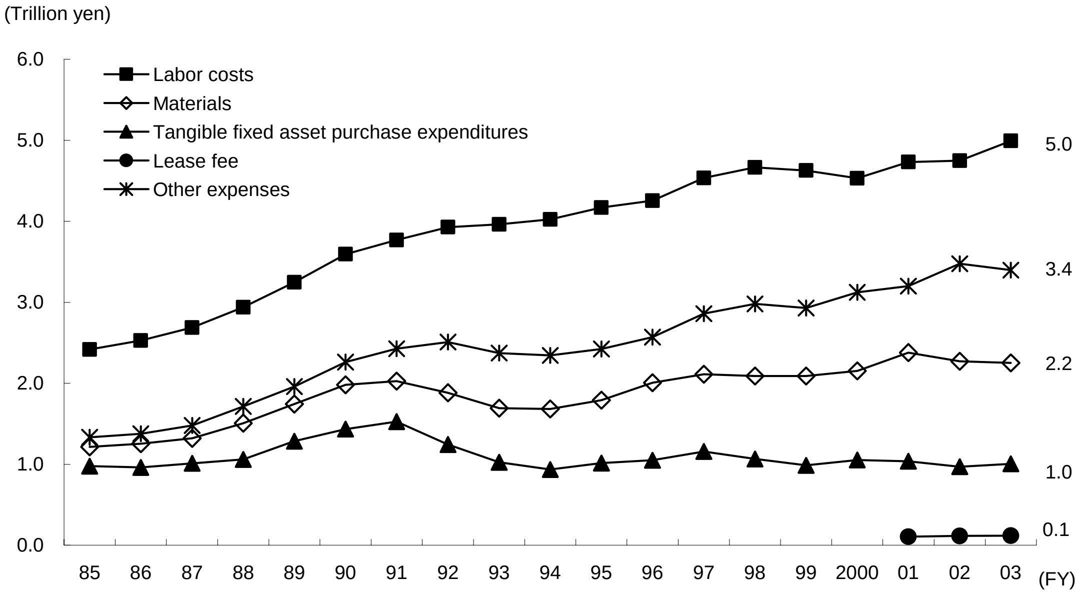


Figure 2-1-29 Trends in R&D expenditures at business enterprises, by type

Notes: 1. Lease fee was separated from 'Other expenses' in FY2001.
2. The software industry and wholesale trade were newly added to the scope of the survey in 1996 and 2001, respectively.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

Non-profit institutions and public organizations had lower ratios than any other institutions on expenditures for labor costs, while their tangible fixed asset purchase expenditures showed higher ratios.

When looking at expenditures by type of institution, local government-owned institutions were characterized by exceptionally high labor costs. On the other hand, public corporations and incorporated administrative agencies have higher ratios of expenditures for the purchase of tangible fixed assets, because they include those requiring large-scale facilities and equipment for nuclear and space R&D (Figure 2-1-30).

Universities and colleges had a higher share of labor costs than other institutions, accounting for about 65% of expenditures, while raw material costs were the lowest in share. When looking at expenditures by the field of study within the natural sciences, all areas had lower than average shares of labor costs, while the physical sciences and engineering in particular tended to require larger than average shares of total costs for tangible fixed assets (Figure 2-1-31).

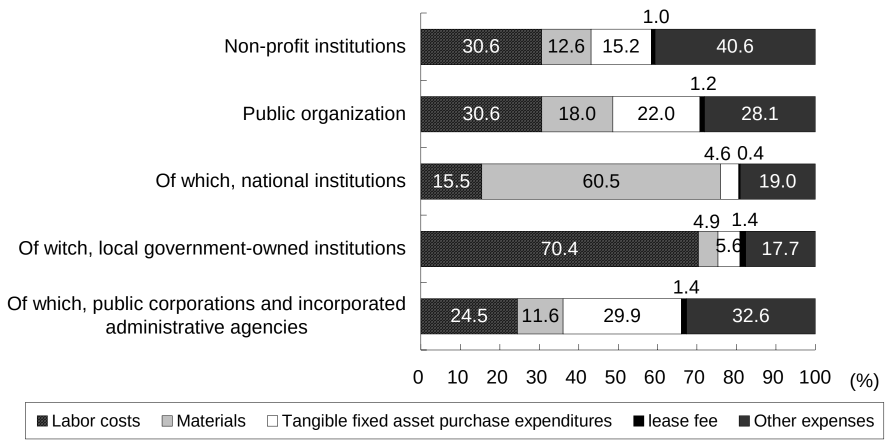


Figure 2-1-30 Composition of research expenditures at non-profit institutions and publicorganizations by type (FY2003)

Source: Statistics Bureau. "Report on the Survey of Research and Development"

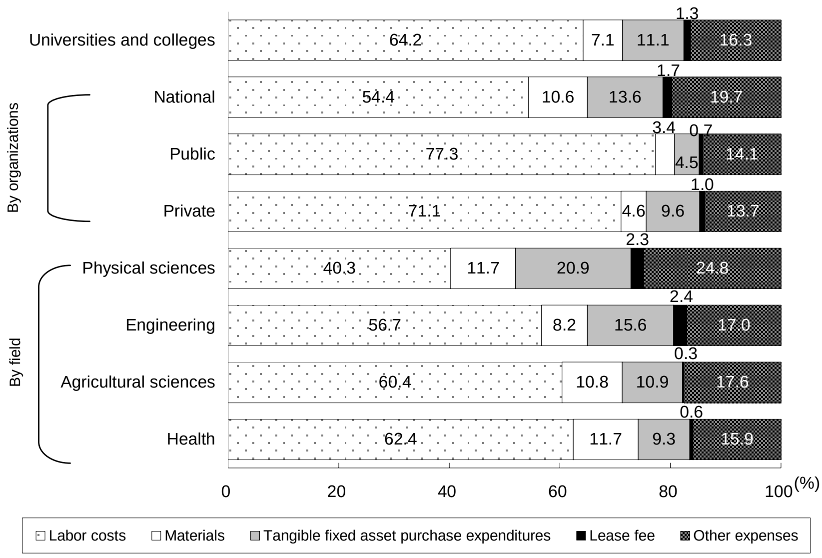


Figure 2-1-31 Composition of R&D expenditures at universities and colleges, by type (FY2003)

Note: The figures for all universities and colleges and those by organization include the humanities and social sciences.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.2 Research Personnel

Statistics on research personnel, along with those on R&D expenditures, are another effective indicator of the extent of research activities. Personnel engaged in R&D[17] can be classified as researchers and support personnel (assistant research workers, technicians, and clerical and other supporting personnel).

2.2.1 Researchers

2.2.1.1 Number of Researchers

Countries use different methods for determining the number of researchers.

The Frascati Manual defines researchers as "professionals engaged in the conception or creation of new knowledge, product processes, methods, and systems, and in the management of the projects concerned." But this definition is quite vague, and countries that follow the Frascati Manual also specify their own definitions of the term "researcher" for counting researchers.

For this reason, there are differences between countries in methods for measuring the number of researchers, and international comparisons are difficult. In comparison between Japan and the United States, the number of researchers counted in the Report on the Survey of Research & Development conducted by the Statistics Bureau of Japan's Ministry of Internal Affairs and Communications is not exactly equivalent to the researchers counted in the U.S. National Science Foundation's National Patterns of R&D Resources. Differences of methods for determining the numbers of researchers are shown in Table 2-2-1, and would appear to be obstructing a fair statistical comparison.

The category of researcher at universities and colleges, in Japan, consisting of teachers, doctoral students, medical staff, etc., differs between Japan and the United States in the following ways.

(1) Teaching Staff

In 1995, a year in which it's possible to compare teachers in Japan and the United States, 160,634 teachers at universities and colleges in Japan, including those in the humanities and social sciences, were classified as researchers, while in the United States only the 89,300 university and college teaching personnel who responded that they had obtained a doctoral degree and were primarily engaged in research were classified as researchers —a smaller result than in Japan.

It would appear, then, that the number of teaching personnel in the United States who are involved in research is much larger than in Japan when the same kind of statistics are used. On the other hand, if the same statistical method used in the United States were applied to Japan, the number of Japanese researchers would be smaller.

17 Research personnel: "Report on the Survey of Research and Development" compiled by the Statistics Bureau classifies personnel engaged in R&D as follows. (2002 revision)

Researcher: Persons who hold a university degree (or persons who have equivalent or greater knowledge in their specialty), who are engaged in research activities in their own chosen subject. "Researchers" as used herein, refers only to full-time researchers, and excludes those who also perform other duties in addition to research.

Assistant research workers: Persons who assist researchers and who are engaged in research activities under their direction and who have the possibility of becoming researchers in the future.

Technicians: Persons, other than researchers and assistant research workers, who are engaged in technical services related to research activities under the guidance and supervision of researchers and assistant research workers.

Clerical and other supporting personnel: Excepting those mentioned above, persons who are engaged in miscellaneous activities, clerical work, accounting, etc., relating to research activities. Japanese statistics on persons engaged in R&D are as of April 1 of the appropriate year up to 2001, and as of March 31 for 2002.

Table 2-2-1 Comparison of Japanese and U.S. definitions of researchers

Country	Japan (until 2001)	United States
Companies	• Have university graduate (or higher) qualifications • Two years or more of research experience • Have a research theme in which conducting research • Researchers calculated by FTE	• University graduate level, or have equivalent or higher level of expert knowledge • Engaged in research themes • Researchers calculated by FTE
Private research institutions	• Have university graduate (or higher) qualifications • Two years or more of research experience • Have a research theme in which conducting research • Researchers calculated by FTE	• People who have Ph.D.s, and who state that they are mainly engaged in research and development • Actual number of researchers (head count)
Government research institutions	• Have university graduate (or higher) qualifications • Two years or more of research experience • Have a research theme in which conducting research • Researchers calculated by FTE	• People who have Ph.D.s, and who state that they are mainly engaged in research and development (excluding military-related personnel) • Actual number of researchers (head count)
Universities and colleges	• Teachers, enrolled doctoral students, medical staff, or those who have university graduate (or higher) qualifications • Two years or more of research experience • Engaged in research themes (including teaching staff) • Actual number of researchers (head count) (FTE values are also reported to the OECD)	• People who have Ph.D.s, and who state that they are mainly engaged in research and development, and university graduates engaged in research assistance • Actual number of researchers (head count), excluding graduate students • Graduate students are FTE converted with a 50% coefficient

Note: In Japan, categories were changed during a 2002 survey revision to “Business enterprises,” “non-profit institutions,” and “ public organizations.” The requirement of “two years or more of research experience” was cut.
Source: Japan - Ministry of Internal Affairs and Communications, Statistics Bureau (Statistics Bureau). "Report on the Survey of Research and Development"
United States - National Science Foundation. "National Patterns of R&D Resources: 2002 Data Update"

(2) Number of Graduate School Students

A comparison for 1999 reveals that 59,057 people who were studying in doctoral courses, including the humanities and social sciences, in Japan were classified as researchers. This figure is virtually identical to the 1999 figure of 59,007 graduate school students in doctoral courses counted in the Ministry of Education, Culture, Sports, Science and Technology’s “Handbook of Education, Culture, Sports, Science and Technology Statistics (2003 edition).”

In the United States, however, the number of graduate school students receiving remuneration for research assistance work is 91,308 people (NSF, “Science and Engineering Indicators 2002”), which is reduced by the FTE (Full-Time Equivalent) rate coefficient of 50% to arrive at a total of about 45,700 researchers. In the United States, therefore, while the count extends beyond doctoral courses to include people in Master’s course programs as well, it is limited to students who are engaged in research assistance work, and is further reduced by a predetermined coefficient. Thus, it is highly probable that the estimate for number of researchers would yield a lower result than Japan’s method of including all students engaged in doctoral course programs.

Therefore, when making comparisons between Japan and the United States, it is important to remember that the measurement of researcher numbers in Japan is overestimated, primarily at the universities. In 2002, the Ministry of Education, Culture, Sports, Science and Technology conducted a “Survey of Full-time Equivalency Data at Universities and Colleges,” the results of which will be used in the future to estimate the number of researchers.

As a result, while there may be differences in the methods of measuring researcher numbers, it is useful, however, to look at general trends for each country from its own methods. The United States had the largest number of researchers (1999: 1,261,000), followed by Japan, at 757,000 (2002: 646,000 using FTE), and Germany (2001: 264,000) (Figure 2-2-2).

The total number of researchers in Japan increased by 0.75% in 2002 over the previous year (4.3% using FTE), and was followed by a year-on-year increase of 0.13% in 2003 (-4.34% using FTE). However, the 2002 survey included revised sections (expansion of surveyed industries, a changed survey date, and an altered definition of researchers, etc.). The annual average rates of increase since 1983 (using FTE) were 4.58% from 1983-1988, 3.91% from 1988-1993, 4.40% from 1993-1998 and 3.01% from 1998-2003.

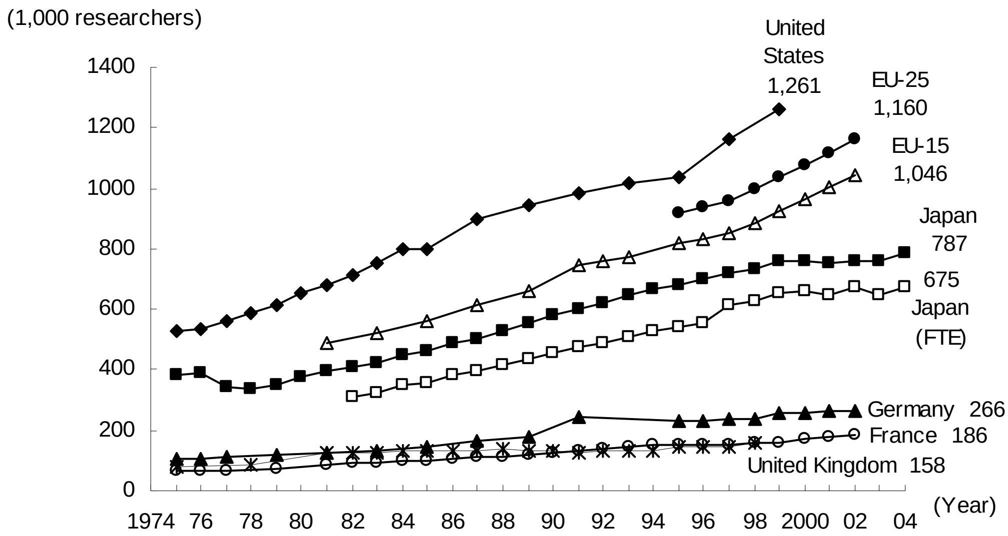


Figure 2-2-2 Trends in numbers of researchers in selected countries

Notes: 1. The figures for all countries include social sciences and humanities.
2. Figures for Japan's number of researchers up to 2001 are as of April 1, after 2002 are as of Mach 31.
3. Japan's FTE values up to 1996 are OECD estimates.
4. In Japan, the software industry has been covered in the survey since FY1997 and the wholesale industry since FY2002.
5. U.K. figures through 1983 show total number of researchers in industrial (scientists and researchers) and national institutions (degree-holding researchers and above), and do not include universities and private research institutions.
6. EU - 15(15 countries: Belgium, Germany, France, Italy, Luxembourg, Nether-lands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland, and Sweden) figures are OECD estimates.
7. EU - 25(10 countries with EU-15: Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak, and Slovania) figures are OECD estimates.

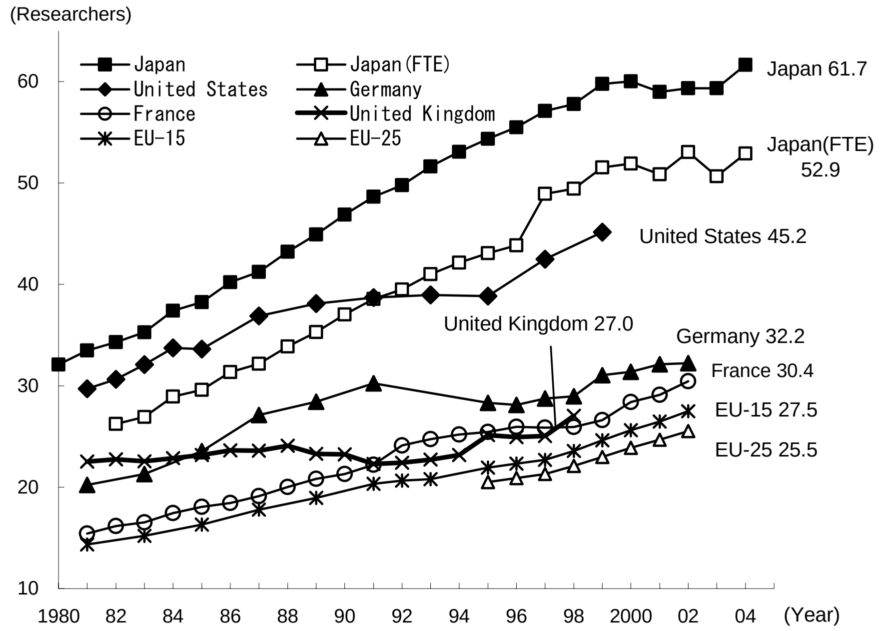
Source: Japan: Statistics Bureau. "Report on the Survey of Research and Development"
Others with Japan (FTE values) : OECD, "Main Science and Technology Indicators"

2.2.1.2 Number of Researchers per 10,000 Population and per 10,000 Laborers

In Japan, the number of researchers per 10,000 people was 61.7 in 2004, while the number of researchers per 10,000 people was 118.2, the highest figures among the advanced nations (Figure 2-2-3).

But the trends in recent years show that the numbers of researchers per 10,000 people and per 10,000 laborers have been stagnant in Japan since about 2000, but grow again at 2004.

(1) Number of researchers per 10,000 people



(2) Number of researchers per 10,000 laborers

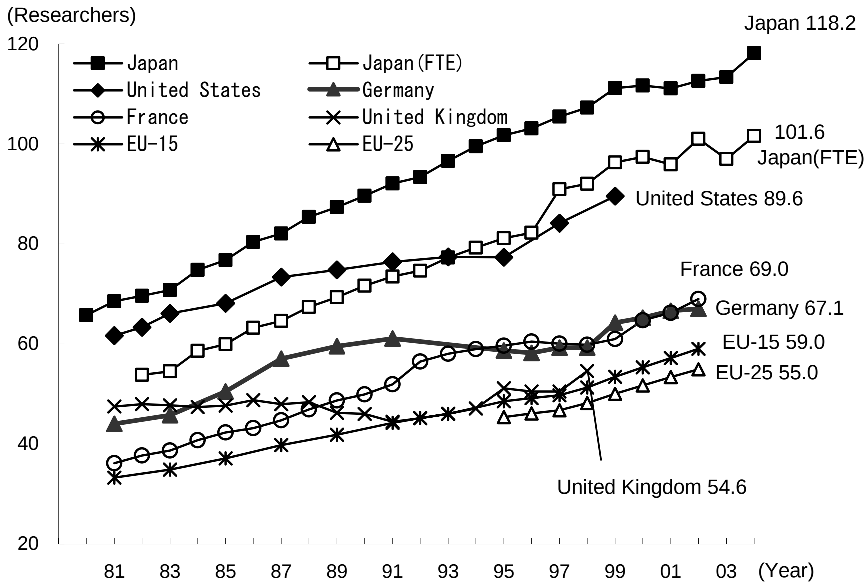


Figure 2-2-3 Trends in numbers of researchers per 10,000 people and 10,000 laborers

Notes: 1. The figures for all countries include social sciences and humanities.
2. Figures for Japan's labor force and number of researchers are as of March 31 of each year, except up to 2001 are as of April 1.
3. EU-15 and EU-25 figures are OECD estimates.

Source: Number of researchers data: Same as in Figure 2-2-2.

Population and labor force data:

Japan - Statistics Bureau. "Population Estimates Series", "Monthly Report on the Labor Force Survey"

Other countries include Japan's FTE value - OECD. "Main Science and Technology Indicators"

2.2.1.3 Number of Researchers by Sector

As for the number of researchers by type of organization, industry (companies) had the most in Japan at 58.3% of the total, followed by universities and colleges at 36.1% and government research institutions (public institutions) at 4.3%.

The United States has a greater percentage of researchers working in industry, and the percentage of researchers in its government research institutions is low, similar to Japan. In Europe, meanwhile, research personnel are concentrated to a high degree in government research (Figure 2-2-4).

The following sections show the characteristics of researchers in Japan by sector.

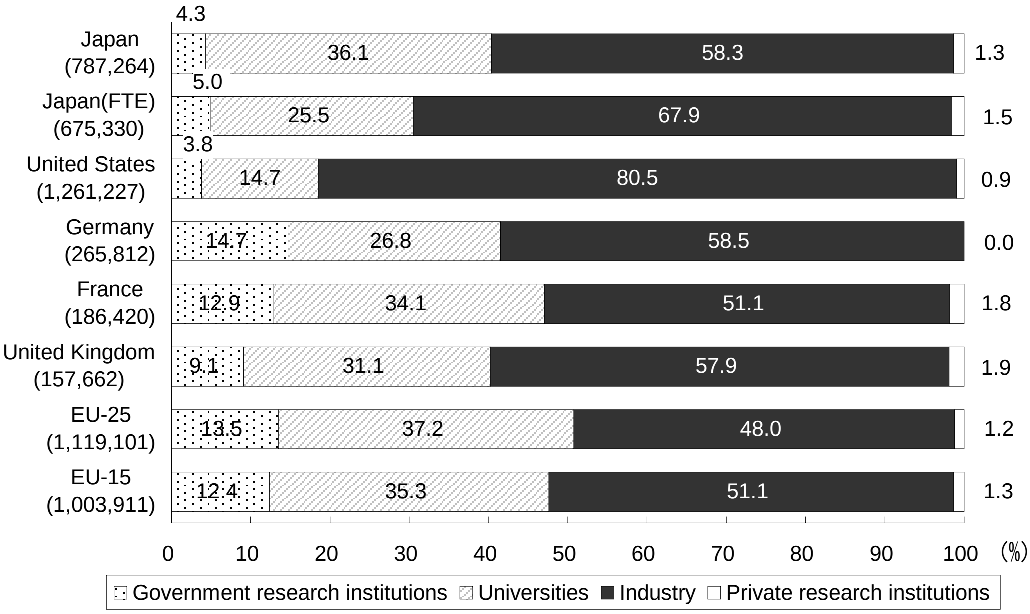


Figure 2-2-4 Share of researchers by sector in selected countries

Notes: 1. For the comparison, statistics for all countries include research in social sciences and humanities. Statistics for Japan, as of March 31, 2004, include the FTE value for public institutions, universities and colleges, companies, and nonprofit organizations.
2. Japan's FTE values are Statistics Bureau data.
3. The data are estimates for Japan in 2004, the United Kingdom in 1998, the United States in 1999, and Germany and France in 2001, and EU-15 and EU-25 are in 2001.
4. Data for private research institutions in Germany is included in data for government research institutions.

Source: Japan - Statistics Bureau. "Report on the Survey of Research and Development"
Others - OECD. "Main Science and Technology Indicators"

(Business Enterprises)

In the last five years from 1999 to 2004 (with 2002 using the revised survey), the number of researchers in business enterprises increased by 6.9% (an average annual rate of increase of 1.34%, from 429,000 researchers to 459,000), which, while slowing, is still increasing compared to other organizations. This hints that industry, as well, has come to place great importance on research and development (Figure 2-2-5)

As for the number of researchers by type of industry, the information and communication electronics and equipment industry registered the highest number, followed in order by the electrical machinery, equipment and supplies industry, the motor vehicles, the general machinery industry, the chem.-ical products industry, the electronic parts and devices industry, the information and communications industry, the food industry, the drugs and medicens industry (Figure 2-2-6).

As for the number of researchers out of 10,000 employees, except for academic research institutions, the information and communication electronica equipment industry had the largest number, at more than 3.1 times higher than the average for all indu-

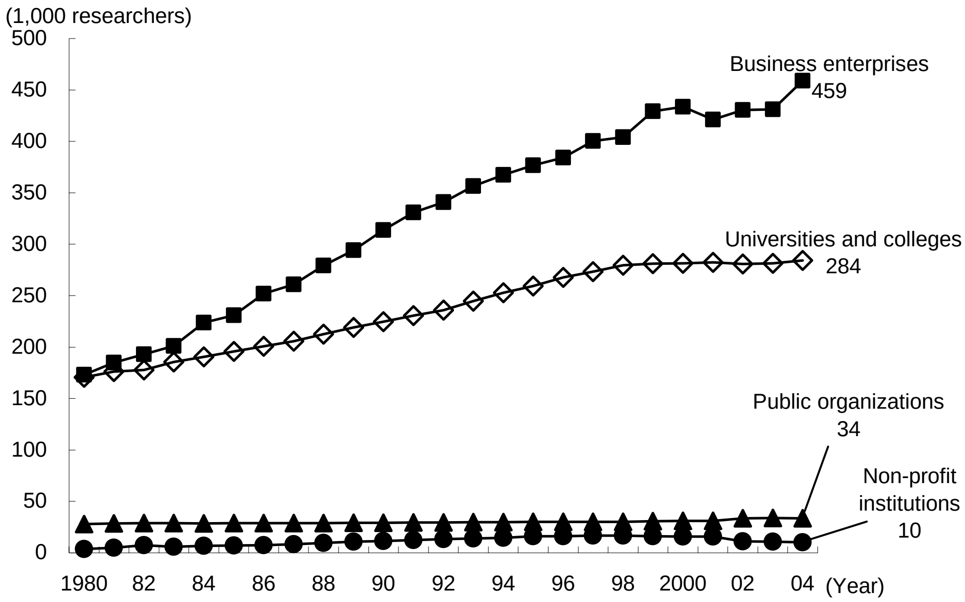


Figure 2-2-5 Trends in numbers of researchers by sector in Japan

Note: 1. Numbers include researchers in the humanities and social sciences and are as of March 31 of each year, except for FY2001, which is as of April 1.
2. Survey categories were changed in FY2002; numbers up to FY2001 are for researchers whose primary duty is research at the following organizations (except at universities and colleges, where the number includes those who conduct research as an additional post).

Up to 2001	After 2002
Companies	Enterprises
Private research institutions	Non-profit institutions
research institutions	Public organizations
Universities and colleges	Universities and colleges

Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (8))

stries, followed in order by the electronic and electrical measuring instruments industry, the oils and paints industry, the precision machinery industry, and the electronic parts and devices industry (Figure 2-2-7).

By field of research, engineering ranks the highest. Next is physical science, followed by health, and finally agricultural sciences. Within the engineering field, researchers are concentrated in "electrical engineering and telecommunications engineering," and "mechanical engineering, shipbuilding and aeronautical engineering." Within the physical sciences, chemistry has the majority. These three fields employ more than three-fourths of all Business enterprises researchers (Figure 2-2-8).

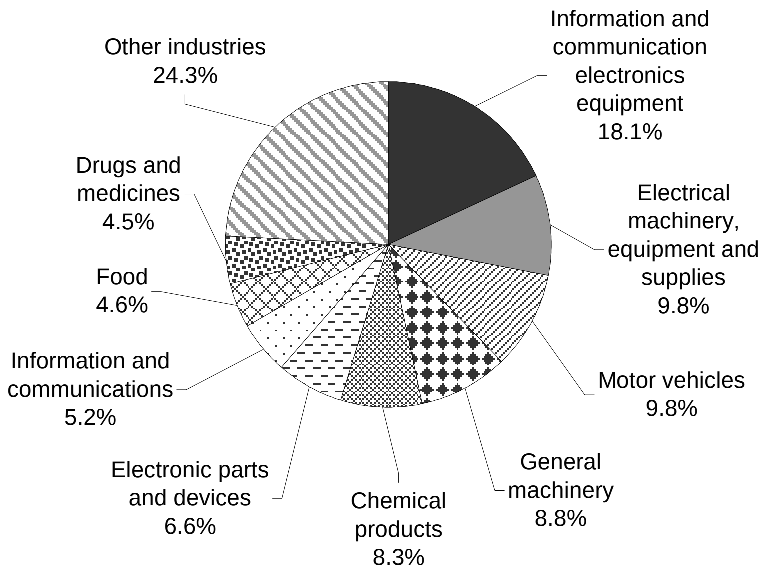


Figure 2-2-6 Researchers at business enterprises, by type of industry (2004)

Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (9))

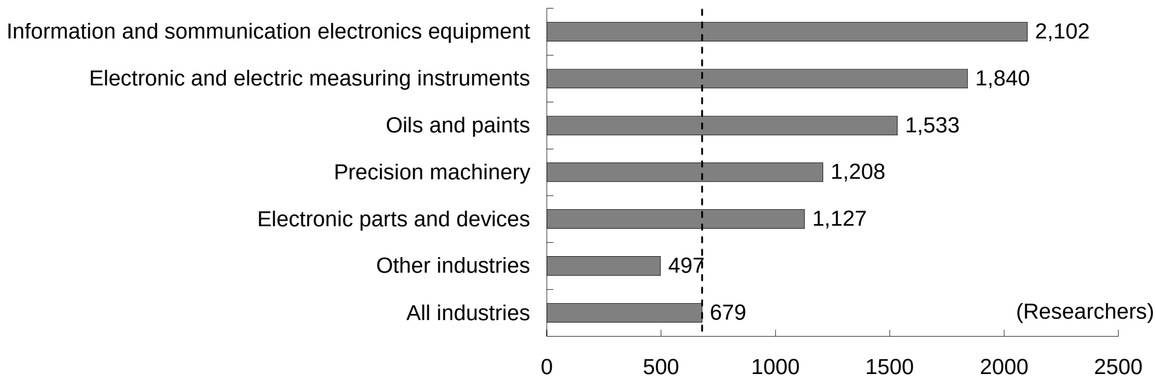


Figure 2-2-7 Number of researchers per 10,000 employees at business enterprises (top five industrial categories except academic research institutions) (2004)

Notes: 1. Regarding researchers per 10,000 employees, the data for number of employees and number of researchers are as of March 31, 2004.
2. Academic research institutions (5,749 researchers per 10,000 employees) are not shown on graph.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (9))

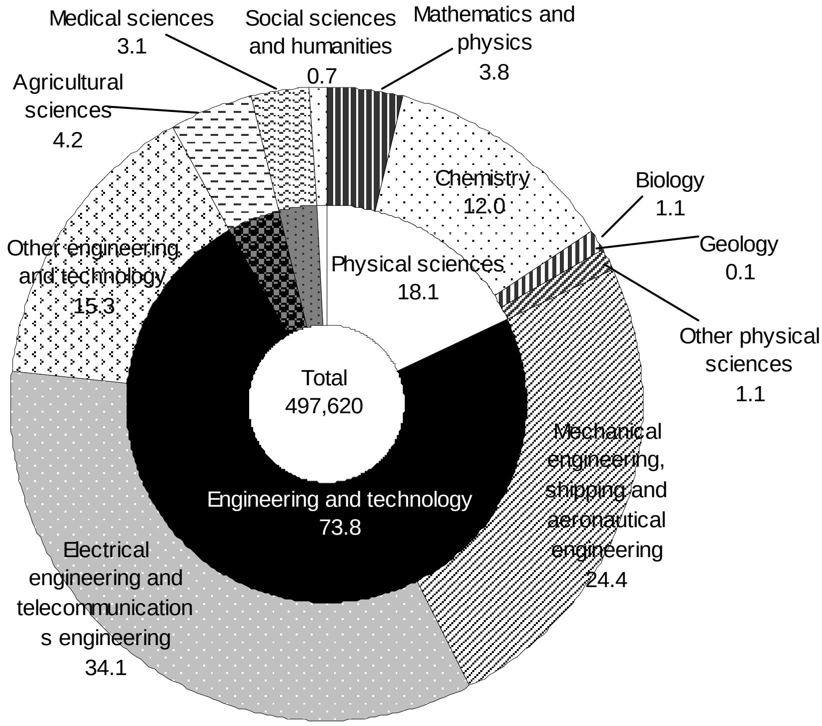


Figure 2-2-8 Composition of number of business enterprises researchers by field of research (2004)

Note: Figures are their shares in percentages to total company researchers.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

(Non-profit Institutions and Public Organizations)

A chronological comparison of the number of researchers is made difficult by the transformation of national experimental research institutions into incorporated administrative agencies, in addition to the revision of the Statistics Bureau's "Survey of Research and Development." However, the number of researchers stands at 10,400 in non-profit institutions and within public organizations, at 3,200 in national institutions, 14,000 in local government-owned institutions, and 16,500 in public corporations and incorporated administrative agencies (Figure 2-2-9).

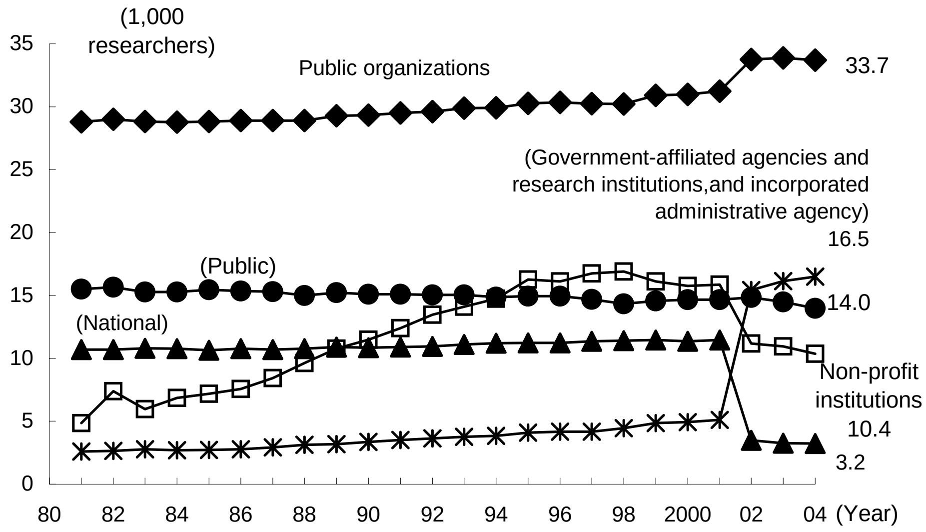


Figure 2-2-9 Trends in the numbers of researchers in non-profit organizations and public institutions

Notes: 1. Numbers include researchers in the humanities and social sciences and are as of March 31 of each year, ecept up to 2003, which is as of April 1.
2. Survey coverage categories were changed in FY2002; numbers up to FY2001 for non-profit institutions use the values of private research institutions.
3. Values up to FY2001 are for researchers whose primary duty is research.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (8))

When looking at sector composition, a disproportionately large share of researchers was seen in engineering at non-profit institutions and among public organizations, in health and engineering at national institutions, in agricultural sciences at local government-owned institutions, and in engineering and the physical sciences at public corporations and incorporated administrative agencies (Figure 2-2-10).

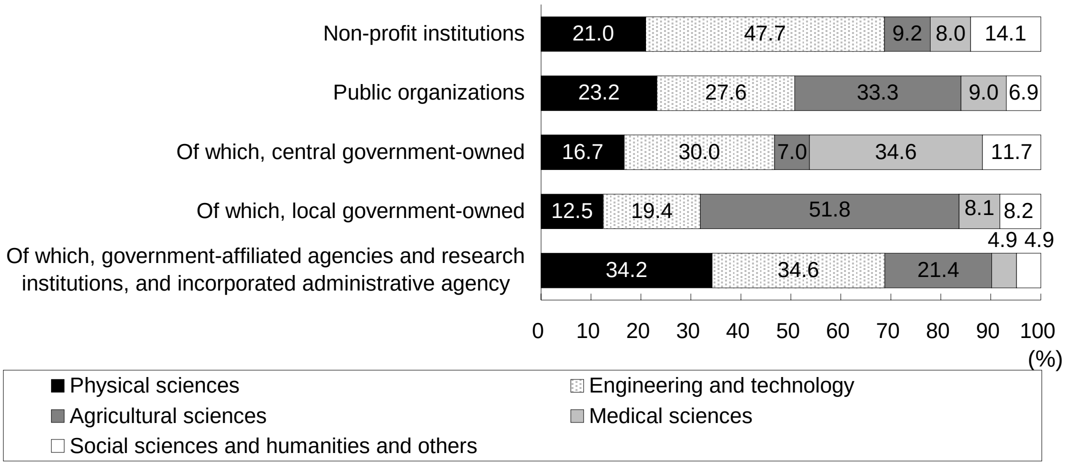


Figure 2-2-10 Composition of researchers in non-profit institutions and public organizations by organization and field (2003)

Note: The number of researchers is as of March 31, 2004.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

(Universities and Colleges)

The number of researchers at universities and colleges, including those in the humanities and social sciences, has increased by 1.2% in the last five years (1999-2004, an average annual rate of increase of 0.23%) up to 281,000 researchers from 284,000. Looking at the number of researchers by type of institution in 2004, private universities and colleges have 131,300 researchers, followed by national universities and colleges (131,100), after which comes local public universities and colleges (22,000) (Figure 2-2-11). However, in terms of researchers whose primary role is research, the order becomes national universities (125,000), followed by private universities (118,000), and then local public universities (18,000).

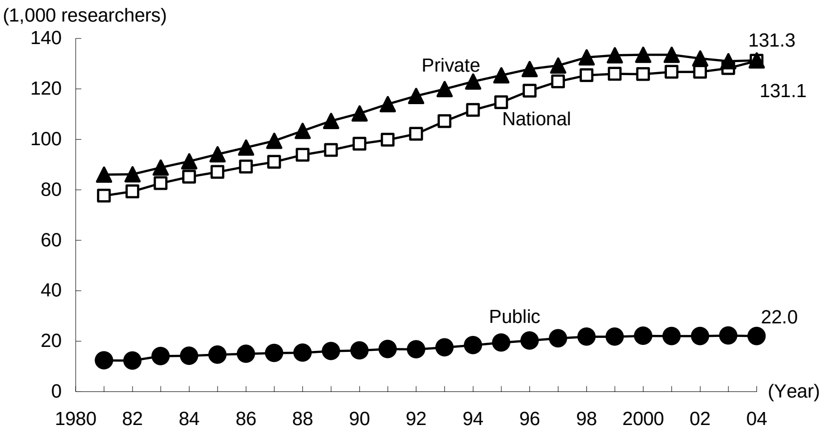


Figure 2-2-11 Trends in numbers of researchers in universities and colleges

Note: Numbers include researchers in the humanities and social sciences and are as March 31 of each year, except up to 2001, which are as April 1.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (8))

Researchers in universities and colleges consist of faculty members, doctoral students, medical staff and others. Looking at the composition of researchers by type of institution, in national universities and colleges, doctoral students make up a large ratio of the researchers, and private universities and colleges have a greater ratio of teachers and medical staffs and a smaller ratio of students for doctoral degrees. The figures for public universities and colleges fall in between those for the national universities and the private universities and colleges (Figure 2-2-12).

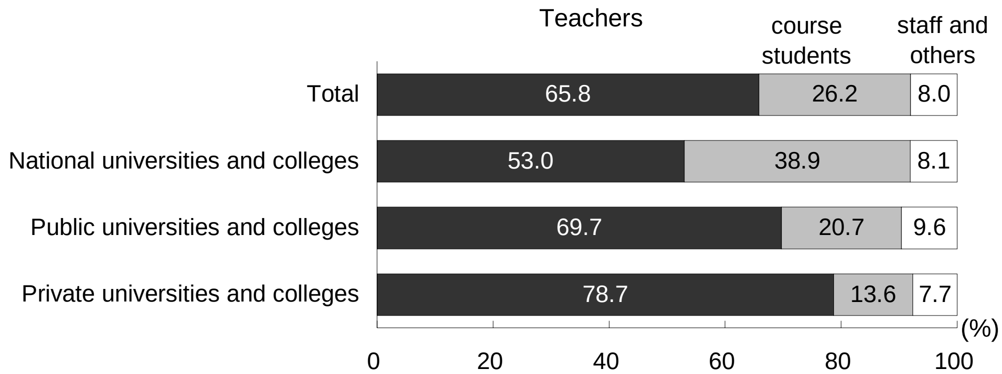


Figure 2-2-12 Composition of researchers in universities and colleges (2004)

Note: Numbers include researchers in the humanities and social sciences as of March 31, 2004.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

By sector composition, a large share of university researchers were health specialists, whether faculty members, doctoral students, or medical staff. Other sectors with relatively high shares of the total were engineering, for teachers, and science, for students in doctorate programs (Figure 2-2-13).

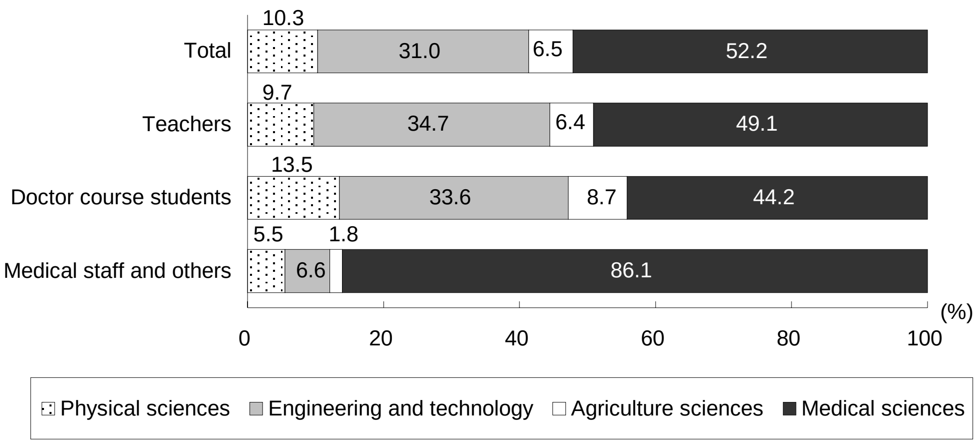


Figure 2-2-13 Share of researchers in the natural sciences at universities and colleges by field (2004)

Note: The numbers of researchers is as of March 31, 2004.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

For the number of researchers by academic field in the most recent five-year period (1999-2004), balanced annual growth rates are seen in the engineering (at 2.17%), and agriculture science (at 1.18%), and, while the physical sciences and health sciences registered a decline of an average annual rate of 0,26% and 1.14% respectively (Figure 2-2-14). Looking at specific sectors, the electrical and telecommunications sectors (average annual growth rate of 2.69%) and civil engineering and architecture (average annual growth rate of 1.61%) are showing particularly fast increases in the number of researchers (Figure 2-2-15).

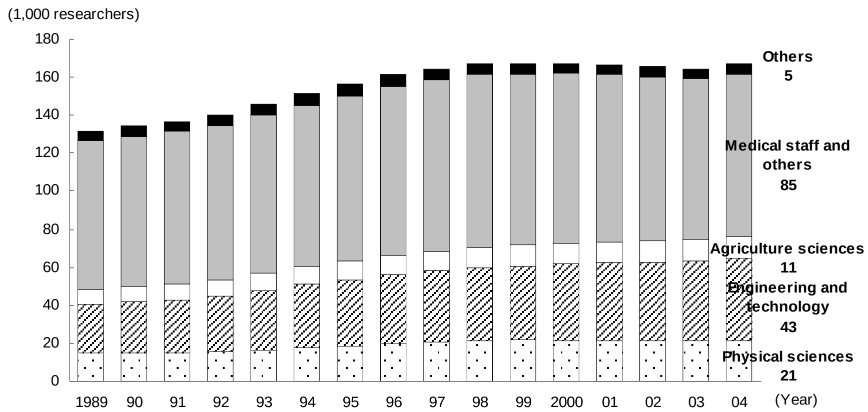


Figure 2-2-14 Trends in the numbers of researchers at universities and colleges by field and specialty

Note: The number of researchers is for the natural sciences only and is as of March 31 of each year, except up to 2001,which are as of April 1.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

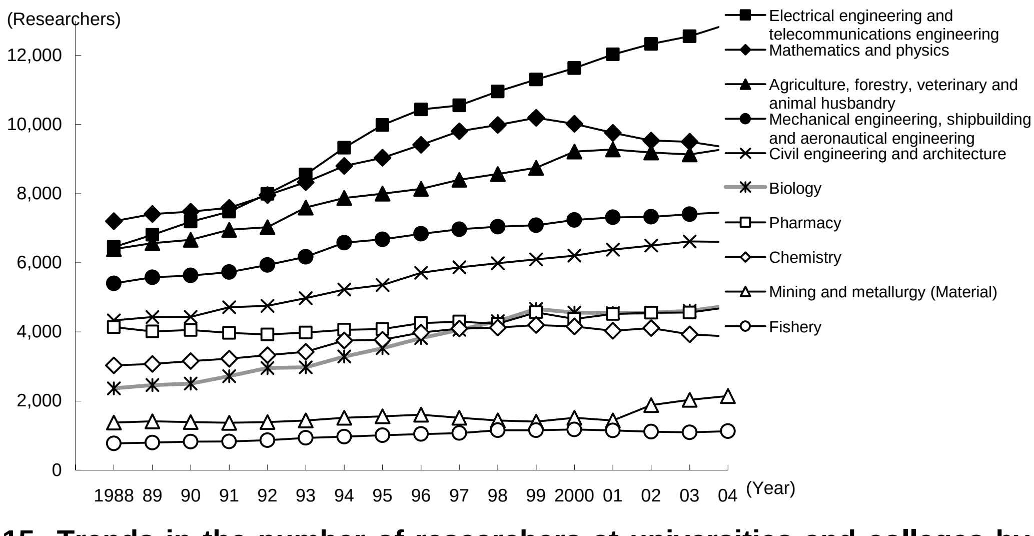


Figure 2-2-15 Trends in the number of researchers at universities and colleges by detaild filed and specialty

Notes: 1. The number of researchers is for the natural sciences only and is as of March 31 of each year, except up to 2001, which are as of April 1.
2. “Mining and metallurgy” was changed in 2002 to “materials,” to which was added materials engineering, raw materials engineering, and materials process engineering, etc.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

(Women Researchers)

Women researchers, including those in the humanities and social sciences, have steadily incre- ased year by year, reaching 96,000 in 2004, representing about 11.6% of the total number of rese- archers (Figure 2-2-16). But looking at all workers, 26.16 million women employees accounted for 41.3% of the total of 63.29 million employees in Japan in 2004, according to the "Labor Survey of the Ministry of Internal Affairs and Communications." It is clear that the ratio of women engaged in the R&D field remains lower than that of women in the labor market in general. The proportion of women researchers by type of organization was 6.6% at companies, etc., 10.7% at non-profit institutions, 11.7% at public organizations, and 20.4% at universities and colleges, clearly demonstrating that universities and colleges provide women researchers more opportunities than elsewhere.

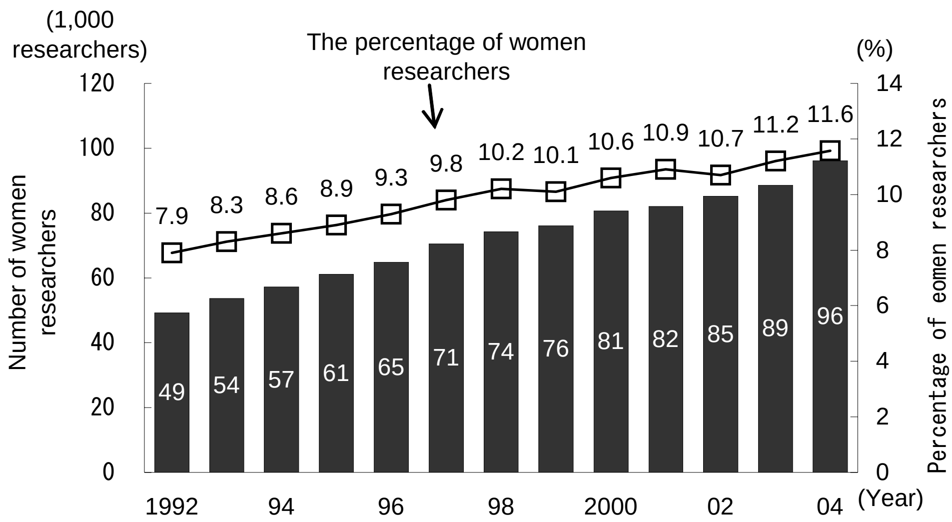


Figure 2-2-16 The percentage of all researchers that are women

Note: Numbers include researchers in the humanities and social sciences and are as of March31 of each year, except up to 2001, which are as of April 1.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.2.2 Personnel Engaged in R&D

The definition of personnel engaged in R&D, which includes both regular researchers and rese-arch support staff, varies in scope from one country to the next, so that simple comparisons are probably untenable. Nevertheless, in just such a comparison with the selected countries of Europe, Japan had the largest number of personnel engaged in R&D at 994,000, followed in order by Germany, France, and the United Kingdom. Japan has relatively low numbers of personnel who are engaged in R&D but are not researchers themselves, with 0.26 research support staff for ea- ch researcher, a figure that is one-third the standard for European nations (Figure 2-2-17). The number of research and development-related workers in Japan showed a year-on-year decline in 2000, and a 3.5% decline in the most recent five-year period (1999-2004). The downward trend in the number of research assistants was strengthened in the same five-year period, declining by 24.1%, an annual average of -5.4% (Figure 2-2-18).

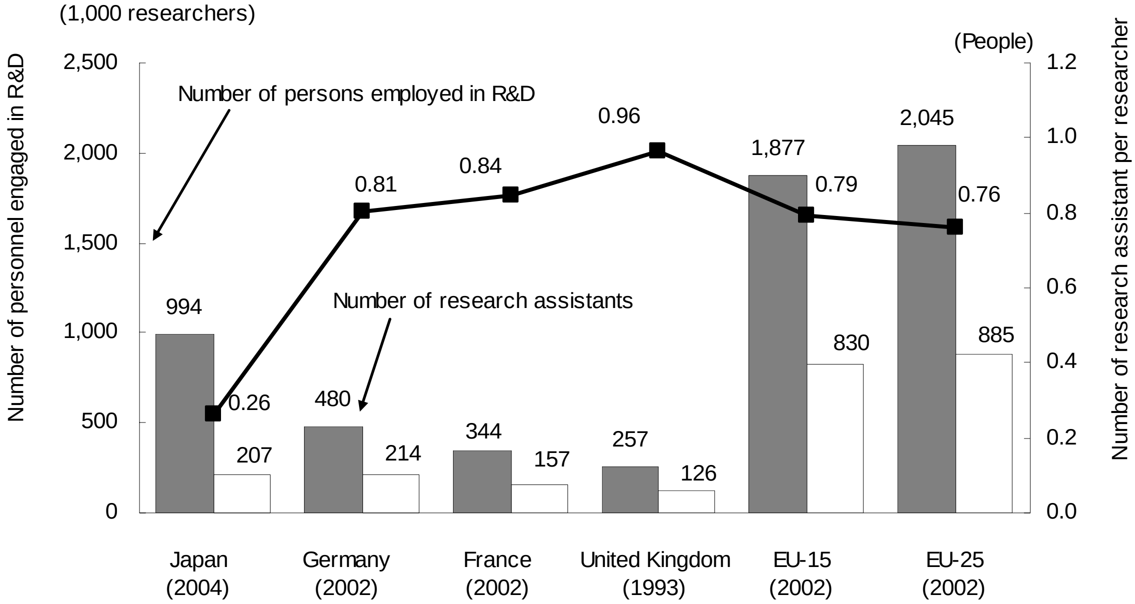
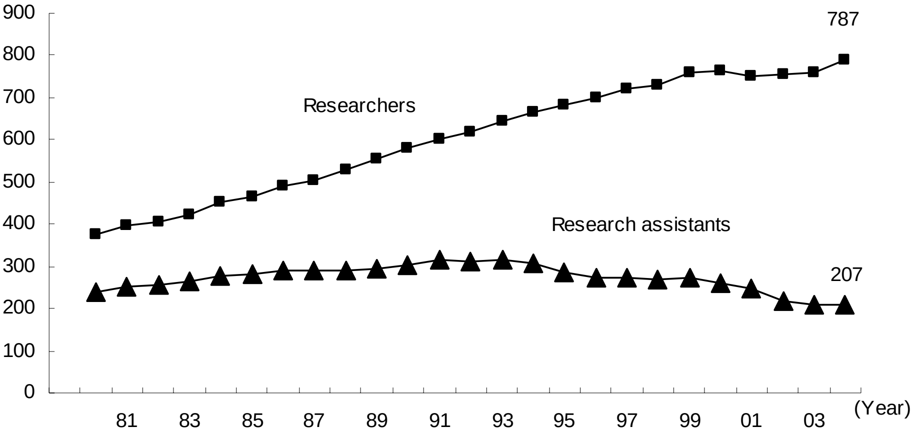


Figure 2-2-17 Number of research assistants per researcher in selected countries

Notes: 1. For comparison, figures for all countries include social sciences and humanities.
2. Figures for EU-15 and EU-25 are OECD estimates.
3. Research assistants refers to people who assist researchers, people who provide technical services that add value to research, and people employed in research administration, which in Japan is referred to as assistant research workers, technicians, and clerical and other supporting personnel.

Source: Japan - Statistics Bureau. "Report on the Survey of Research and Development"
Others - OECD. "Main Science and Technology Indicators"



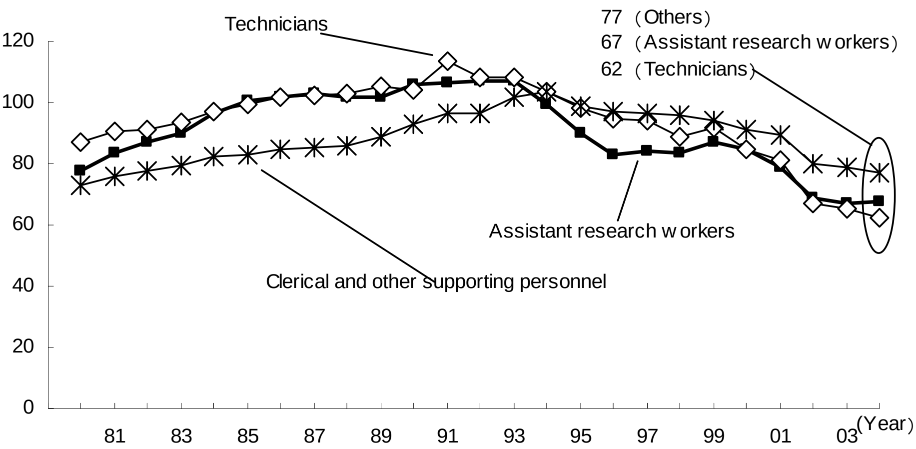


Figure 2-2-18 Trends in persons engaged in R&D in Japan

Note: Numbers include personnel in the humanities and social sciences and are as of March 31 of each year, except up to 2001, which are as of April 1.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (7))

The percentage of researchers of all personnel engaged in R&D has increased from 73.5% in 1999 to 79.2% in 2004. On the other hand, the share of assistant research workers decreased from 8.4% to 6.8%. The percentage of technicians decreased from 8.9% to 6.3%. Clerical and other supporting personnel have decreased from 9.1% to 7.8% (Figure 2-2-18). In this way, the number of research assistants per researcher continues to decrease. However, promotion of the Science and Technology Basic Plan has curbed the downward trend at public institutions and universities and colleges (Figure 2-2-19).

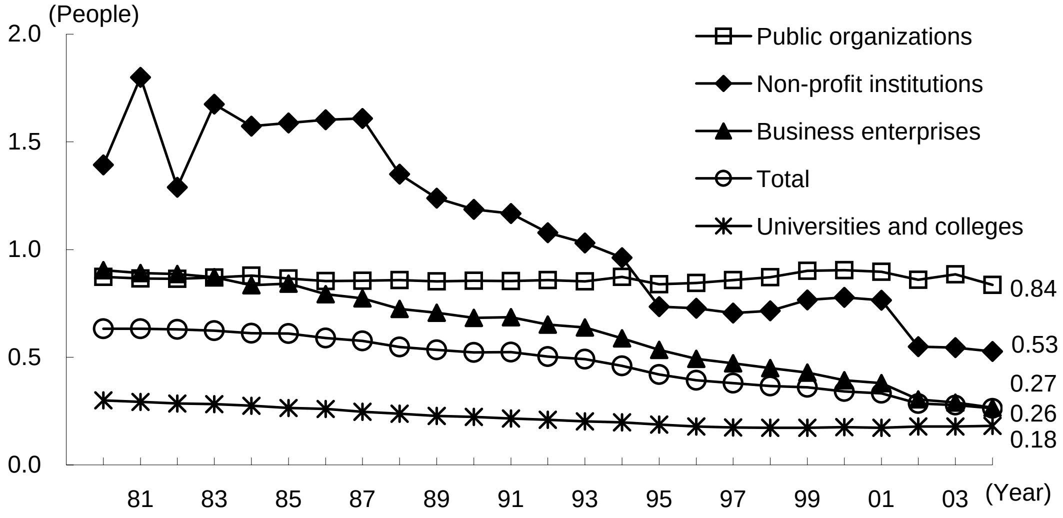


Figure 2-2-19 Trend in the numbers of research assistants per researcher in Japan

Notes: 1. The numbers of researcher and research assistants include those in the humanities and social sciences and are as of March 31 of each year, except prior for 2001, which are as of April 1.
2. Survey categories were changed in 2002; numbers up to 2001 are for researchers at the following organizations:

Up to 2001	After 2002
Companies	Business enterprises
institutions	Non-profit institutions
Government research institutions	Public organizations
Universities and colleges	Universities and colleges

Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (7))

The composition by organization of the number of personnel engaged in R&D in Japan reveals that all universities and colleges, including both public and private schools, have the lowest number of research support staff per researcher (Figure 2-2-20).

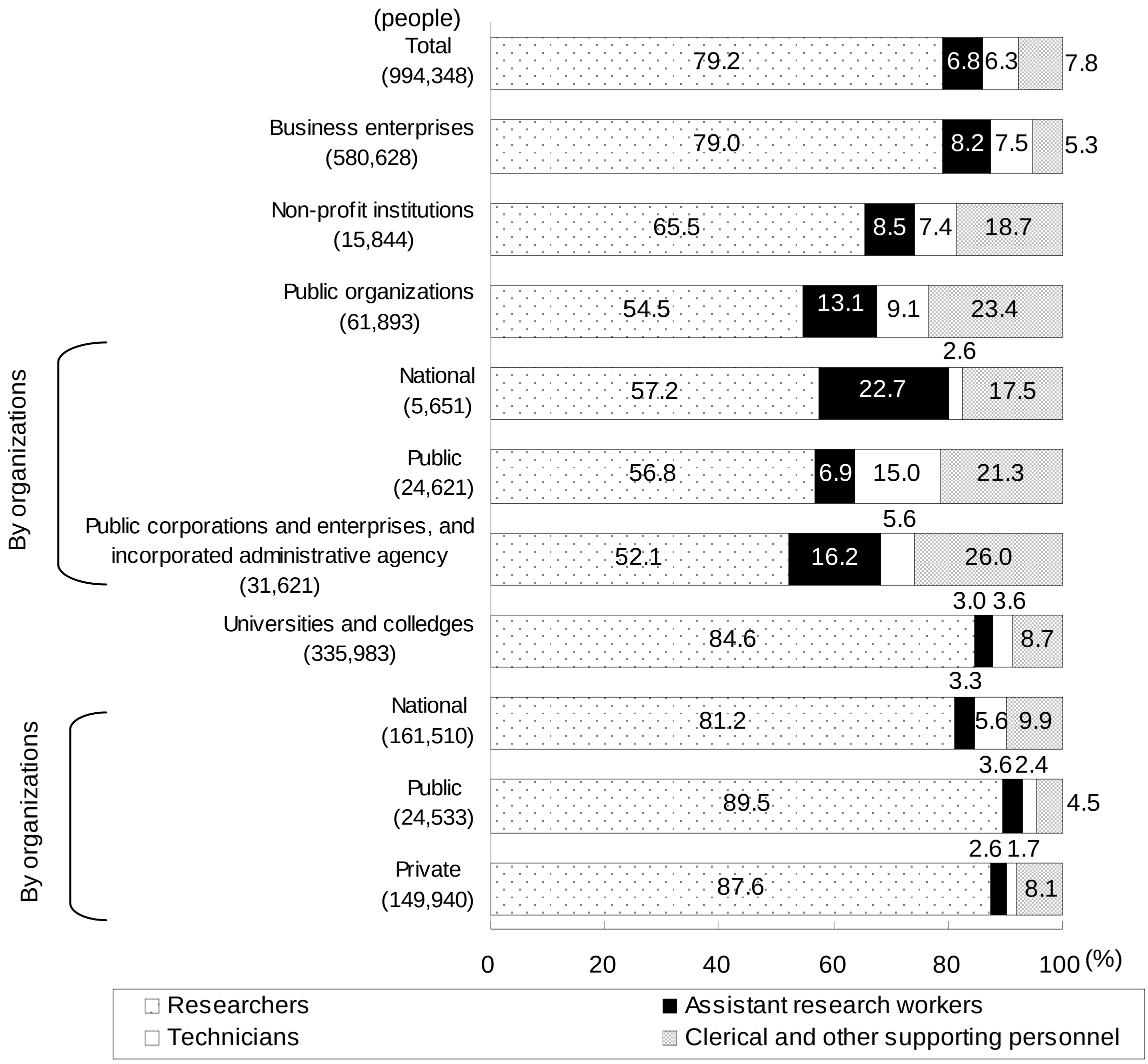


Figure 2-2-20 Composition of personnel engaged in R&D by sector in Japan (2004)

Note: Numbers for all personnel engaged in R&D include those in the humanities and social sciences and are as of March 31, 2004.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.2.3 Production and Employment of Research Personnel

2.2.3.1 Overall Degree Trends

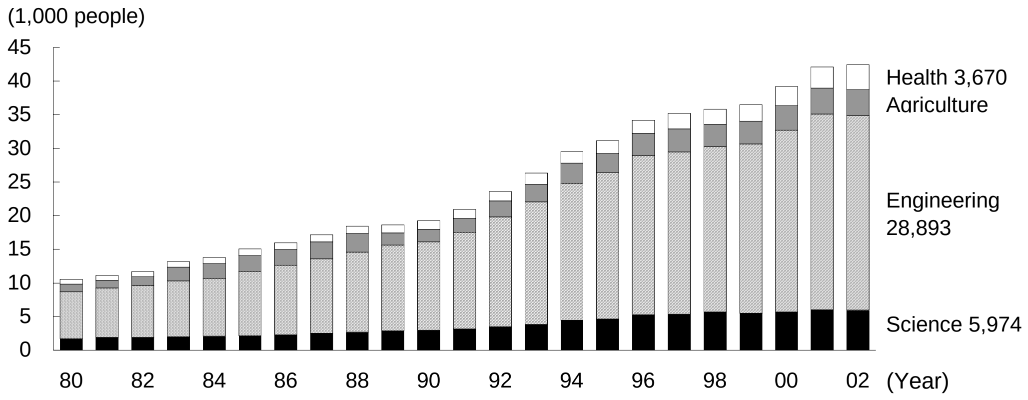
The number of people acquiring a master's degree or doctoral degree in the natural sciences in Japan has been rising alongside an expansion of graduate schools. While the number of doctorates decreased in 1999, those conferred in 2000 exceeded those conferred in 1998. During the five-year period from 1997 to 2002, the number of master's degrees conferred rose by 1.11 times (average annual growth rate of 2.1%), and the number of doctorates by 1.11 times (average annual growth rate of 2.2%). Looking at degrees by major for 2002, the engineering field accounted for the largest number of new master's degree holders at 28,893, while the largest number of new Ph.D.s was in the health science field at 6,853 (Figure 2-2-21).

Master's and doctoral degrees differ from country to country due to differences in culture and educational systems. Social factors such as industrial structure and numbers of students can affect the number of awarded degrees. Thus, it is difficult to compare the data at face value. It is useful, however, to compare trends, and this section describes the degree trends in the natural sciences and engineering in selected countries.

The United States awards the largest number of degrees, a little over three times as many as does Japan. Compared to 1980, the ratio of engineering and health science degrees to total degrees has increased. Japan is second in number of degrees awarded, following the U.S., and has a higher ratio in engineering. The United Kingdom, Germany and France follow in the order named. Of these countries, Germany has a higher ratio in the physical science and health science fields, and the U.K. is higher in physical science and engineering. Also, if we look at doctorates only, the number in physical science fields in Japan is quite a bit lower than in other selected countries (Figure 2-2-22).

The number of graduate school students as a proportion of all university students is also lowest in Japan among selected countries (Figure 2-2-23).

(1) Master's degree



(2) Doctorates

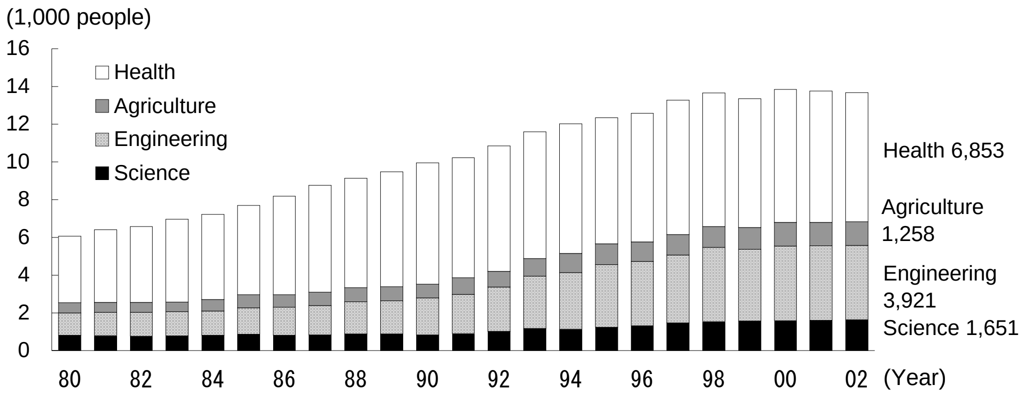
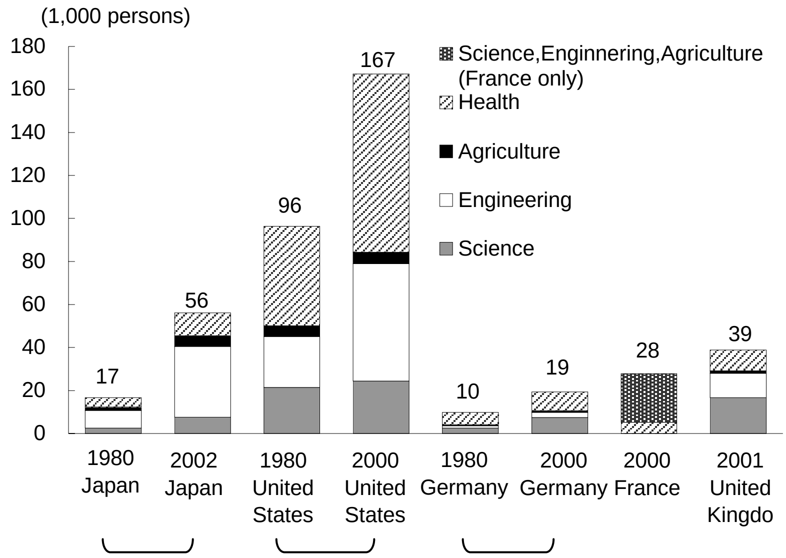


Figure 2-2-21 Degree trends in Japan (natural science)

Note: The figures are awarded degrees in FY2002.
Source: MEXT. "Statistical Abstract of Education, Science and Culture 2005."

(1) Total (awarded at graduate schools)



(2) Doctorates

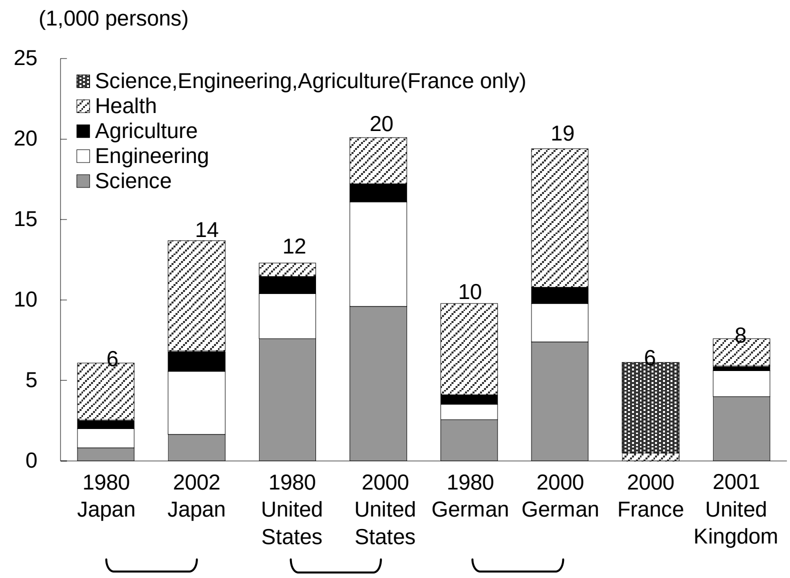


Figure 2-2-22 Number of awarded degrees in selected countries (natural science)

Notes: 1. Totals include master's and doctoral degrees (Germany: only doctorates). U.S. health sciences include first-professional degrees.
2. 1980 data for Germany are for the former West Germany.
3. France does not distinguish between physical sciences, engineering, and agricultural sciences.

Source: MEXT. "International Comparison of Education Indexes 2003, 2005."

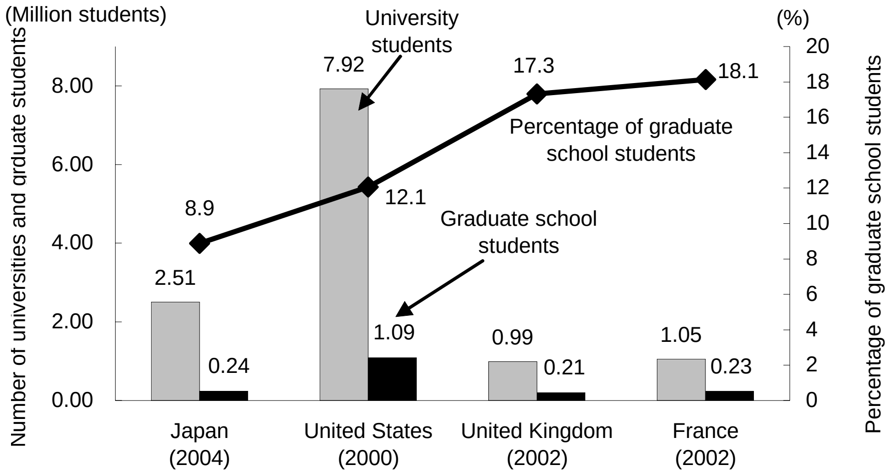


Figure 2-2-23 Number of graduate and university students, and percentage of graduate school students in selected countries

Note: Numbers for the United States and the United Kingdom are for fulltime students.
Source: MEXT. "International Comparison of Education Indexes 2004"

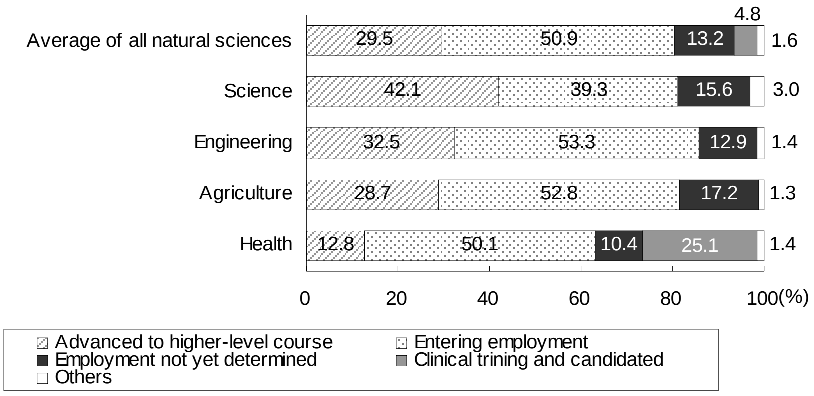
2.2.3.2 Employment of Research Personnel

In order to enable the utilization of the skills of research personnel who have received a university and/or graduate school education, it is important that they be ensured an easy transition into industry or research institutions, etc. following graduation.

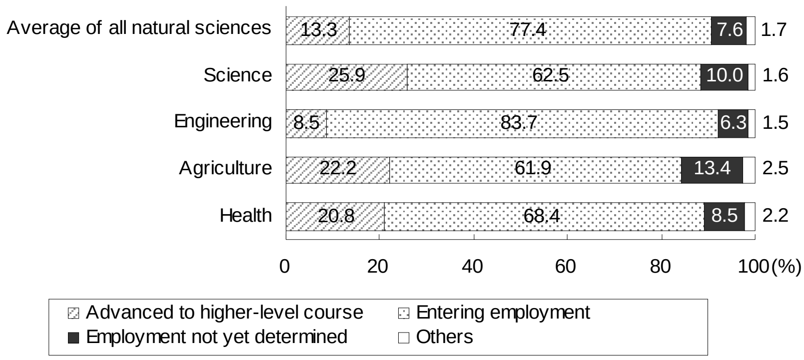
Here, we shall look at the employment situation for Japan's research personnel from the viewpoint of careers chosen by people in the natural sciences after graduating from university, or after completing master's or doctoral courses. At the university graduate stage, 42.1% of science specialists continue on to graduate work, a proportion that is higher than other specialties. After completing master's degrees, the proportion of engineering specialists who continue on with education drops (to 8.5%), with the vast majority (83.7%) turning to employment. After completing doctoral courses, a large proportion (about 30%) of people in physical science and agricultural science fields do not have definite plans for the time after receiving their doctorates (Figure 2-2-24).

If we look at a number of industries to examine their characteristics in terms of which field of the natural sciences their employees tend to come from, manufacturing industries such as the electrical machinery and tools industry, and the transport machinery and tools industry, consist almost entirely of engineering specialists. By contrast, other manufacturing industries, such as the chemicals industry, take people broadly from all four fields: the physical sciences, engineering, agricultural sciences, and health sciences. In addition, while the electrical machinery, tools manufacturing and other manufacturing industries have a high proportion of personnel who have completed master's courses, they also have an exceptionally low proportion of people who have completed doctoral courses (Figure 2-2-25).

(1) Upon university graduation



(2) Upon completion of master's degree



(3) Upon completion of doctor's degree

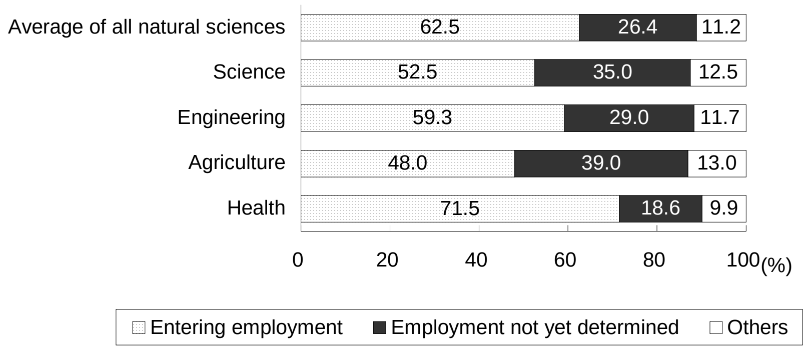
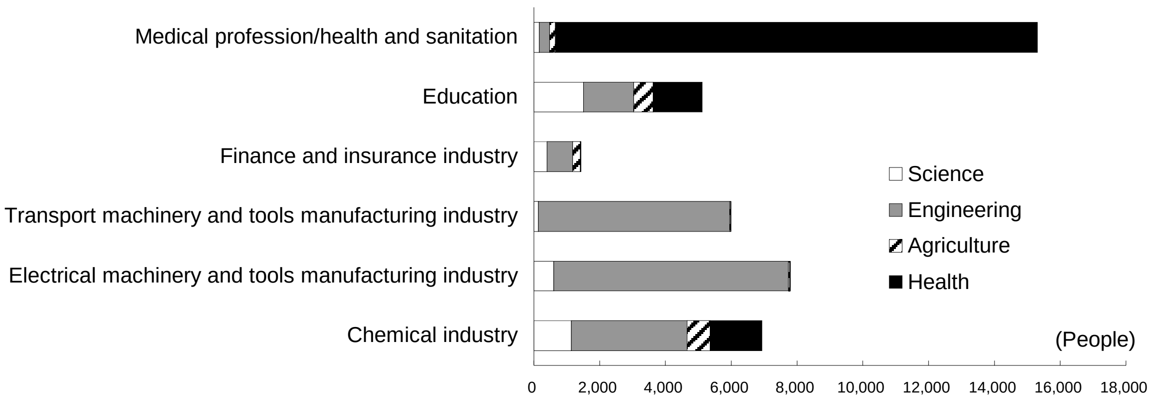


Figure 2-2-24 Trends in career choice, by university degree level (March 2004)

Notes: 1. "Average of all natural sciences" is the average value of science, engineering, agricultural, and health.
2. "Employment not yet determined" refers to people who are employed in a temporary work, engaged in housework, are not still at school working as a researcher, have not entered a technical school or other type of school, a school in a foreign country, or an employment skills development facility, etc., or are clearly neither engaged in any employment nor enrolled in advanced education.
3. "Others" for those who are university graduation and have completed a master's degree refers to people who are deceased or unidentified.
4. "Other" for those who have completed a doctor's degree refers to people who have advanced to higher-level course, are engaged in clinical training to be a physician, or who are deceased or unidentified.

Source: MEXT. "Basic Survey Report on Schools 2004."

(1) By academic field



(2) By academic degree

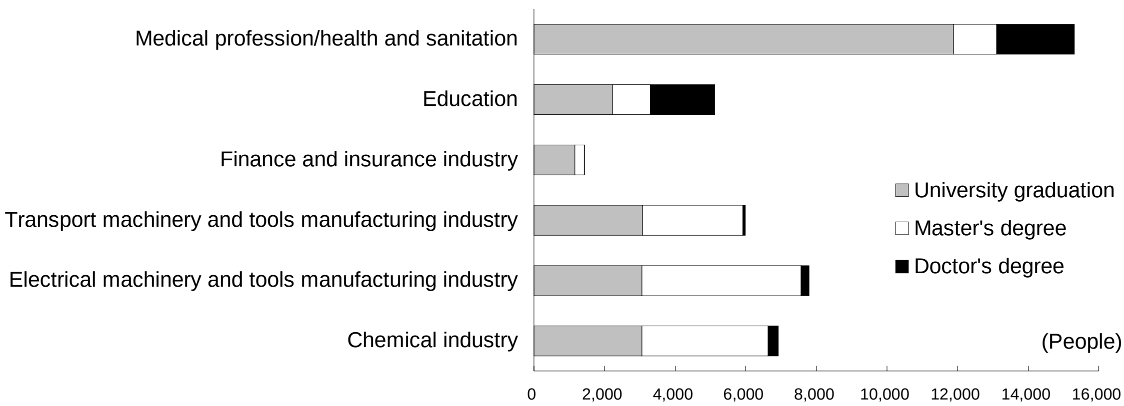


Figure 2-2-25 Employment situation in major industries, by academic field and by degree (March 2004)

Source: MEXT. "Basic Survey Report on Schools 2004"

2.3 Trends Related to Research Performance

The data on numbers of scientific papers, numbers of patents applied for and granted, technology trade balances, and high-tech product trade balances, which indicate the results of R&D activities in science and technology, reflect a nation's activity and level and strength of R&D activities. These statistics are considered to be significant indicators demonstrating levels of R&D and technological strength.

This chapter describes these trends in Japan and selected countries.

2.3.1 Scientific Papers

Scientific papers are the results of R&D. It is impossible to make a simple comparison between scientific papers because of the language normally used by the researchers and the language they are written in, etc. However, here is a comparison of the number of scientific papers and the number of citations on the basis of the database[18] compiled by the Thomson Scientific.

2.3.1.1 Trends in the Number of Scientific Papers, and Number of Citations, in Selected Countries

Of the scientific papers published in major scientific journals around the world between 1981 and 2003, Japan's share of scientific papers and citations was as shown in Figure 2-3-1. Japan's share of scientific papers in 1981 was fourth in the world, after the United States, the United Kingdom, and Germany. However, ever since Japan surpassed the United Kingdom in 1992 to obtain the No.2 ranking, Japan has maintained its position at No.2.

Moreover, since excellent papers tend to attract large numbers of citations in other papers, the number of citations can be viewed as one indicator of a paper's quality. A look at the number of citations of papers authored by Japanese researchers through the year 2000 by year of publication reveals that Japan's share of total citations has tended to rise over time. Nevertheless, Japan has ranked after the United States, the United Kingdom, and Germany in the number of citations ever since 1989, and the ratio to total citations remains much lower than the share of the total number of scientific papers published (Figure 2-3-1).

18 Thomson Scientific's database: About 8,700 journals are listed in the Web of Science database (original data of the National Science Indicators), of which about 5,900 are natural science journals, about 1,700 are social science journals, and about 1,100 are arts and humanities journals. The selection standards for the listing of journals are determined according to the following criteria: (1) International editorial conventions, (2) Timeliness of publication, (3) Article title, abstract, and keywords, at the very least, noted in English and (4) Quality sufficiently maintained through the use of peer review or complete implementation of citations.

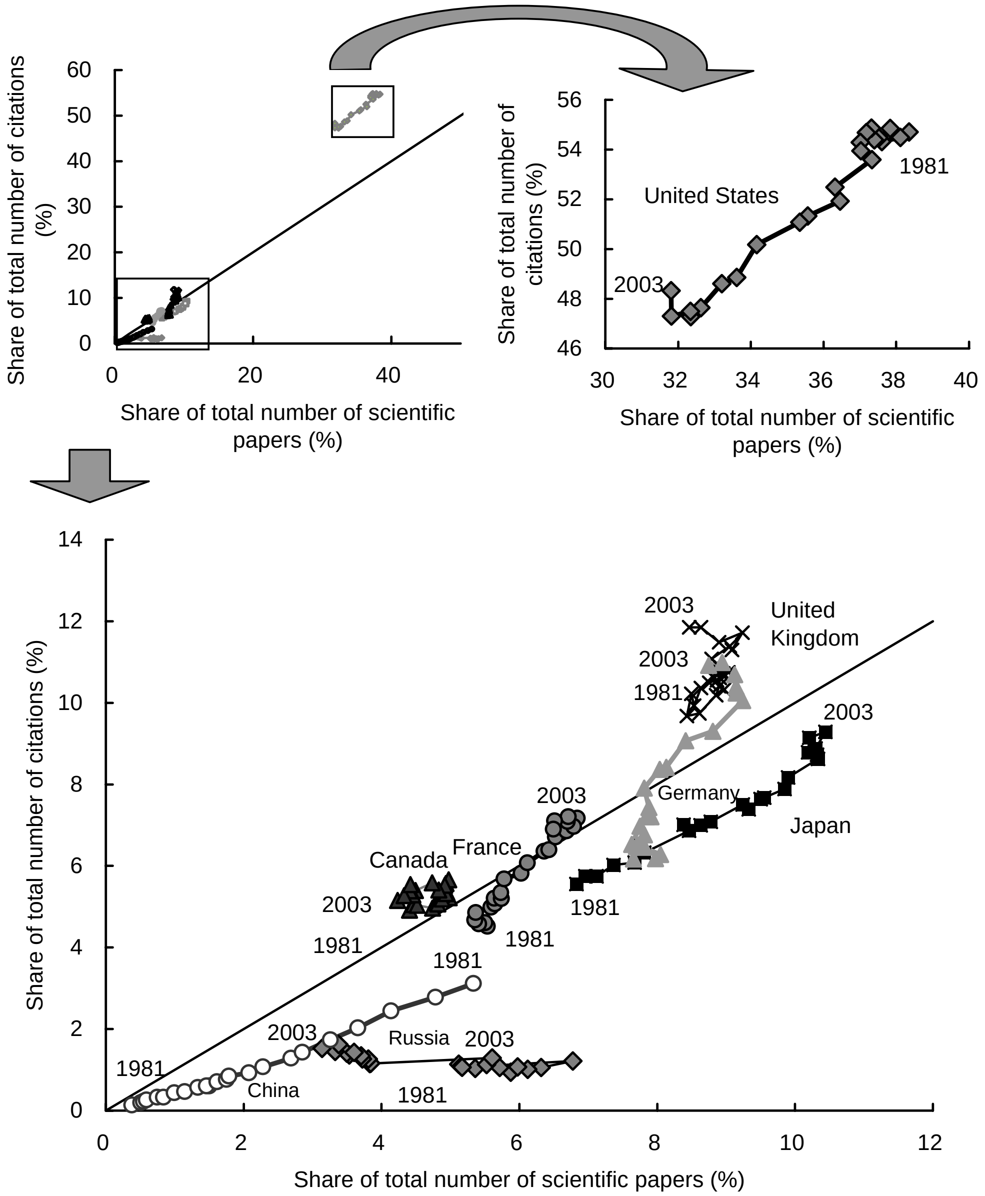


Figure 2-3-1 Relationship between the world total for scientific papers and for citations in scientific papers

Notes: 1. The figures for Russia include those for the Soviet Union.
2. The figures for Germany include those for the former East Germany.
Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (Thomson Scientific)

2.3.1.2 Relative citation impact for scientific papers in selected countries

The Relative Citation Impact (RCI) shows the number of citations per scientific paper from Japan divided by the number of citations per scientific paper for the world as a whole. Japan's RCI value is less than 1.0, putting it in a position relatively lower than other major selected countries. Where the RCI for Japan and the United States has stayed relatively stable since 1981, it has risen in the other major countries, with particularly strong increases seen in recent years for the United Kingdom, Canada, and Germany (Figure 2-3-2).

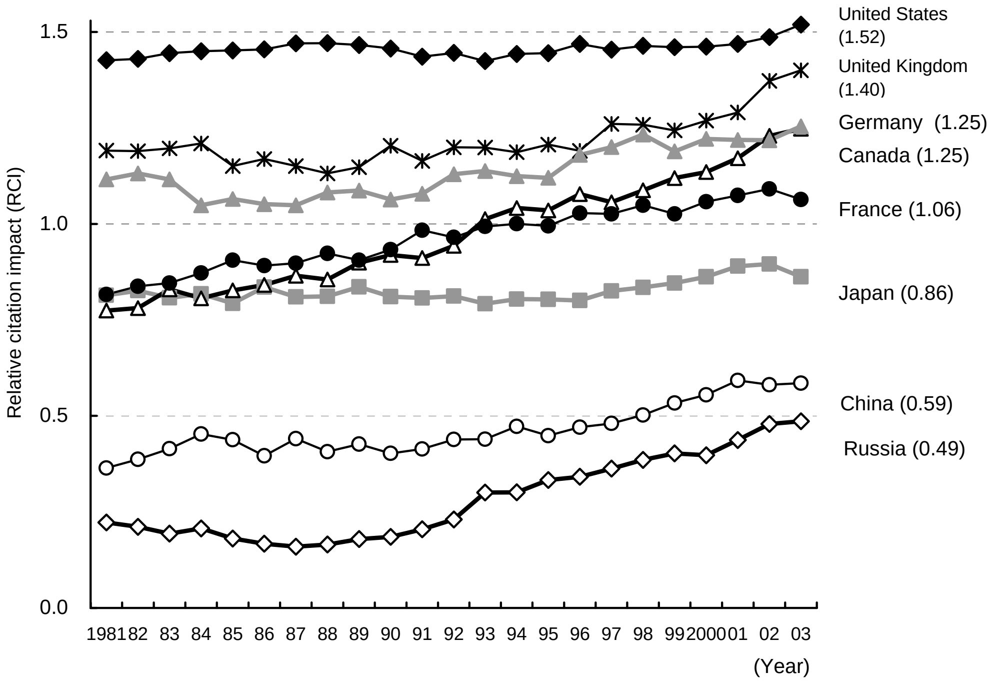


Figure 2-3-2 Trends in the relative citation impact for scientific papers in selected countries

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (Thomson Scientific)

For Japan's RCI by field, excepting materials science, no sector exceeds 1.0, and the results are generally low across fields (Table 2-3-3).

Table 2-3-3 Relative citation impact in Japan, by field

Rank	Research field	Relative citation
1	Material science	1.04
2	Immunology	1.00
3	Chemistry	0.98
4	Physics	0.96
5	Plant and animal science	0.94
6	Space science	0.94
7	Engineering	0.91
8	Agricultural science	0.88
9	Geosciences	0.88
10	Biology and biochemistry	0.87
11	Molecular biology and genetics	0.84
12	Clinical medicine	0.80
13	Mathematics	0.78
14	Pharmacology	0.75
15	Ecology / environment	0.73
16	Neuroscience and behavior	0.73
17	Microbiology	0.72
18	Computer science	0.52

Note: Data is for 1999-2003

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (Thomson Scientific)

2.3.1.3 Trends in the Number of Scientific Papers in Selected Countries, by Field

The share of scientific papers written in selected countries by fields from 1999 to 2003 is shown in Figure 2-3-4. The life sciences field, which includes papers in the medical sciences, biology, agricultural sciences, and plant and animal science, accounts for the relatively high proportion of as much as 60% of all scientific papers in the United States and the United Kingdom. In Japan, Germany, and France, by contrast, the life sciences field accounted for about 50% of all scientific papers, with the fields of physics and chemistry accounting for a relatively high 30% of their totals.

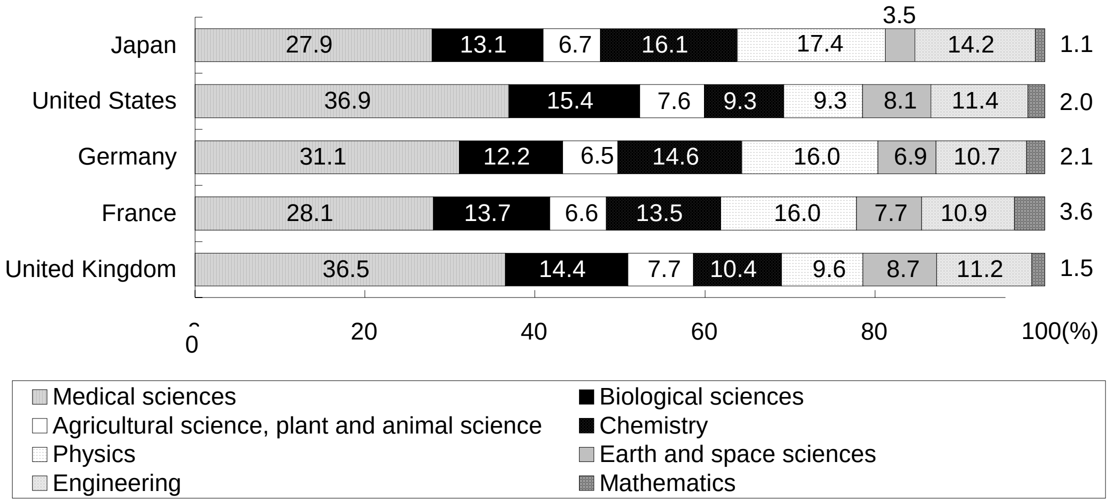


Figure 2-3-4 Number of scientific papers in selected countries, by field

Notes: 1. The composition of each field is as follows. Eighteen fields listed in the Thomson Scientific's National Science Indicators database are here amalgamated into eight fields.

(1) Medical sciences: Clinical medicine, immunology, neuroscience and behavior, and pharmacology
(2) Biological sciences: Biology and biochemistry, microbiology, and molecular biology and genetics
(3) Agricultural sciences, science: Agricultural sciences, plant and animal sciences
(4) Chemistry: Chemistry
(5) Physics: Physics
(6) Earth and space sciences: Space science, ecology/environment, and geosciences
(7) Engineering: Computer science, engineering, and materials science
(8) Mathematics: Mathematics

2. Figures of shares are calculated based on the numbers from 1999 to 2003

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on “National Science Indicators, 1981-2003” (Thomson Scientific)

Figure 2-3-5 shows the share of Japan's scientific papers of all papers written worldwide, by field, for the years 1999 to 2003. Materials science, physics, and pharmacology are above Japan's average for all fields, demonstrating that Japan's research in these areas is relatively flourishing.

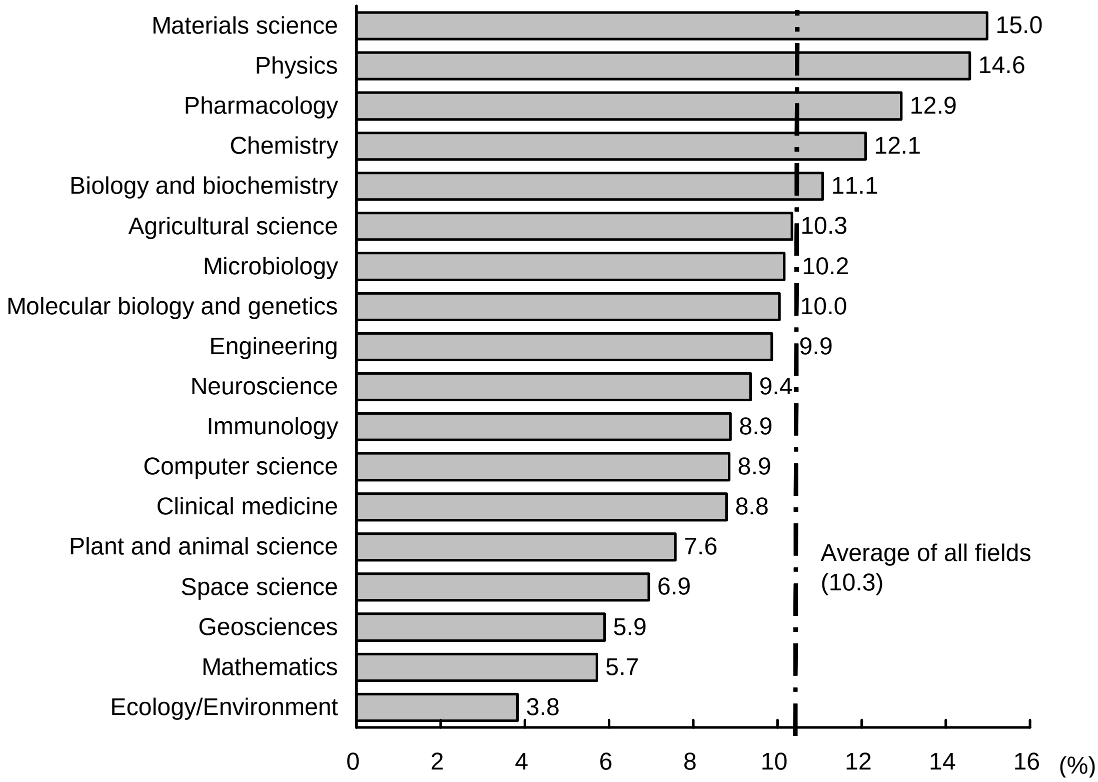


Figure 2-3-5 Japan's share of scientific papers, by field

Notes: 1. Figures are calculated from the aggregate values for 1999-2003.
2. Figures are Japan's share of all scientific papers in the world for each sector.

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (Thomson Scientific)

2.3.1.4 Relative comparative Advantage of Japan's Scientific Papers by Field

Another indicator marking trends in scientific paper production by field is the "Relative Comparative Advantage (RCA)" indicator. This takes the ratio of a country's scientific papers in a certain field to the country's total number of papers, and compares that ratio to the worldwide ratio of field papers to the total number. Figure 2-3-6 shows the trends in RCA for Japan's scientific papers. We can see that the value for chemistry has generally followed a downward trend through the years, while clinical medicine is rising sharply.

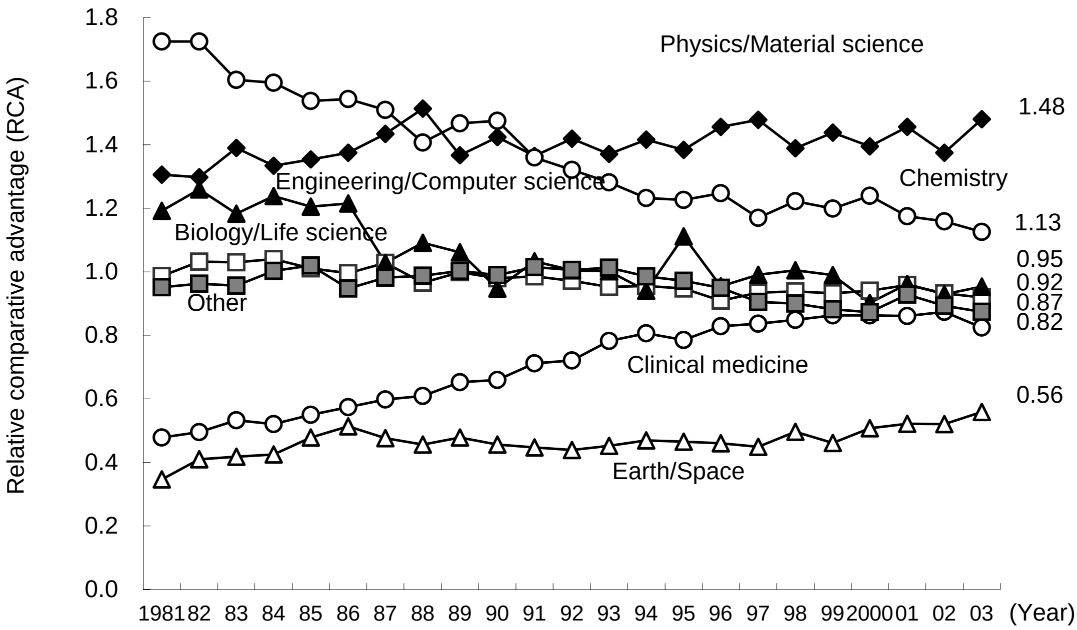


Figure 2-3-6 Trends in relative comparative advantage of scientific papers in Japan, by field

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (Thomson Scientific)

2.3.2 Patents

Generally speaking, countries in which a large number of patents are applied for can be considered countries in which private corporations and other organizations carry out active R&D. Countries with a large number of patent applications in foreign countries can be viewed as taking aggressive strategies for the future establishment of foreign production centers or maintenance of markets. Moreover, countries with many patents granted are more likely to be countries with a large number of effective patents and inventions.

2.3.2.1 Patents in Selected Countries (Trends in Application and Registration)

As for the number of patent applications in major advanced nations (both applications filed domestically and in other countries, with those filed in other countries including patents filed as Patent Cooperation Treaty (PCT) applications[19] and European Patent Convention (EPC) applications[20]) Japan was ranked No.1 in the world through 1989. Since 1992, however, when the United States moved into the top ranking, the order has remained steady with the United States at the top, followed by Japan, Germany, the United Kingdom, and France. In particular, the increase in patent applications in the United States has been remarkably rapid since 1989 (Figure 2-3-7).

Meanwhile, the trend for the number of patents granted is modestly upward for most countries, with Japan and the United States emerging as particularly close rivals in recent years (Figure 2-3-8). There was a spike in Japan's patent grants in the year 1996, due to the introduction in that year of the patent post-grant objection system, which served to shorten the patent filing process.

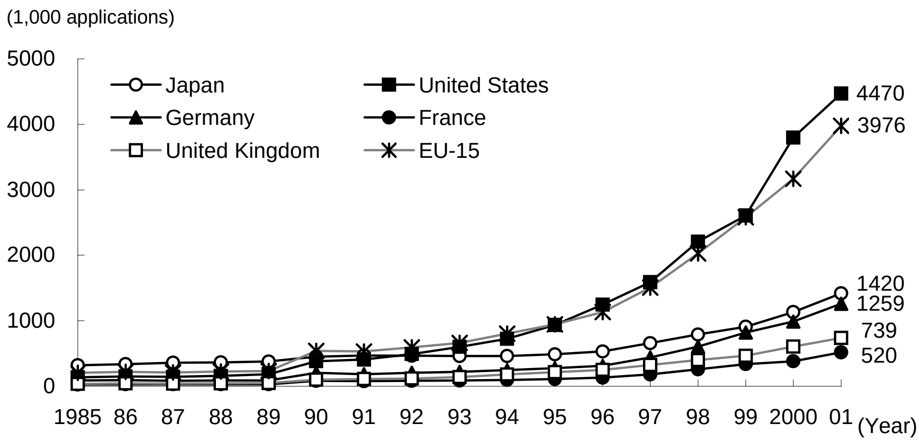


Figure 2-3-7 Trends in the number of patent applications in selected countries

Note: 1. Total number of patent applications made either inside or outside the country according to the patent applicants' nationality.
2. These data include designated countries under the Patent Cooperation Treaty (PCT) and the European Patent Convention (EPC).
3. The EU-15 consists of Belgium, Germany, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland, and Sweden.

Source: Japan Patent Office. "Patent Agency Yearbook", "Japan Patent Office Annual Report"
World Intellectual Property Organization (WIPO). "Industrial Property Statistics"

19 PCT Application: In 1978, the Patent Cooperation Treaty (PCT) went into effect, by which it became possible for the applicant to apply for patents in more than one country (designated countries) at the same time, when he presents one application at one place. The number of PCT member countries is 126 as of February 8, 2005.

20 EPC Application: In 1977, the European Patent Convention (EPC) went into effect, and since June 1978, the European Patent Office (EPO) has been processing EPC applications. When a European patent is granted after an examination by the EPO, the patent has the same validity in the other EPC member countries designated by the applicant. The number of EPC member countries is 30 as of March 22, 2005.

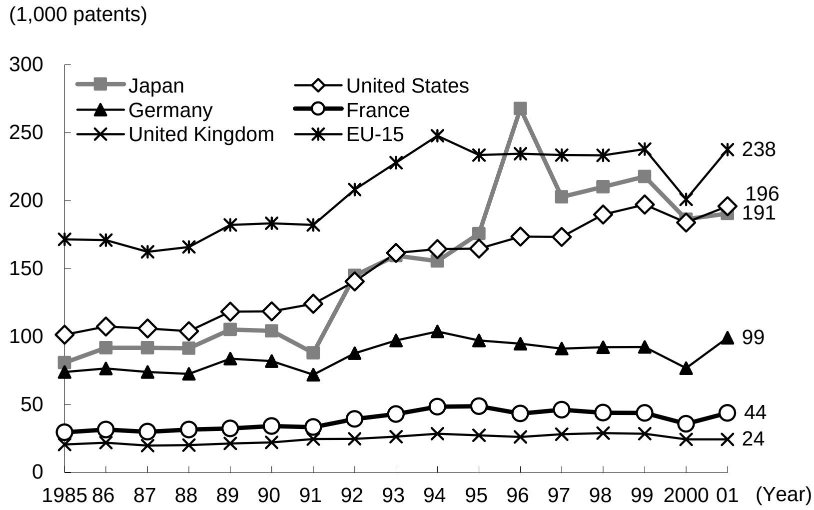


Figure 2-3-8 Trends in the number of patents granted by selected countries

Notes: The total number of patents granted either inside or outside the country according to the nationality of the persons holding the patent rights.
Source: Japan Patent Office. "Patent Agency Yearbook," "Japan Patent Office Annual Report"
WIPO. "Industrial Property Statistics"

In most major countries, the share of patent applications made by their own citizens that are made in other countries, and of patents granted by other countries to their citizens, is fairly high. In Japan, however, this ratio is relatively lower than elsewhere. In addition, the proportion of patent applications by non-Japanese researchers in Japan, and of patents granted to non-Japanese researchers in Japan, is much lower than in other major countries (Table 2-3-9).

Table 2-3-9 Number of patent applications (granted patents) in select countries (2002)

Nationality of applications	Country where patents were applied for							
	Japan	United States	Germany	France	United Kingdom	Other	Total	Applications in foreign countries (%)
Japan	388,390	66,578	32,150	25,140	29,773	904,977	1,447,008	73.2%
	109,375	33,223	7,705	6,464	7,142	26,357	190,266	42.5%
United States	47,750	190,907	85,615	50,485	86,995	4,087,656	4,549,408	95.8%
	6,020	87,606	8,876	8,412	9,968	74,642	195,524	55.2%
Germany	15,035	27,015	80,222	26,964	32,344	1,082,337	1,263,917	93.7%
	1,963	11,260	19,242	8,393	7,808	50,399	99,065	80.6%
France	5,393	9,213	11,744	21,790	11,604	463,029	522,773	95.8%
	785	4,041	2,829	11,010	2,703	22,318	43,686	74.8%
United Kingdom	6,168	11,855	13,479	7,879	34,500	670,239	744,120	95.4%
	479	3,965	1,402	1,375	3,975	13,095	24,291	83.6%
Other	33,885	70,089	69,188	42,864	69,490	—	—	—
	4,364	19,936	3,872	1,457	1,965	—	—	—
Total	496,621	375,657	292,398	175,122	264,706	—	—	—
	122,986	160,031	43,926	37,111	33,561	—	—	—
Percentage of foreign nationalities	21.8%	49.2%	72.6%	87.6%	87.0%	—	—	
	11.1%	45.3%	56.2%	70.3%	88.2%	—	—	

Notes: 1. Numbers in the upper row refer to patent applications, while number in the lower row refer to granted patents.
2. These data include designated countries under the Patent Cooperation Treaty (PCT) and the European Patent Convention (EPC).
Source: WIPO. "Industrial Property Statistics"

2.3.2.2 Japanese Patent Applications and Patents Granted in Foreign Countries

The United States holds the highest share of patent applications from Japanese applicants to foreign countries, while Europe holds the highest share of the different regions in the world (Figure 2-3-10 (1)).In the same way, the United States accounted for the largest share of patents granted to Japanese re- searchers in foreign countries, followed in order by Germany, the United Kingdom, South Korea, and France. Patents granted overseas tended to be concentrated in the major advanced nations (Figure 2-3-10(2)).

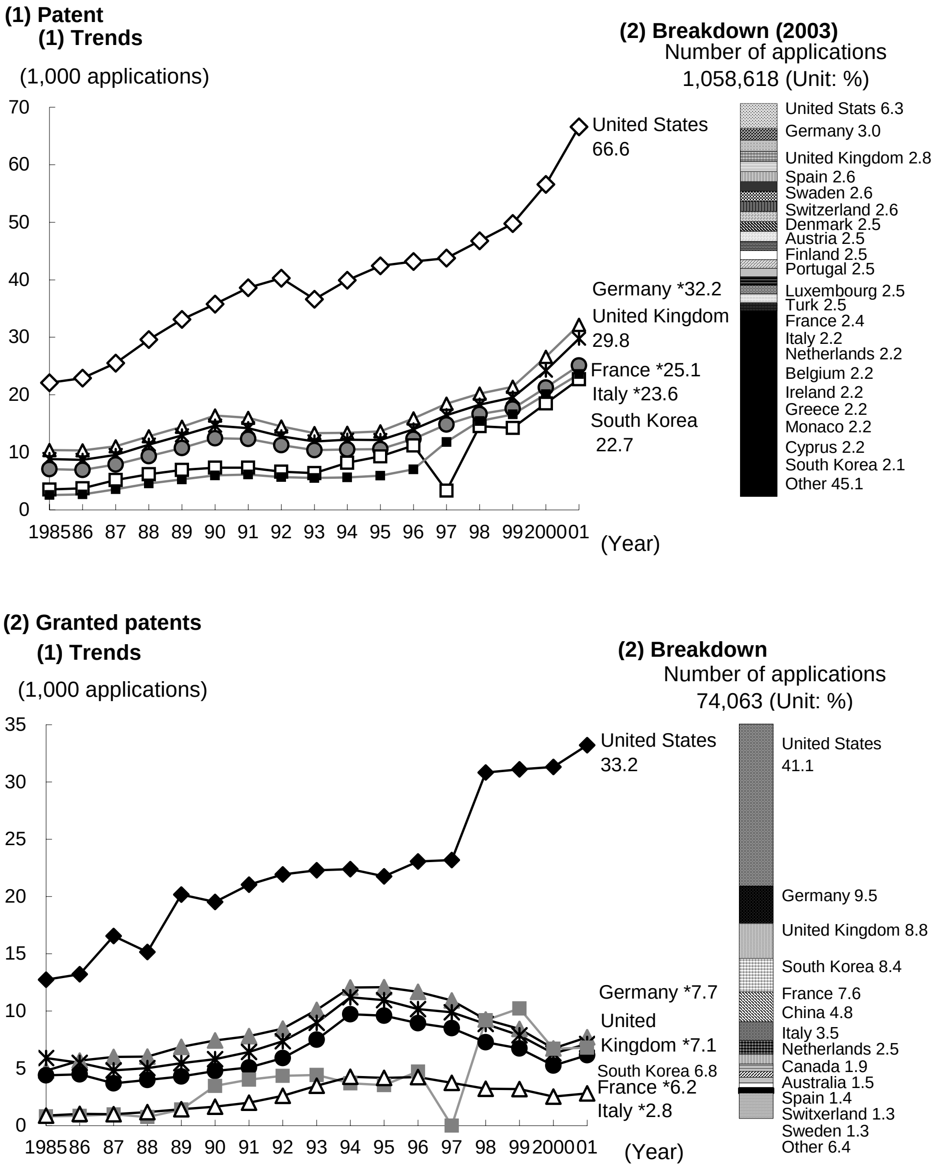


Figure 2-3-10 Number of patent applications and granted patents by Japanese researchers in foreign countries

Notes: 1. These data include designated countries under the PCT and the EPC.
2. "*" indicates EPC member countries.
Source: WIPO. "Industrial Property Statistics"

For the share of patent applications and patents granted held by Japanese in major countries, the numbers in South Korea were fairly high for some years but have recently been declining. The United States registered the highest proportion of Japanese patent applications and patents granted (Table 2-3-11).

Table 2-3-11 Changes in the ratio of Japanese researchers making applications and being granted patents in selected countries

Country \ Year	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
United States	18.9	20.3	21.8	21.5	19.1	19.0	18.0	19.3	18.5	17.8	16.9	17.1	17.7
	17.8	21.6	21.8	22.5	22.7	22.0	21.5	21.0	20.7	20.9	20.3	19.9	20.0
Germany	12.5	14.9	14.7	12.6	11.3	10.5	10.0	10.3	10.5	10.0	9.7	10.1	11.0
	14.4	17.4	18.1	18.2	19.4	20.9	21.4	21.1	19.9	17.9	17.1	16.2	16.0
France	12.6	15.2	15.6	13.7	12.7	12.2	11.8	12.6	13.2	12.8	12.7	13.3	14.4
	11.7	13.6	14.3	15.5	16.9	17.7	17.2	18.2	16.9	15.8	15.2	14.5	15.1
United Kingdom	12.6	15.0	14.9	12.9	11.8	11.3	10.5	10.8	11.1	10.4	10.2	10.4	11.2
	17.2	18.0	18.9	19.4	21.0	23.0	22.6	23.0	22.1	20.5	19.4	18.7	18.0
Netherlands	9.3	9.7	9.6	8.0	7.8	7.0	7.2	8.3	12.2	13.3	13.3	13.7	14.7
	9.9	10.5	10.8	11.7	12.3	12.9	13.9	13.6	11.8	11.0	10.3	9.8	9.7
Sweden	5.9	7.4	7.1	5.8	5.4	5.2	4.9	5.5	9.7	10.6	10.4	10.6	11.7
	6.3	6.7	7.2	7.7	8.8	8.9	9.4	9.1	7.9	6.9	6.6	6.5	7.0
Switzerland	6.4	7.3	6.7	5.7	5.4	5.2	5.0	5.5	9.7	10.8	10.6	10.8	11.6
	7.9	6.7	7.7	8.1	8.9	9.0	9.1	8.6	8.0	7.8	7.5	7.4	6.7
South Korea	30.1	23.4	20.3	16.6	13.6	13.5	9.6	9.8	2.6	12.0	10.7	10.7	11.9
	35.8	44.8	46.3	41.4	38.6	31.6	28.4	28.6	-	17.4	16.3	19.2	19.7
Canada	11.1	11.7	11.0	9.7	8.5	6.7	6.0	6.5	6.4	6.3	6.1	6.4	7.6
	10.9	12.7	13.1	13.9	14.4	17.5	18.7	21.7	19.0	15.7	15.0	14.7	12.8

Notes: 1. Numbers in the upper row refer to patent applications, while numbers in parentheses refer to granted patents.
2. These data include designated countries under the PCT and the EPC.
Source: WIPO. "Industrial Property Statistics"

2.3.2.3 Trends in patent applications and patents granted in Japan

The number of patent applications in Japan peaked in 1992, but then fell when a new system was introduced allowing multiple inventions to be filed under a single patent application. The number of patent applications resumed their increase in 1995. Patent applications in Japan by foreign applicants have been relatively flat in recent years.

Meanwhile, the number of patents granted in Japan has been rising even as the share of patents granted to non-Japanese has decreased (Figure 2-3-12). Note that the sharp increase seen between 1995 and 1996 was mainly due to the patent post-grant objection system, which speeded up the grant process.

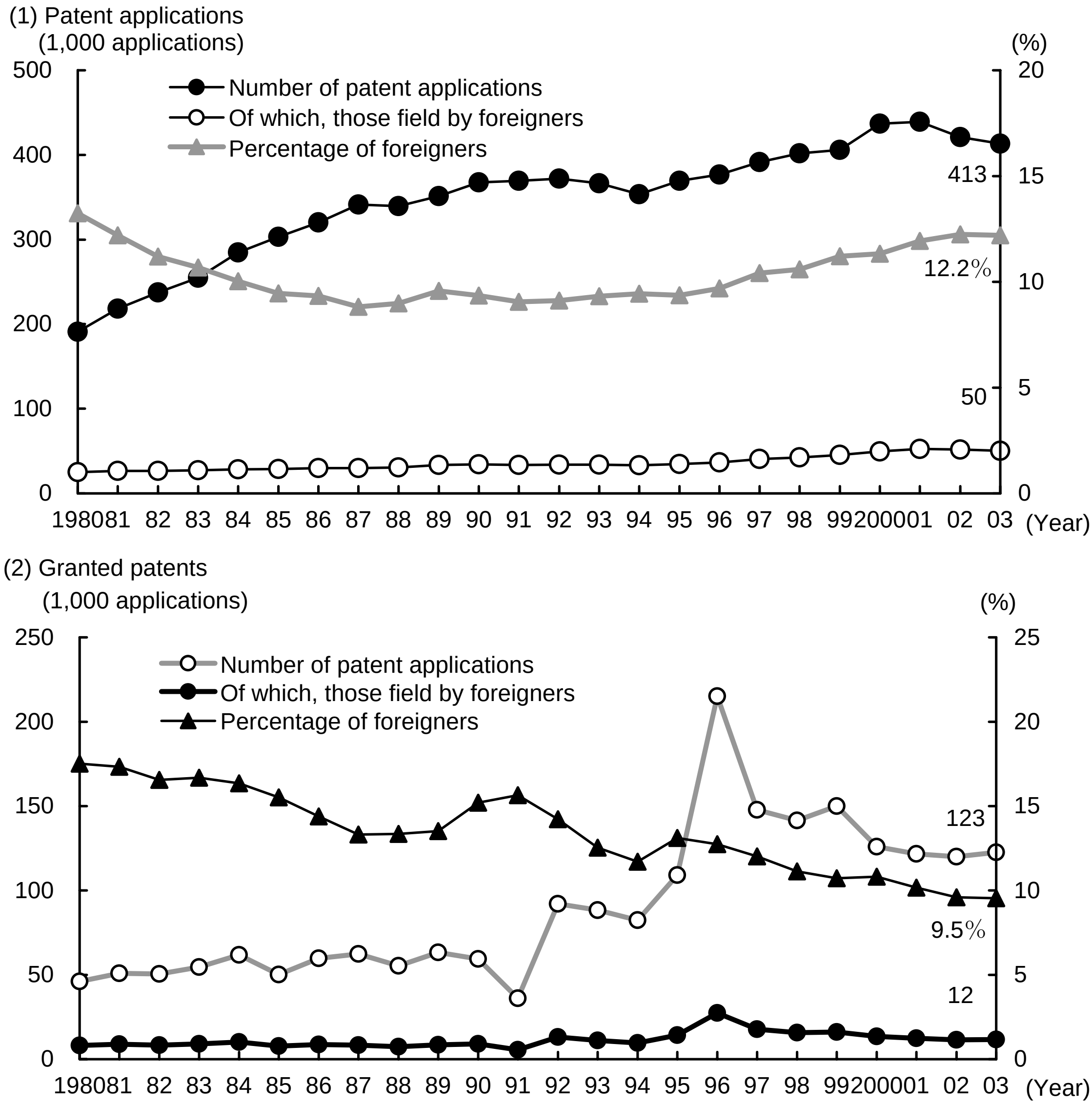


Figure 2-3-12 Trends in number of patent applications and granted patents in Japan

Source: Japan Patent Office. "Patent Agency Yearbook," "Japan Patent Office Annual Report"

2.3.2.4 Foreign patent applications and patents granted in Japan

A look by nationality at the number of patent applications by non-Japanese in Japan reveals that patent applications from the United States started to decrease recently, while those from other countries have been generally flat. The number of patents granted peaked in 1996 and has been declining since then (Figure 2-3-13).

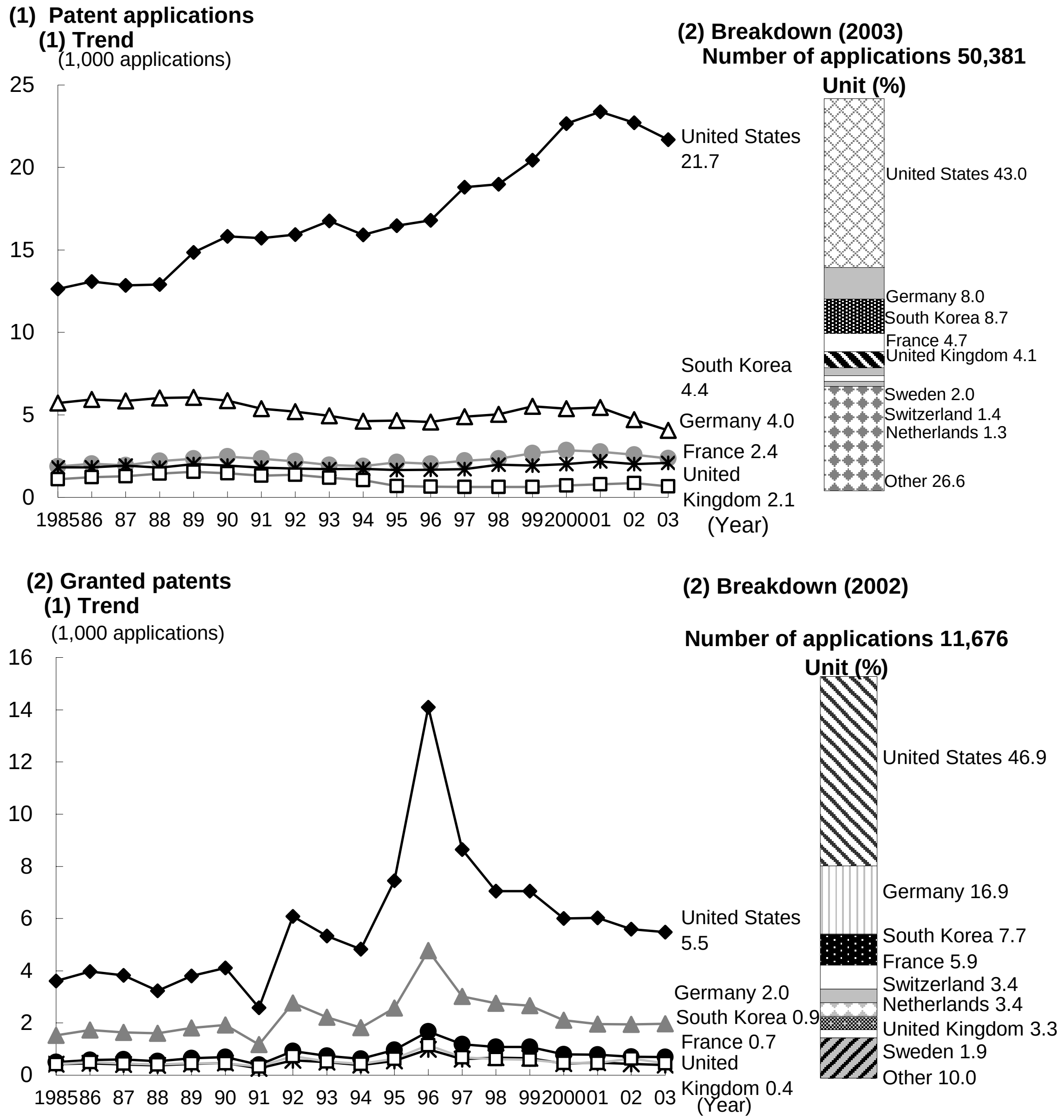


Figure 2-3-13 Number of patent applications and granted patents by nationality of foreign inventors

Source: Japan Patent Office. "Patent Agency Yearbook," "Japan Patent Office Annual Report"

2.3.2.5 Patent Applications in Japan by Field

Patent applications by category[21] in 2002 showed no change in ranking from the previous year (Table 2-3-14) .

Table 2-3-14 Number of patent applications by field of technology in Japan (2002)

Fields of technology	Number of applications	Composition rate (%)
Human necessities	40,723	10.7
Performing, operations, transportation	66,703	17.5
Chemistry, metallurgy, textiles	44,112	11.6
Fixed construction	15,088	4.0
Mechanical engineering	32,368	8.5
Physics	94,918	25.0
Electricity	86,430	22.7
Total	380,342	100

Source: Japan Patent Office. "Japan Patent Office Annual Report 2004"

21 Patent classifications are assigned to patents at the point when the applications are disclosed (after a period of 18 months or more).

2.3.3 Technology Trade

Patents, utility models, and technical know-how result from R&D efforts in science and technology. In addition to being used by corporations for their own purposes, they are traded internationally, for example in the form of transfer of rights, approval of utilization, and others. These transactions are what are known as technology trade.

2.3.3.1 Trends in the Technology Trade

The import-export value of technology trade in major selected countries has been growing in response to the advancing globalization of corporate activities, and to trends in recent years that put greater emphasis on intellectual property rights (Figure 2-3-15). While differences in the methods for gathering statistics in each country make simple comparisons difficult, the United States appears to have by far the largest technology trade imports and exports, with the export value, in particularly, soaring far beyond all other countries.

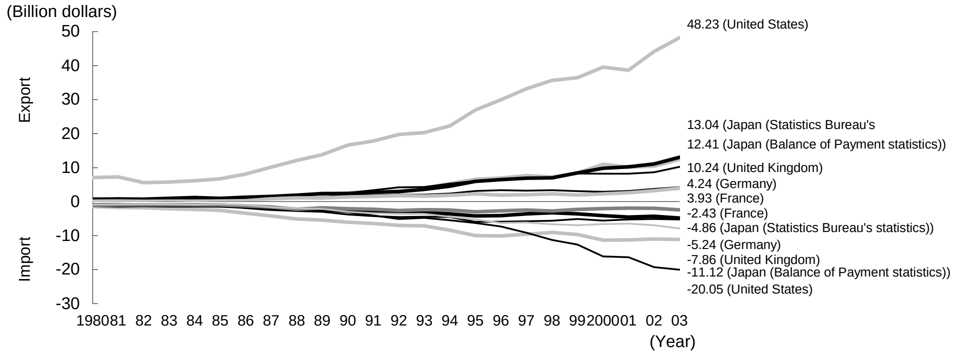


Figure 2-3-15 Trend in technology trade of selected countries

Notes: 1. The amounts are converted into dollars, based on IMF exchange rate.
2. (Balance of Payments Statistics) refers to "Balance of Payments Monthly" published by the Bank of Japan. (Statistics Bureau's statistics) refers to the "Report on the Survey of Research and Development," published by the Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications.
3. The figures are totals for the calendar year; the fiscal year is used only for the figures of Japan ("Report on the Survey of Research and Development").
4. The major reasons for differences between the figures provided by the Bank of Japan and those provided by the Statistics Bureau are as follows.
1) Survey Method: The Balance of Payments Monthly contains compilations of all sums listed in the balance of international payments item "Royalties and License fees" in reports submitted based on the Foreign Exchange and Foreign Trade Law, while the report on the Survey of Research and Development contains compilations of responses to surveys mailed to companies and handled as designated statistics based on the Statistics Law.
2) Survey Coverage: The Balance of payments Monthly covers all residents who remitted foreign exchange by invisible trade involving 5 million yen or more, while the Survey of Research and Development omits industries such as retail and restaurants from its target.
3) The Scope of Technology Trade: The Balance of Payments Monthly includes rights and technical guidance, etc., for patents, utility models, and know-how, as well as compensation for trademark, industrial designs, and copyrights.
Furthermore, the Balance of Payments Monthly does not include technology trade cases where foreign ex-change transfers cover the value of the technology export portions of plant export.

Sources: Japan - Bank of Japan. "Balance of Payments Monthly," Statistics Bureau. "Report on the Survey of Research and Development"
United States - Development of Commerce. "Survey of Current Business"
Germany - Deutsche Bundesbank. "Zahlungsbilanz-statistik"
France - Ministere de l'Economie, des Frances et de l'industrie/Banque de France. "La Balance des Paiements et la Position Exterieure de la France"
United Kingdom - Office for National Statistics. "Overseas Earnings from Royalities and Services" (1980-90), and "UK trade in Services" (1991-)

Sources for the value of Japan's technology trade include the Bank of Japan's "Balance of Payments Monthly" (hereinafter in this chapter referred to as "Balance of Payments statistics") and " Report on the Survey of Research & Development" (hereinafter in this chapter referred to as "Statistics Bureau's statistics") by the Statistics Bureau (Ministry of Internal Affairs and Communications). Where the Statistics Bureau's statistics focus on the state of research activities in Japan, the Balance of Payments statistics focus on foreign currency management.

From the perspective of balance of payments, the Balance of Payments statistics show that the values of imports and exports are nearly equal, while the Statistics Bureau's statistics show an excess of exports.

2.3.3.2 Trends in the Technology Trade Balance

Japan's technology trade balance has been rising, while that for the United States has been falling, with the result that the Statistics Bureau's statistics for 2002 show Japan in the No.1 ranking. While the Balance of Payments statistics had shown an excess of imports, the trade balance has been improving and has rolled over to an excess of exports (Figure 2-3-16). Elsewhere, France and the U.K. have moved into an excess of exports while Germany continues to show an excess of imports.

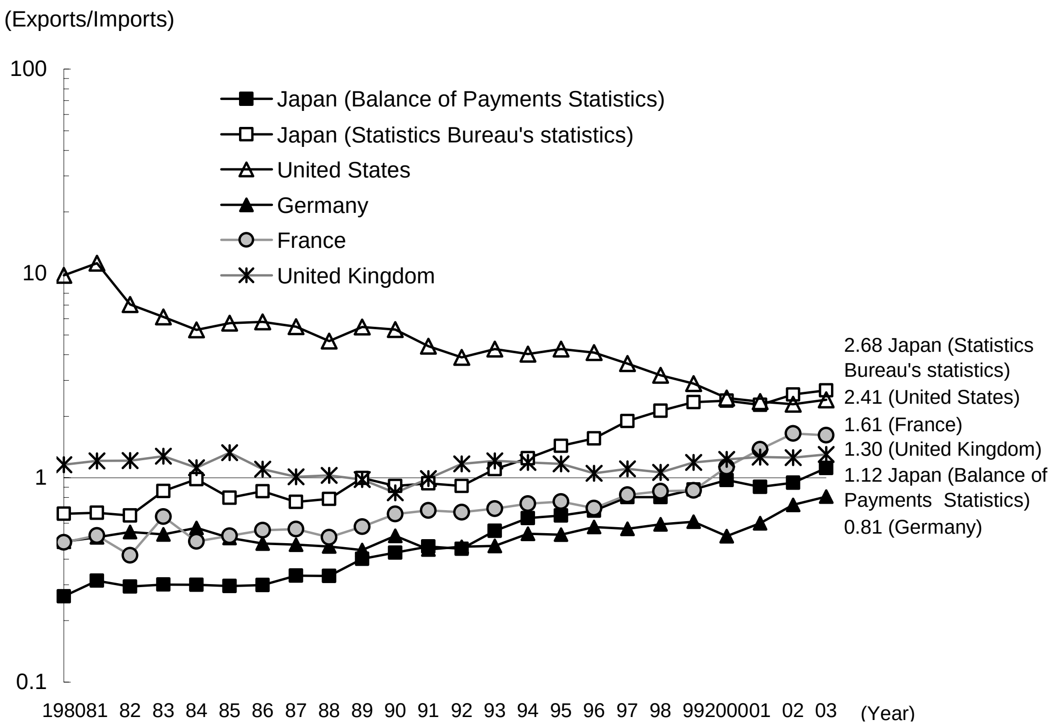


Figure 2-3-16 Trends in the technology trade balance of selected countries

Source: Same as in Figure 2-3-15

For the technology trade balance between major selected countries, the United States shows an increasingly strong excess of exports. In Japan, the Balance of Payments statistics and the Statistics Bureau's statistics reveal conflicting trends, with the former showing an excess of imports trend, and the latter showing an excess of exports trend (Table 2-3-17).

Table 2-3-17 Technology trade balance between selected countries by counterpart

Country (Year) \ Technology trade couterpart		Japan	United States	Germa ny	France	United Kingdom
Japan	(2002)	*	0.71	0.56	0.30	0.93
		*	1.73	1.27	0.44	2.95
	(2003)	*	0.75	0.54	0.34	1.22
		*	1.79	1.01	0.38	2.94
United States	(2002)	1.26	*	1.55	1.57	2.87
	(2003)	1.19	*	1.40	1.39	2.50
Germany	(2001)	0.86	0.44	*	0.43	0.46
	(2002)	1.43	0.74	*	0.54	0.44
France	(2002)	16.82	2.35	1.38	*	1.58
	(2003)	13.52	2.42	1.33	*	1.39
United Kingdom	(2002)	1.46	0.91	0.97	0.75	*
	(2003)	1.05	0.88	1.00	0.63	*

Note: 1. The trade balance is a ratio derived by dividing the total export value by the total import value.
2. Japan's data is divided into two rows, with the upper row showing the Bank of Japan Balance of Payments statistics (2002) values, and the lower row showing Statistics Bureau's statistics (FY2004) values.

Source: Germany - Federal Ministry of Education and Research. "Bundesbericht Forschung 2004"
Other countries - Same as in Figure 2-3-15.

2.3.3.3 Trends in Japan's Technology Trade with Other Countries (Regions)

Japan's technology trade balance with major countries is improving in the long run, with fluctuations in some years, according to the Statistics Bureau's statistics (Figure 2-3-18).

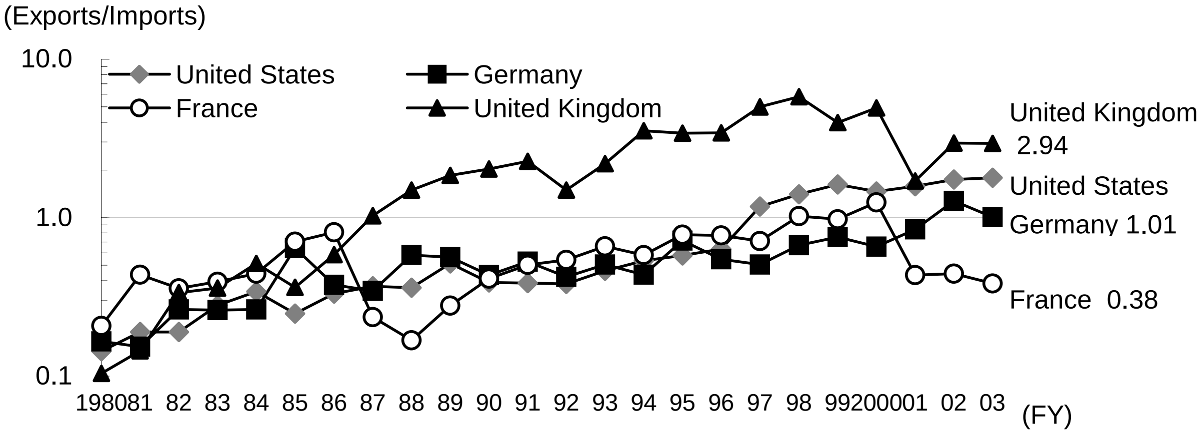


Figure 2-3-18 Trends in technology trade balance of Japan with other selected countries

Source: Statistics Bureau, "Report on the Survey of Research and Development"

A look at Japan’s technology trade for FY2003 by region shows that North America was the destination for more than half of all technology exports by value, followed in order by Asia and Europe. The United States was the single largest export destination, with nearly half of all exports by value, while in Asia the major partner countries (regions) were relatively closer to Japan. In Europe, the United Kingdom was the destination with the highest percentage of exports For technology imports by value, the United States was the overwhelmingly most important source, at two-thirds of all technology imports, while imports from Europe were distributed relatively evenly from all major European countries except France, which held a disproportionately high share (Figure 2-3-19).

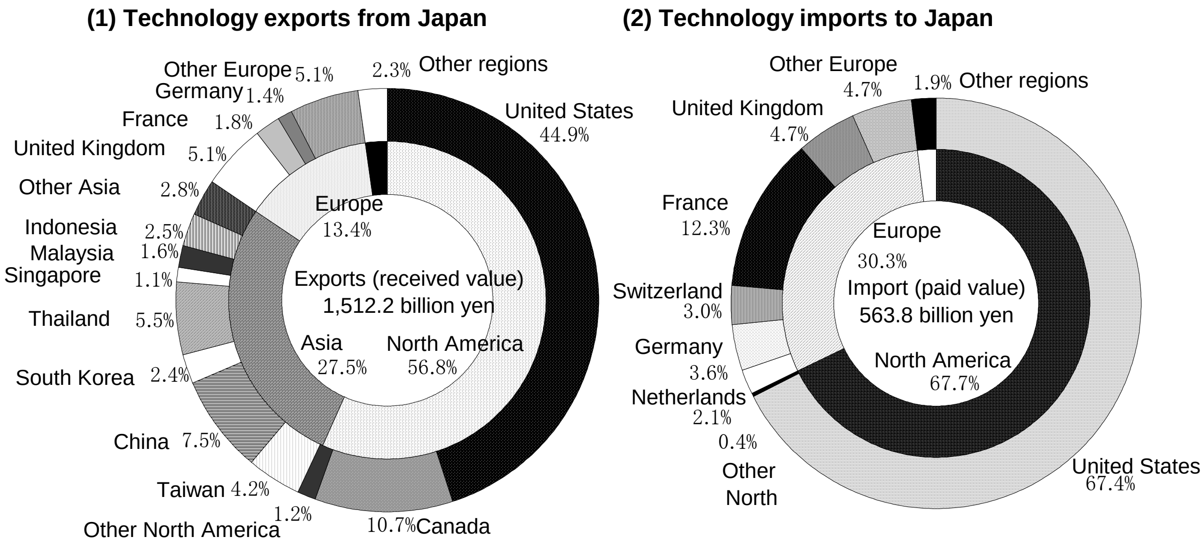


Figure 2-3-19 Composition of Japan's technology trade, by selected country and region (FY2003)

Source: Statistics Bureau. "Report on the Survey of Research and Development"

As late as FY1996, Japan had an excess of imports with Europe and North America, and an excess of exports with Asia. Starting in FY1997, however, Japan's technology trade balance shifted to an export surplus with all regions, and then to an import surplus with Europe in FY2001 (Figure 2-3-20).

(Billion yen)

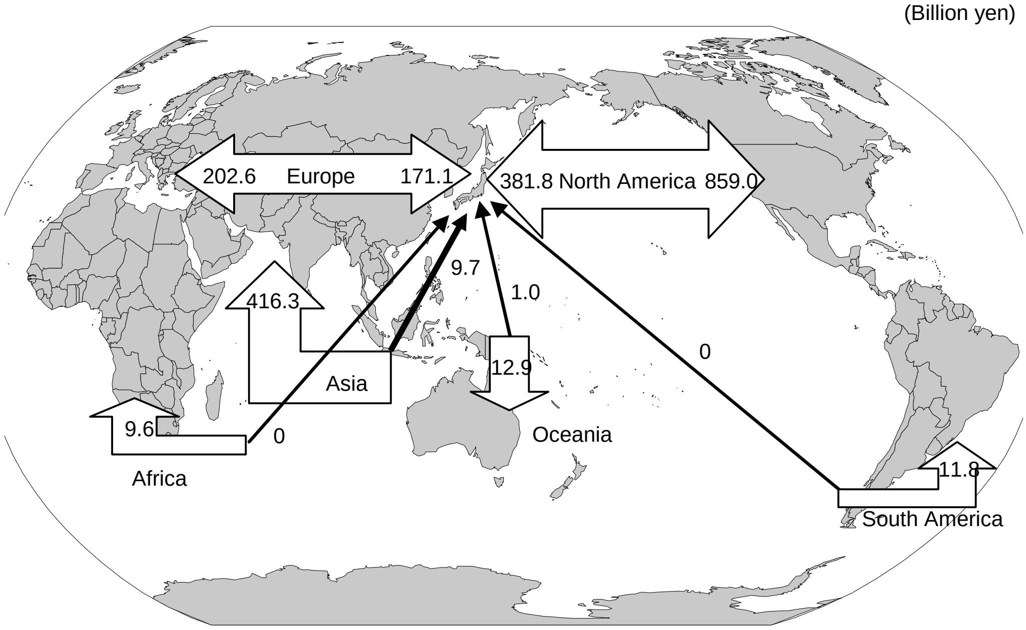


Figure 2-3-20 Technology trade by region (FY2003)

Source: Statistics Bureau, "Report on the Survey of Research and Development"

2.3.3.4 Trends of Japan's Technology Trade by Industry Sector

Using the Statistics Bureau's statistics to look at Japan's technology trade by industrial category in the manufacturing sector in FY2003, we find that such high-tech related industries as the motor vehicles industry, the information and telecommunications machinery industry, the electrical parts and devices industry, the electrical machinery industry, and the pharmaceutical industry accounted for the majority of both exports and imports (Figure 2-3-21).

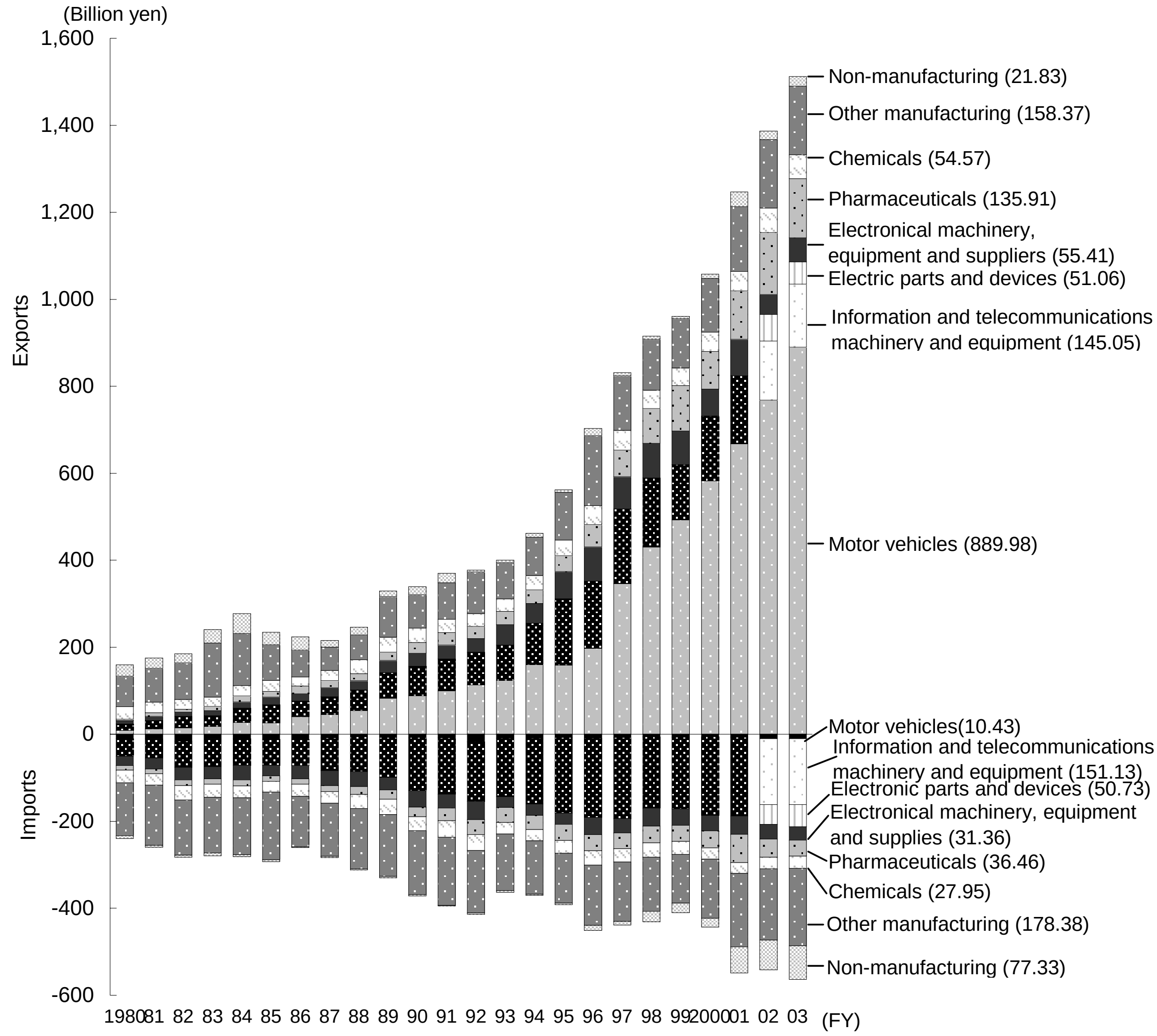


Figure 2-3-21 Trends in technology trade by industry sector

Note: The 2002 revision of industrial categories split "telecommunications, electronics and electrical instruments into "Information and telecommunications machinery and equipment" and "Electrocis parts and devices".
Source: Statistics Bureau. "Report on the Survey of Research and Development

For the trends over time in the technology trade balance, the motor vehicles industry has long had an excess of exports and is steadily widening its technology trade balance. The technology trade balance in the electrical parts and devices industry—a new category since FY2002—has shown an excess of exports, while the information and communications machinery industry has shown an excess of imports. The electrical machinery, equipment and supplies industry, which had once been tilted toward imports, has had an excess of exports since FY1993. While the drug and medicines industry has in recent years been in general balance, it tilted over to an excess of exports in FY1996, and has tended more in the direction of that trend since (Figure 2-3-22).

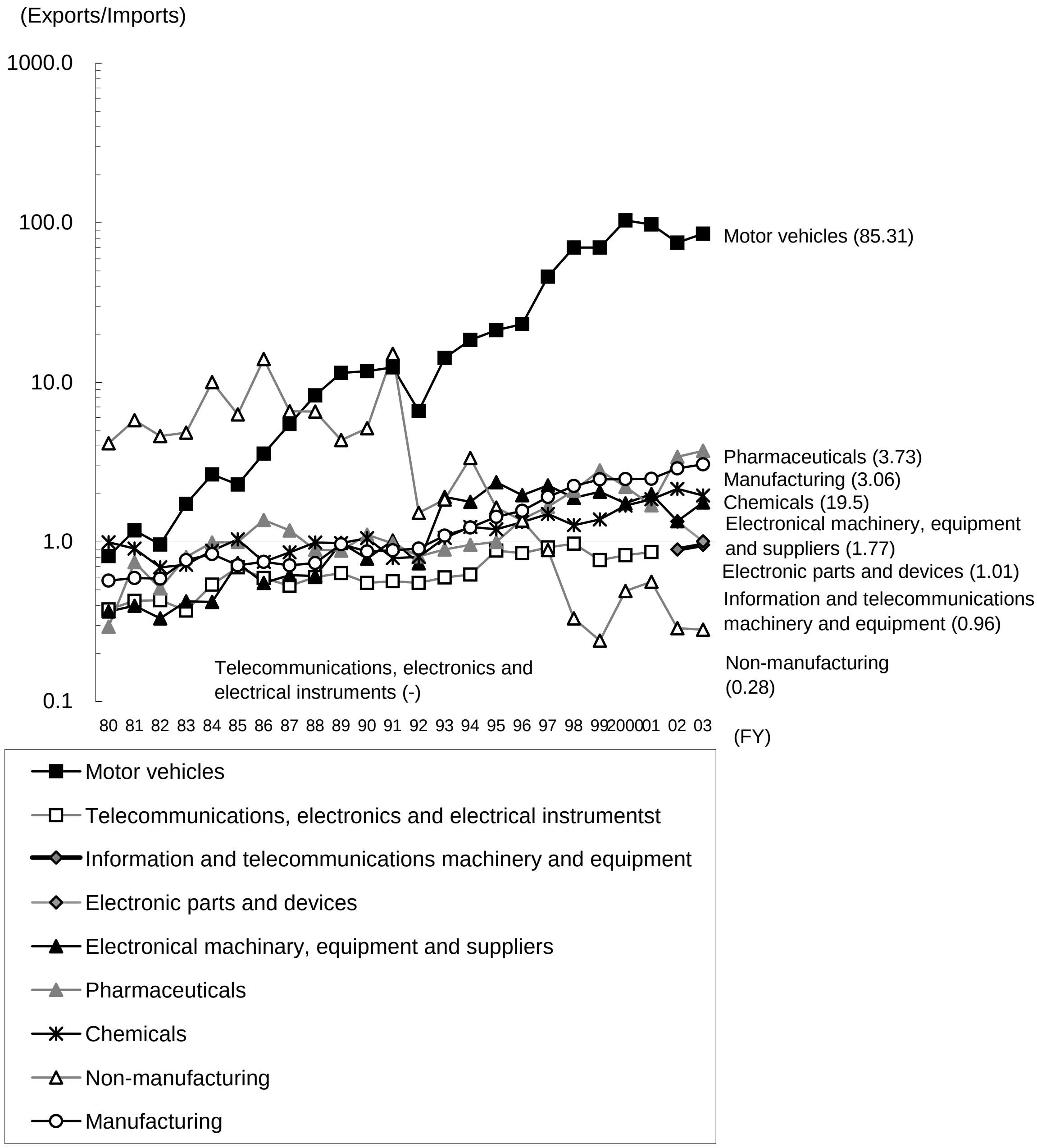


Figure 2-3-22 Trends in technology trade balance in major industry sectors

Source: Statistics Bureau. "Report on the Survey of Research and Development"

For the balance of payments in technology trade by trade partner country, region and industrial category, the motor vehicle industry shows an excess of exports with all other countries, with a particularly large technology export trade by value with the United States. The information and telecommunications machinery and equipment industry generally shows a strong excess of exports with Asia, but holds an excess of imports overall. The drug and medicine industry trades overwhelmingly with Europe and the United States, and holds an overall export surplus (Figure 2-3-23).

Table 2-3-23 Technology trade balance of payments by trade partner country and region for major industrial categories in Japan (FY2003)

Motor vehicles (Billion yen)

Export and import	Technology Exports	Technology Imports	Exports-Imports
United States	462.6	5.4	457.2
United Kingdom	45.9	0.2	45.7
Thailand	52.8	0.0	52.8
Taiwan	28.9	-	28.9
China	22.4	0.0	22.4
South Korea	4.1	0.2	3.9
Other	273.2	4.6	268.6
Total	890.0	10.4	879.5

Information and telecommunications machinery and equipment (Billion yen)

Export and import	Technology Exports	Technology Imports	Exports-Imports
Taiwan	11.4	2.7	8.7
China	34.7	0.1	34.6
Malaysia	12.3	-	12.3
Singapore	5.4	0.0	5.4
South Korea	8.3	0.5	7.8
United Kingdom	2.4	2.9	-0.6
Netherlands	13.0	5.8	7.2
France	1.1	4.8	-3.6
United States	27.3	120.1	-92.8
Other	29.3	14.2	15.0
Total	145.1	151.1	-6.1

Pharmaceuticals (Billion yen)

Export and import	Technology Exports	Technology Imports	Exports-Imports
United States	88.6	11.8	76.8
France	6.0	1.4	4.5
United Kingdom	19.1	9.1	10.1
Netherlands	0.1	0.7	-0.6
Switzerland	2.1	3.5	-1.5
Germany	6.6	5.9	0.7
Sweden	0.1	0.8	-0.7
Other	13.3	3.2	10.2
Total	135.9	36.5	99.5

Note: Symbol Key: "－" amounts to exactly zero.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.3.4 High-tech Industries

High-tech industries[22] require large investments in R&D, as well as sophisticated technology during their manufacturing process.For this reason, the size of high-tech product ex- ports can be seen as an indicator of one aspect of an industry's international competitiveness in science and technology. Therefore, we use OECD data to look at the export shares of high-tech industries, and to make country comparisons of trade balances.

2.3.4.1 Trends in the Export Shares of High-tech Industries in Major Countries

Japan's share of high-tech industrial exports by value was second only to the United States among OECD countries. This share had been declining. (Figure 2-3-24).

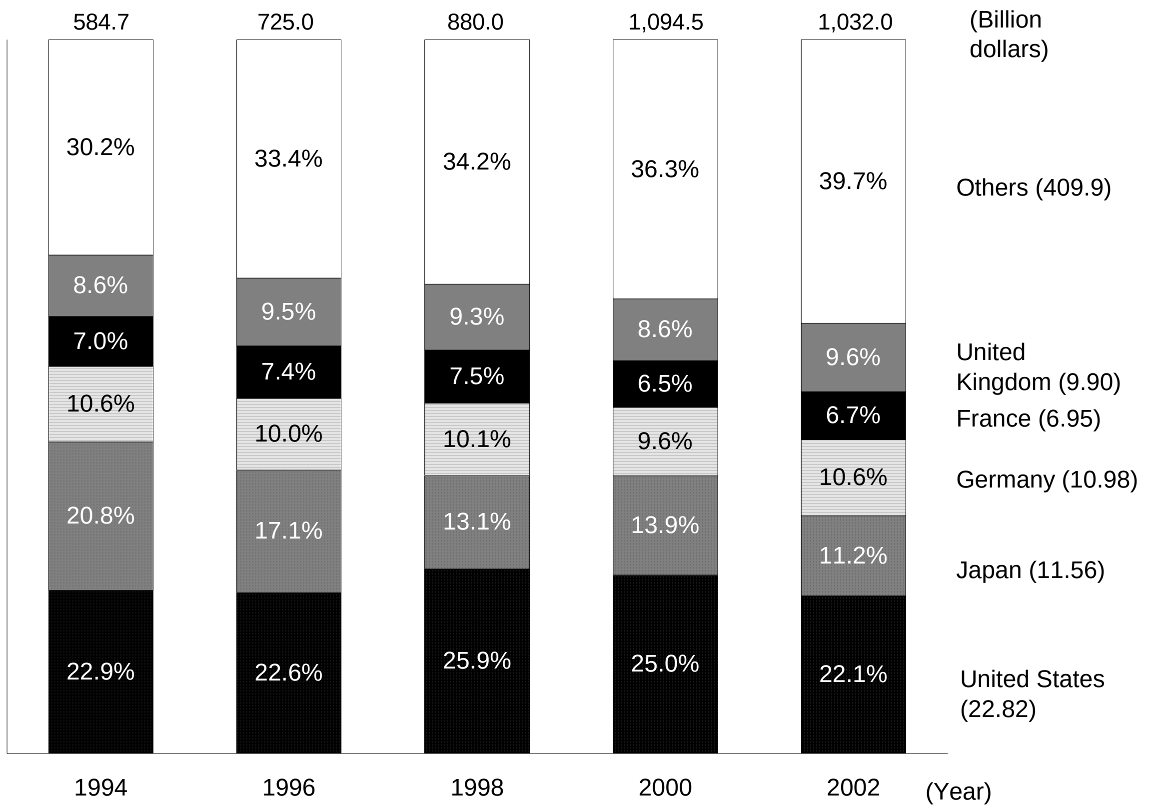


Figure 2-3-24 Export market shares for high-tech products by country in OECD countries

Note: The amount of export is converted into dollars.
Source: OECD. "Main Science and Technology Indicators"

22 High-tech industry: At the OECD, the ratio of R&D expenditures to production is calculated by industry sector, and the five industries with the highest ratios are classified as high-tech industries: aerospace, office and computing machinery, electronics, pharmaceuticals, and medical/ precision/optical equipment.

With the exception of the United Kingdom and France, the total value of high-tech industrial exports has declined in all major countries, while the share for other OECD countries is rising. Japan's share of the total was particularly high in the electronics industry and medical/precision/optical equipment industry. Japan's share was relatively low in the aircraft and the drug and products industry (Figure 2-3-25).

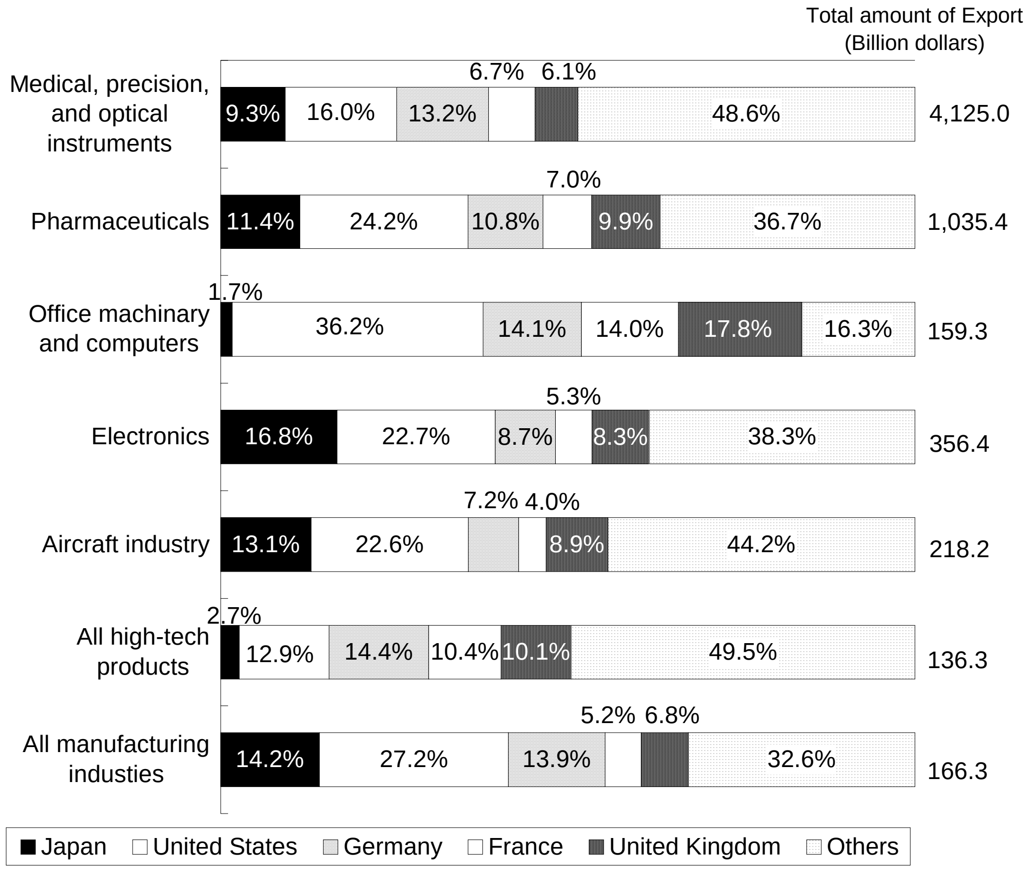


Figure 2-3-25 Share of high-tech products by country manufactured in OECD (2002)

Note: The amount of export is converted into dollars.
Source: OECD. "Main Science and Technology Indicators," "STAN Database"

2.3.4.2 Trends in Export from and Import to Japan's High-tech Industry

The trend for Japan's high-tech industry shows that both exports and imports increased slightly by value. It would appear that the high-tech industry is much less affected by changes in the business climate than the manufacturing industry as a whole (Figure 2-3-26).

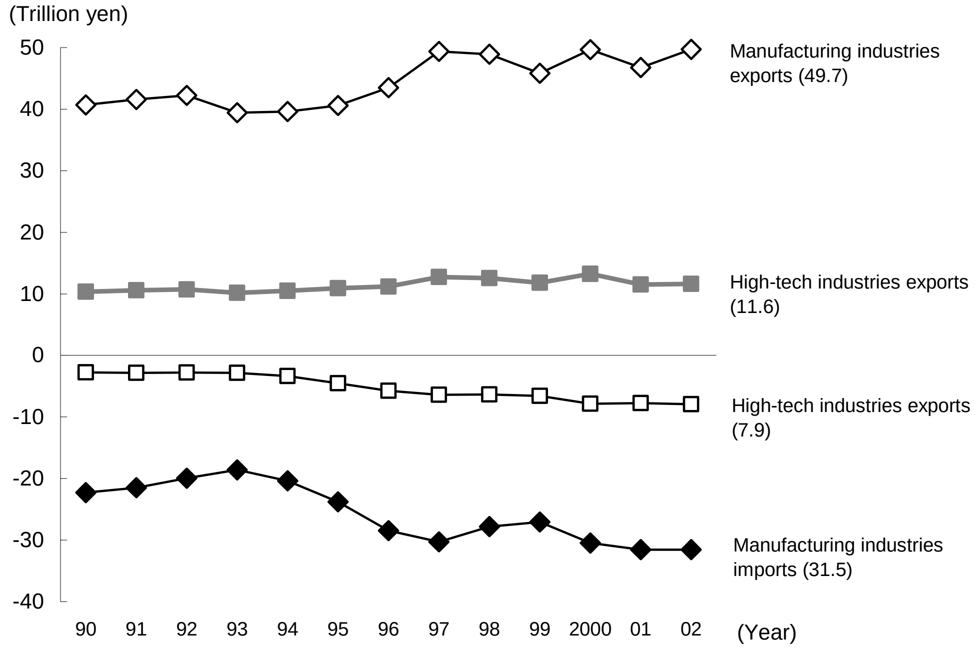


Figure 2-3-26 Trends in imports and exports, by value, for Japan's general manufacturing industry, and the high-tech industry
Source: OECD. "Main Science and Technology Industries," "STAN Database"

2.3.4.3 Trends in High-Tech Industry Trade Balances in Major Countries

A look at Japan's trade balance in high-tech industries shows that the balance of payments ratio is approaching 1.0. The United States, Germany, France and the United Kingdom have balance of payments ratios nearing 1.0 (Figure 2-3-27).

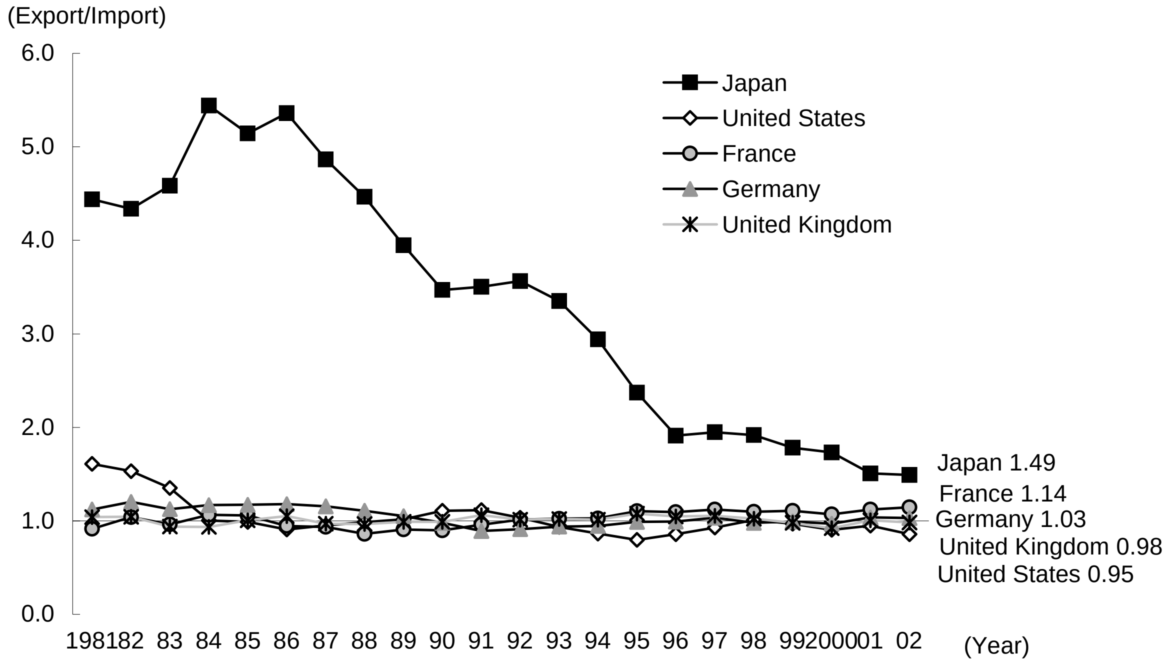


Figure 2-3-27 Trends in high-tech balance of payment ratios for selected countries

Source: OECD. "Main Science and Technology Indicators"

2.3.4.4 Balance of Payments for Japan’s High-tech Trade, by Industries

The balance of payments for Japan’s high-tech trade in 2002, by industry, was as shown in Table 2-3-28. The electronics industry showed a higher balance of payments ratio than the high-tech industry overall. The medical, precision, and optical equipment industries had about the same balance of payments ratio as the manufacturing industry as a whole. The drug and medicines industry and the aerospace industry, on the other hand, had extremely low balance of payment ratios, and were both heavily tilted toward imports.

Table 2-3-28 Balance of payments for Japan's high-tech trade, by industry (2002)

Industry \ Export and import amounts	Exports (billion yen)	Imports (billion yen)	Trade balance
All manufacturing	49,700	31,533	1.58
All high-tech products	14,494	9,728	1.49
Electronics	7,678	3,550	2.16
Office Machinery & Computer Industry	3,222	2,768	1.16
Medical, precision, and optical equipment	2,857	1,822	1.57
Pharmaceuticals	479	822	0.58
Aerospace	258	766	0.34

Source: OECD. "Main Science and Technology Indicators," "STAN Database"

2.4 Efforts to Develop New Science and Technology Indicators

The indicators discussed in Chapters 2.1 to 2.3, such as R&D expenditures, numbers of researchers, numbers of scientific papers, numbers of patent applications and grants, and value of technology trade, are important as basic data for use in planning Japan's science and technology policies. While various surveys and investigations have helped to provide the above data, under the increasing complexity and globalization, etc., of scientific and technological activities in recent years, the current indicators and survey methods are being reviewed, and new indicators are being developed to grasp the shape of the national scientific and technological activities more accurately. In this section, we introduce the efforts being taken by the OECD and those being taken in Japan.

2.4.1 Efforts by the OECD

The OECD established the Working Party of National Experts on Science and Technology Indicators (NESTI) as a subsidiary organization within the Council for Science and Technology Policy (CSTP). The NESTI is working to improve methods for collecting internationally comparable R&D data and on the development of new indicators.

At its June 2003 meeting, NESTI revised the Oslo Manual, an international standard for the collection and interpretation of data on innovation activities. The preparation of the revision proposal—work in which Japan is participating—is currently underway.

Additionally, NESTI is reviewing Field of Science (FOS) classifications used in R&D statistics and is also moving forward with a study aimed at the development of indicators regarding Human Resources in Science and Technology (HRST).

2.4.2 Efforts in Japan

2.4.2.1 Ministry of Internal Affairs and Communications

The Ministry of Internal Affairs and Communications has been conducting surveys of business enterprises, non-profit institutions, public organizations, and universities concerning science and technology indicators for R&D expenditure, the numbers of researchers, the amount of technology transfer, etc., in Japan. This survey was originally started in 1953 as the Basic Statistical Survey of Research Institution, with the name changing in 1960 to the current Survey of Research & Development. Since that time, the coverage of the survey has been expanded and new variables added several times, to reach its present focus. To reflect the increasingly important roles of software and services in industry, and to improve the quality of international comparisons, the survey was subjected to an exhaustive review by the Statistics Council in FY2001, after which a new survey was launched in FY2002 with new survey categories and survey coverage.

2.4.2.2 Ministry of Education, Culture, Sports, Science and Technology

In November 2002, the MEXT conducted the "Survey of Full-time Equivalency Data at Universities," targeting teachers and doctoral students at all types of universities across Japan in order to gain an understanding of the Full-Time Equivalency (FTE) of researchers at "universities" in the "Survey of Research and Development."

The total results for valid replies showed that the full-time equivalencies of teachers and doctoral students at universities are annual averages of 46.5% and 70.9%, respectively.

	Persons	FTE factor	FTE
Faculty members	171,094	0.465	79,604
Doctoral students	64,019	0.709	45,419

Table 2-4-1 Full-Time Equivalency (FTE) for university faculty and doctoral students (2002)

Note: Data on the number of people comes from the "FY2002 Report on the Survey of Research and Development."

Since 1991, the National Institute of Science and Technology Policy (NISTEP) has revised the science and technology indicators every three to four years and drawn up reports for the purpose of obtaining a comprehensive, objective grasp of scientific and technological activities. In the fifth edition of the "Science and Technology Indicators Report" compiled in April 2004, the previous science and technology indicators were revised mainly as follows.

1. Introduces indicators that demonstrate the progress of a knowledge-based society
2. Introduces indicators that demonstrate transformations in knowledge production methods for science and technology
3. Introduces data on coordination between industry and academia
4. Enhances indicators relating to dissertations and patents
5. Improves the reliability and applicability of comprehensive science and technology indicators

In addition to the above revision, since FY2001 data has been updated and published once a year. The updated data of the fifth edition was published in April 2005.

Part 3 discusses the measures adopted in FY2004 for the promotion of science and technology, in line with the Second Science and Technology Basic Plan.

3.1 Development of Science and Technology Policies

The Science and Technology Basic Law was promulgated and put into effect on November 15, 1995. Based on a recognition of the important role that science and technology should play in the development of Japan's economy and society, in the improvement of the welfare of the nation, and in the sustainable development of human society, the objective of this law is to achieve higher standards of science and technology through the promotion of such measures as the implementation of the Science and Technology Basic Plan, etc., for the comprehensive and systematic promotion of science and technology.

Article 9 of the Law stipulates that the government must draw up a basic plan for science and technology, for the purpose of the comprehensive and systematic promotion of measures for the promotion of science and technology.

3.1.1 The Science and Technology Basic Plan

With the launching of the Council for Science and Technology Policy (CSTP) in January 2001, the Prime Minister submitted an inquiry regarding the general strategy for science and technology, which called for the adoption of a five-year science and technology basic plan to be launched in FY2001. Based on the recommendations contained in the "Basic Plan for Science and Technology" submitted by the previous Council for Science and Technology on December 26, 2000, the CSTP examined and discussed the general strategy in view of the comprehensive integration of the natural sciences with the social sciences and the humanities, and in strategic consideration of anticipatory investments in science and technology for the future, and then issued a recommendation in March 2001. In response to the comprehensive strategy, the Cabinet officially launched the Second Science and Technology Basic Plan (hereinafter referred to as the "Basic Plan") on March 30, 2001 after the consultation of the CSTP.

The Basic Plan was adopted in consideration of the form science and technology should take in the 21st century, and for the comprehensive promotion of the government's science and technology policies, while also emphasizing the building of a new relationship between science and technology, and society.In this plan, the basic direction of Japan's science and technology policy is to have a clear vision, with three essential qualities comprising the basis for being an advanced science- and technology-oriented nation, as "a nation contributing to the world by the creation and utilization of scientific knowledge," "a nation with international competitiveness and the ability for sustainable development," and "a nation securing safety and quality of life." Toward the realization of this vision, the plan emphasizes the need for high-quality basic research, and calls for prioritized and efficient investment in research and development activities covering topics of interest to the state and society in each sector, including the life sciences, information and communications technology, the environment, and nanotechnology and materials. Moreover, in order to enhance the level of Japan's scientific and technological activities, and to better promote the restoration of the results of these activities to society, the plan focuses on expansion of investment, reform of the science and technology systems that cover research and development activities, human resources development, and the interface between science and technology, and society, and on strengthening independent international cooperation activities and information dissemination capabilities, as well as internationalization of the domestic research environment, in order to promote the internationalization of scientific and technological activities. The plan calls for continued efforts to promote science and technology with an updated understanding of future trends in the major countries of Europe and North America, and for this purpose asserts that a total of about 24 trillion yen[1]

1 figures are based on the presumption that government research and development investment will be 1% of GDP during the period of the Basic Plan, with a nominal GDP growth rate of 3.5%

for governmental research and development investment will be required in the five years from FY2001 to FY2005 (Figure 3-1-1).

In view of the above, while taking into consideration future social and economic trends, the necessity for the promotion of science and technology, and a fiscal situation that is even more severe than it was during the period of the First Basic Plan, Japan should be striving to expand the funds necessary for the promotion of the policies presented in the Basic Plan, based on prioritized and efficient allocation of funds, and in accordance with trends in the effects of rationalization and financial resource assurance achieved in research system reforms under the Basic Plan.

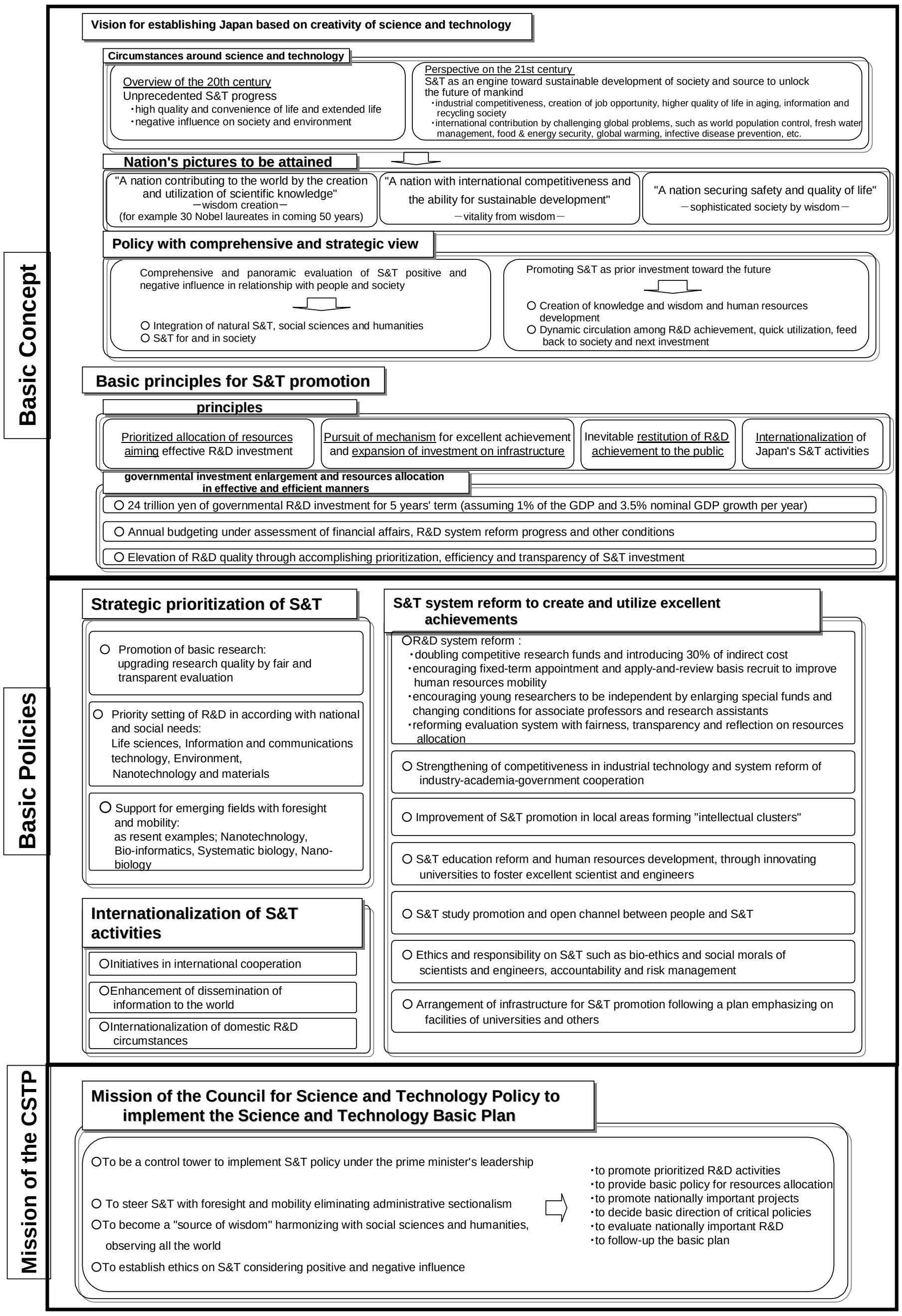


Figure 3-1-1 Main points of the Second Science and Technology Basic Plan

3.1.2 The Council for Science and Technology Policy

Since its establishment in January 2001, the Council for Science and Technology Policy has generally met once a month with the participation of the Prime Minister as council chairman (a total of 44 sessions as of March 2005). The major items discussed and ratified during FY2001 are as presented below.

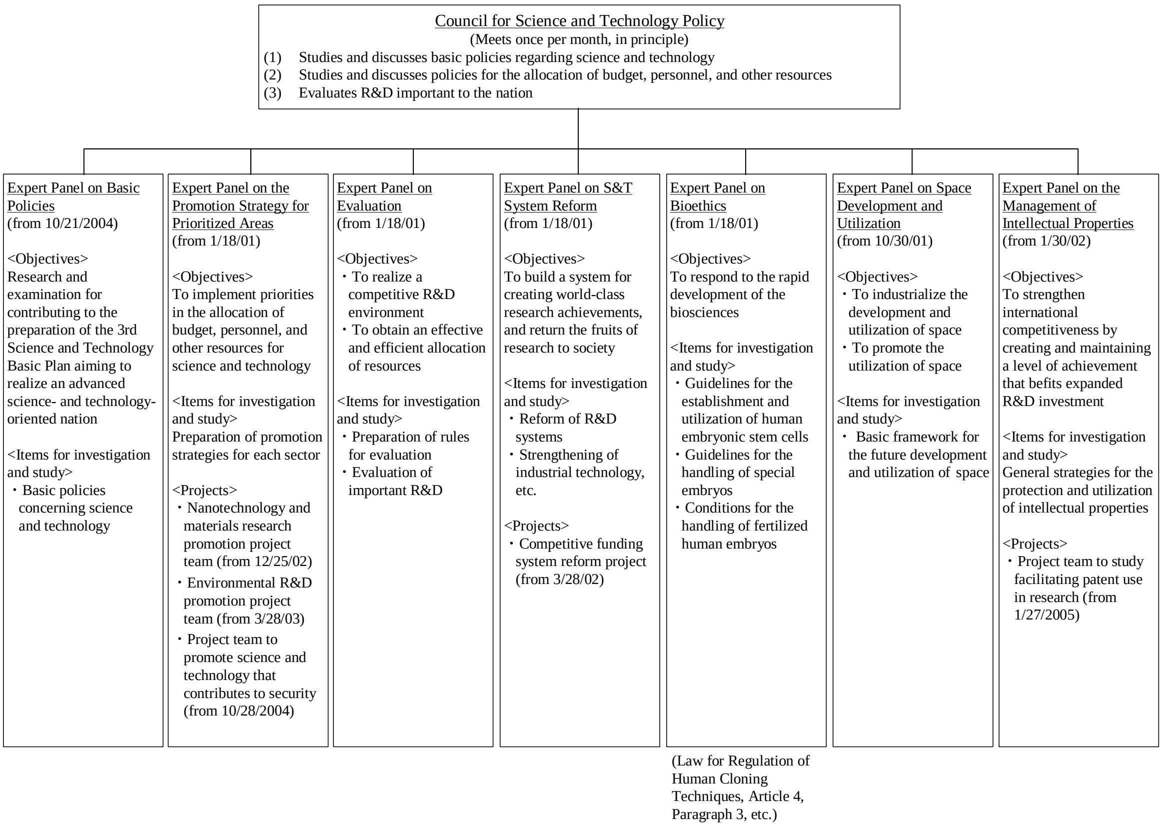


Figure 3-1-2 Organization of the Council for Science and Technology Policy

Table 3-1-3 Chairman and Members of the Council for Science and Technology Policy (as of the end of March 2005)

●Chairman: Junichiro Koizumi, Prime Minister

●Members

・Six cabinet ministers: Hiroyuki Hosoda, Chief Cabinet Secretary; Yasufumi Tanahashi, Minister of State for Science and Technology Policy; Taro Aso, Minister of Internal Affairs and Communications; Sadakazu Tanigaki, Minister of Finance; Nariaki Nakayama, Minister of Education, Culture, Sports, Science, and Technology; and Shoichi Nakagawa, Minister of Economy, Trade, and Industry

・Seven noted members of society: Hiroyuki Abe, professor emeritus, Tohoku University; Taizo Yakushiji, visiting professor, Keio University; Tadamitsu Kishimoto, visiting professor, Osaka University; Ayao Tsuge, former representative director & managing director, Mitsubishi Heavy Industries, Ltd.; Reiko Kuroda, professor, University of Tokyo; Kazuko Matsumoto, professor, School of Science and Engineering, Waseda University; and Hiroyuki Yoshino, director and advisor, Honda Motor Co., Ltd.

・One head of a government institution**:** Kiyoshi Kurokawa: President of the Science Council of Japan

(1) Reform of Science- and Techno logy-Related Budget for FY 2005

As Fiscal 2005 is the final year of the 2nd Science and Technology Basic Plan and in order to achieve the various objectives for realizing an advanced science and technology-oriented nation as set forth in the Plan, the Council strengthened efforts for high-quality measures by promoting the reform of the science and technology-related budget, includeeeing thorough elimination of unnecessary duplication.

(Improvement of prioritization (SABC, etc.))

In formulating the FY2005 budget, the Minister of State for Science and Technology Policy and the eminent members of the Council examined every science- and technology-related budget and, with the cooperation of outside experts, prioritized (in 4 levels: S, A, B, and C) the science- and technology-related measures for which relevant ministries and agencies made budget requests, and then, with regard to independent administrative agencies, state-run universities and inter-university research institutes, summarized opinions on their main projects related to science and technology. (October 21, 2004). The prioritization results were as follows:

S: 25 items (9%) — Particularly important research topics that require aggressive implementation

A: 120 items (44%) — Important research topics that require steady implementation

B: 105 items (38%) — Items for which problems must be solved and that need effective and efficient implementation

C: 25 items (9%) — Items requiring review of research details, plans, and promotion systems

In addition, working to enhance the science and technology budget, the CSTP made a summary of "Toward Formation of the FY2004 Science and Technology-Related Budget (Opinion)," and submitted its opinion to the Prime Minister and the relevant ministers (November 26, 2004). In view of the importance of science and technology, expenses for the promotion of science and technology were increased 2.6% in the FY2005 budget from the previous fiscal year, despite the fact that the general expenditures for the fiscal year were reduced. Incidentally, the total science- and technology-related budget, including expenses other than for the promotion of science and technology, was reduced by 0.8%.

(Creation and Promotion of the Coordina-tion Program of Science and Technology Projects)

Eight themes were decided from the standpoint of their national and social importance (① Post-Genome - Promoting the health sciences -, ② Emerging and Re-emerging Infectious Diseases, ③ Ubiquitous Networks - RFID tags and other technologies, - ④ Next-Generation Robots-Shared platform technology-, ⑤ Biomass Utilization Technologies, ⑥ Hydrogen & Fuel Cell, ⑦ Nanobiotechnology, ⑧ Local Science & Technology Cluster) and relevant measures were examined to eliminate unnecessary redundancy and reinforce collaboration in order for it to be reflected in prioritization.

(Thorough reform and focused expansion of competitive research funding)

In order to promote creative R&D activities, it is necessary to develop a competitive R&D environment. To this end, institutional reform was implemented thoroughly to maximize the effect of competitive research funding, and focused expansion of funding was carried out toward achieving the goal of doubling competitive research funding as laid down in the Basic Plan.

As a result, progress has been made in institutional reforms, such as establishment of a screening system, and 467.2 billion yen was appropriated for competitive research funding (up 29.6% over the previous year and up 157.4% over FY2004) in the FY2005 budget.

(2) Guidelines on Budgetary/Perso-nnel Resources Allocation in Scie-nce and Technology

As shown in the Basic Plan, the CSTP relies on the Basic Plan and the promotion strategies for each sector, etc., examines the science and technology measures set forth for the next fiscal year, and presents opinions to the Prime Minister regarding those measures that it believes merit particular priority, and then clarifies its ideas regarding the next fiscal year's important measures and allocation of resources, and presents those ideas to the relevant ministers. Furthermore, to ensure that the resource allocations settled upon in the CSTP are carried out, the council coordinates when necessary with the finance authorities during the budget formulation process.

(FY2005 Guidelines on Budgetary/Person-nel Resources Allocation in Science and Technology (May 26, 2004))

The FY2005 guidelines maintain that in order to achieve various goals set forth in the Basic Plan, it is necessary to accelerate efforts for science-and technology-related measures and strengthen and enhance government investment in science-and technology-related measures in particular, while promoting prioritization in a strategic way. In doing so, priorities were placed on measures that are in line with the basic policies of ① steadily promoting R&Ds of foundations for the future development of Japan, ② promoting scientific and technological activities to ensure Japan’s economic development and international competitiveness, ③ promoting scientific and technological activities to realize a safe and secure life, and ④ reforming the science and technology system.

(R & D projects for Economic Stimulus (The Mirai Creation Project))

In an effort to develop Japan’s economy and to ensure and strengthen the nation’s international competitiveness, R & D projects for economic stimulus (the Mirai Creation Project) were pro moted. Funding for the project was 105.9 billion yen in the FY2004 government budget (up 43% from the previous year).

(3) Major Efforts of the Council for Science and Technology Policy in FY2003

(Examination of Promotion Measures in Priority Areas)

Based on the prioritized strategies determined in the Basic Plan, in FY2001 the CSTP prepared the “Promotion Strategy for Prioritized Areas” for eight major areas, which are the life sciences, information and communications technology, the environmental sciences, nanotechnology and materials, energy, manufacturing technology, infrastructure and the frontier – outer space and the oceans (Figure 3-1-4). CSTP promotes measures based on the promotion strategies for these areas (see section 3.2.2).

Life Sciences Sector

1. Current Situation, and Issues

The 21st century is being called the "Century of Life." While Japan had a late start in analysis of the genome, the country is using its leading-edge R&D performance in SNPs, proteins, etc., to catch up in post-genome research and industrial applications.

2. Thoughts on Prioritizing, and Areas of Priority

Strive to extend the "healthy life expectancy" in an aged society with fewer children, and seek to overcome the infectious diseases, allergies and stress-related illnesses that are now coming to the fore as social problems. Furthermore, achieve a prosperous lifestyle by utilizing diverse bio-resources and bio-functions, and strengthening industrial competitiveness.

(1) Develop technologies to "protect the people's health"
- Technologies for the prevention and treatment of diseases that utilize genome-related technologies to achieve active, long lives
- Elucidation of physiological defense mechanisms and technologies for prevention and medical treatment in relation to infectious diseases and environmental factors
- Promotion of basic research and technologies for the treatment and prevention of mental health and brain diseases

(2) Develop technologies for "competitiveness" and "sustainable development"
- Materials production and environmental response technologies that utilize bio-functions
- Food sciences and technologies that contribute to the improvement of food supply capabilities and to the peoples' diet

(3) Emerging and interdisciplinary areas and the development of advanced analyzing technologies. Build systems and structures that accelerate the return of the fruits of research to society

3. Five-Year R&D Objectives

(1) Realize healthy, secure lives by:
- Developing countermeasures for "lifestyle related diseases," and ailments that lead to "dementia" and "bed-ridden status": Analyze tens of million of SNPs each year/Perform structural and functional analysis of large-scale, highly purified proteins/Identify approximately 10 genes related to each ailment/Shorten drug development times/Realize effective treatment using medicines tailor-made to the constitution of individual patients, etc.
- Developing countermeasures for infectious diseases and environmental factors such as toxic substances: Elucidate the mechanism for the incidence of hepatitis C infections, etc./Use vaccines, etc., to prevent infections and control incidence, etc.
- Developing countermeasures for mental and nervous system diseases: Promote brain science/ Set out to develop new diagnostic and treatment methods for Alzheimer's and other nervous system diseases/Develop non-invasive diagnostic technologies for the measurement of brain functions

(2) Advance technologies for the production of useful substances and technologies for separating environmental pollutants, utilizing genome-related technologies and microorganisms and other plants and animals/Develop crops resistant to environmental stresses to improve food supply capabilities

(3) Promote research into interdisciplinary sectors such as bio-informatics and nanobiology/Promote clinical research/Arrive at consensus in bioethics/Promote social acceptance of genetically modified organism/ Promote accumulation of intellectual properties, etc.

4. Promotion Measures

(1) Build up comprehensive systems of promotion for the evaluation of, and guidance on, measures proposed by various ministries that serve to strengthen national efforts

(2) Develop effective collaboration among industry, academia and government, the development of systems and structures that return the fruits of research to society, etc.

(3) Develop education and research centers for developing human resources for such interdisciplinary sectors as bio-informatics, advanced analysis, and medical treatment device development, in which engineering, physical sciences, medical science, agriculture, etc., are utilized and integrated

Information and Communications Sector

1. Current Situation and Issues

While the gap between Japan and the United States in information and communications technology continues to widen, R&D investment growth in the private sector is stalling, and collaboration among industry, academia, and the government remains insufficient. Since Japan's economy relies heavily on the information and communications industry, strengthening international competitiveness is an urgent task.

2. Thoughts on Prioritizing and Areas of Priority

Prioritize from the viewpoints of strengthening international competitiveness in the core technologies in which Japan has an advantage, such as mobile, optical and device technologies, the achievement of safe, secure and comfortable lives, strengthening the foundation for next-generation information and communications technologies and R&D infrastructure.

○ Building a "high-speed, highly reliable information systems" suitable for a society with a ubiquitous information-network, and the creation of a global market
- Technologies that realize an ultra-high-speed mobile internet system, in which vast amounts of information can be exchanged and utilized with high quality through wireless and optical networks anywhere and anytime, whether at home, in the office or on the move
- Technologies for devices with advanced-function and low-power-consumption
- Technologies for improved convenience, security, and reliability, for software and content, for the flexible and safe utilization of distributed computing power, etc.

○ Next-generation information and communications technologies, including next-generation human interfaces, quantum information and communication, and advanced traffic information systems (ITS, etc.), and so on

○ R&D infrastructures including science and technology databases, supercomputer networks, computational sciences, etc.

○ Human resource development in software, the Internet, interdisciplinary sectors, etc.

3. Five-Year R&D Objectives

(1) Information and communications system with high-speed and highly reliability
- Realize wireless access in the class of tens of megabits per second, fully optical networks at 10 terabits per second, ultra-large scale connections (nodes) with IPv6, and high-quality real-time transmissions, and mobile terminals with 1-gigahertz-class high-speed and advanced functionality that do not require recharging for a week at a time, etc.
- Realize databases that can be accessed by approximately 100,000 people at the same time, advanced coding and authentification technologies, the establishment of development methods for the improvement of software reliability and productivity, digital authorization control systems, etc.

(2) Next-generation information and communications technologies: Realize technologies that can understand user intention by considering surrounding conditions, quantum code key distribution over relatively short distances, advanced ITS using next-generation Internets, gigabit-class high-speed space communications, etc.

(3) R&D infrastructure: Realize electronic science and technology information and search systems, and joint supercomputer networks linking national research institutions and universities, etc.

4. Promotion Measures

(1) Promotion of R&D applications: Strengthen collaboration among industry, academia, and government, etc., to promote R&D activities specifically intended for practical use, promote international standardization, and promote technology development in test beds for real environments

(2) R&D systems: Promote greater movement of researchers between institutions, support and develop venture companies, utilize excellent universities and research institutions as R&D bases, develop high-level instructors in the information and communications field, and expand the scale of human resource development capabilities

(3) Investigation of effects on society: Research the effects of information and communications development on society, coordinate with IT strategy headquarters, form strategic international collaborations to encourage international standardization and technology transfers, etc.

Figure 3-1-4 Strategies for the Promotion of Each of the Four Priority Sectors (September 21, 2001)

Four Priority Sectors: the sectors that receive particular priority and preferential allocation of R&D resources.
Each section below features the current situation and issues, thoughts on prioritizing and areas of priority, five-year R&D objectives, and promotion measures for one of these sectors.

(Figure 3-1-4)

Environmental Area

1. Current Situation, and Issues

With environmental problems becoming both broader in geographical scope and more complex, research is requested to coordinate individual projects and develop planned and integrated programs. Other issues also requiring attention from a comprehensive viewpoint are research on human-environment interactions, and forecasting and preventive research (scenario-driven environmental research).

2. Thoughts on Prioritizing, and Areas of Priority

Engage in research that contributes to the solution of urgent and serious environmental problems, and to the building of sustainable societies. Perform research promoted by scenario-driven initiatives in which natural sciences, humanities and social sciences are merged under inter-ministerial collaboration.

[Important issues]

○ Research into global warming
○ Research into waste-free and resource recycling technologies
○ Research into eco-harmonious river basin and urban area regeneration
○ Research into chemical substance risk management
○ Research into global water cycle
○ Development of intellectual infrastructure such as standard materials and environmental biological resources
○ Advanced research

3. Five-Year R&D Objectives

(1) Research into global warming: Seek possibilities for controlling the emission of greenhouse gases into the atmosphere so as not to endanger mankind and ecosystems, and examine obtaining and systemizing scientific knowledge, developing and advancing remedy technologies and creating scenarios for the control of global warming
(2) Research into waste-free and resource recycling technologies: Develop technologies and systems that contribute to the reduction of waste volumes, improvement of recycling and reutilization rates, and reduction of environmental risks from toxic wastes
(3) Research into eco-harmonious river basin and urban area regeneration: Propose measures for the resolution of such environmental problems as high environmental loads in urban areas and the retreat or deterioration of natural environments, and systematically develop riparian district and urban renewal technologies and systems in order to contribute to the preparation of specific plans for coexistence with nature in major urban areas
(4) Research into chemical substance risk management: While determining the chemical substances that are expected to need risk management, urgently build up the technological infrastructure, knowledge systems, and intellectual infrastructure for comprehensive management of chemical substances, to ensure "safety and security"
(5) Research into global water cycle: Provide the scientific knowledge and technological infrastructure required for assessing the effects on human society of water resource supply and demand and changes in the water cycle, and for establishing water management methods that lead to sustainable development
(6) Intellectual infrastructure for the environmental area: Broaden and upgrade the intellectual infrastructure for environmental research
(7) Promotion of advanced research: Develop innovative knowledge for the resolution of environmental problems, and build new paradigms

4. Promotion Measures

(1) Improvement of R&D quality: Establish promotion and evaluation systems for initiatives, Foster international cooperation, Disseminate R&D results, reflected in environmental policies, and basic efforts on societal understanding, Define roles and foster cooperation among industry, academia, and government, Cooperate with initiatives by local governments and NGOs, etc.
(2) Necessary resources: Enhance and expand competitive funding, Assure and develop human resources, strengthen international research networks, improve systems for accepting foreign researchers, and support and actively utilize environment-related university institutions, Cooperate with other sectors: actively utilize new methods and technologies in other sectors in order to engender reform of environment research paradigms, Develop important large-scale facilities and equipments specific to environmental research

Nanotechnology and Materials Area

1. Current Situation, and Issues

Nanotechnology offers great possibilities for technological innovation in a wide range of industries. Nations everywhere are actively engaged in strategic efforts. In materials technology, competitiveness arises from high value-added functional materials.

2. Thoughts on Prioritizing, and Areas of Priority

Assign priorities from the perspectives of "strengthening industrial competitiveness and forming the basis for sustainable economic growth," "responses to environmental and energy problems, and to an aged society with few children," and "assurance of safe and secure lives for the people, and retention of strategic technologies." Clarify the timetable for technological development, and steadily implement basic measurement, evaluation, and processing technologies, as well as materials technologies, etc.

○ Nano-devices and materials for next-generation information and communication systems
○ Materials for environmental preservation and advanced energy utilization
○ Ultra-small medical systems and materials, and nano-biology utilizing and controlling biological mechanisms
○ Basic technologies such as measurement, evaluation, processing, numerical analysis and simulations, and areas spreading from them
○ Substance and materials technologies that can generate innovative properties and functions

3. Five-Year R&D Objectives

○ Nano-devices and materials for next-generation information and communication systems
– Ensure international competitiveness in high-speed and high IC density device technologies
– Use the competitive development of various devices based on new principles, to select and focus next-generation, cutting-edge core technologies
○ Materials for environmental preservation and advanced energy utilization
– Realize materials for the reduction of CO2 emission volumes required to meet the COP3 objectives, and encourage the use of these materials into society
– Realize technologies for the reduction and elimination of risks arising from chemical substances, and incorporate them into society and national life
○ Ultra-small medical systems and materials, and nano-biology utilizing and controlling biological mechanisms
– Establish the groundwork for bio-functional materials, pinpoint therapies, and other technologies to extend healthy life expectancy
– Elucidate the basic principles to construct the systems that utilize the motive principles, etc., of bio-molecules
○ Basic technologies for measurement, evaluation, processing, numerical analysis and simulations, and areas spreading from them
– Realize highly precise measurement and processing technologies, improved by at least one order of magnitude compared to the levels required by the above three objectives
– Utilize simulations in the development of new materials and new devices
○ Substance and materials technologies that can generate innovative properties and functions
– Develop new materials through R&D activities that go beyond the boundaries of traditional materials classification
– Build up research and production methods that lead to the rapid resolution of social issues

4. Promotion Measures

○ Encourage competition at daily R&D activities, and prepare environments suitable for that purpose
(Emphasis on competitive funding, promotion that goes beyond the boundaries of government ministries/agencies or systems, and the strategic acquisition of intellectual property)
○ Promote cooperation between different areas and researchers
(Support for cooperative efforts among different areas building up networks among researchers and among institutions, etc.)
○ Build a system for the industrialization of R&D results, and promote collaboration among industry, academia, and the government
(Acceleration of technology transfers, improvement of incentives such as support measures, and promotion of human resources mobility)
○ Ensure and develop human resources
(Personnel capable of working in interdisciplinary areas, research assistants, and personnel capable of research evaluation and management)

(Figure 3-1-4)

Four Other Fundamental Areas: areas that are fundamental to the existence of the nation, and that are emphasized as areas in which it is essential for Japan to be involved:

Energy Area

1.Areas of Priority and Five-Year Objectives

(1) R&D that brings about a reform of the total energy system, including supply, transportation, conversion, and consumption
Vigorous and efficient efforts to fulfill 3E goals
(2) R&D essential for upgrading the energy infrastructure
Energy infrastructure-related R&D; upgrades in efficiency and environmental soundness
(3) R&D for safe and secure energy
R&D that reassures people by ensuring safety in all aspects of energy
(4) R&D that comprehensively evaluates and analyzes energy both socially and economically
R&D that comprehensively analyzes and evaluates social, economic, and environmental facets, and deepens social understanding; R&D with the aim of creating industries
* Five-year objectives have been established for the above items.

2. Promotion Measures

1. Important items for improving the quality and efficiency of R&D:

(1) Creation of results that are transferable to developing countries, and active use of international cooperation through participation in international joint research
(2) R&D efforts and evaluation under the conditions of the level of social understanding of R&D results and the diffusion of them
(3) To recognize each role for, and collaboration among, industry, academia and the government in order to promote the efficient development of system technologies
(4) Efficient promotion through inter-ministerial coordination of cross-ministerial themes
(5) Consistent efforts for short-, mid-, and long-term R&D themes

2. Points of concern relating to necessary R&D resources:

Securing and fostering personnel; enhancement of education on energy utilization and safety

Infrastructure Area

1.Areas of priority and Five-Year Objectives

○ Building of Safety
Mechanisms for the generation of abnormal natural phenomena; immediate response systems for disasters (disaster prevention IT, emergency rescue systems, etc.); measures to reduce massive disaster damage to densely populated urban areas; systems for the protection of core functions and cultural assets; ultra-advanced disaster prevention support systems; intelligent transport systems (ITS); measures for land, sea, and air traffic safety; countermeasures against deteriorating social infrastructure; and safety measures in response to toxic or dangerous substances, or to criminal activity
○ Regeneration of the beauty of Japan, and the establishment of a basis for high-quality lives
Rebuilding beautiful living spaces in co-existence with nature; wide-area local topics; restoration of drainage area water cycles and general water management; transportation systems consonant with modern traffic and physical distribution; barrier-free systems and universal designs; and information infrastructure technologies and systems for society
■ A policy of proactive R&D cooperation for social infrastructure building in developing countries is indispensable.
* Five-year objectives have been established for the above items.

2.Promotion Measures

○ Enhancement of policy studies on the development of infrastructure
○ Promotion of collaboration between the science and technology community and the humanities and social science community
○ Enhancement of R&D in cross-governmental areas
○ Stimulation of exchanges among industry, academia, and government researchers (including academic societies)
○ Establishment of international scheme of science and technology for infrastructure, particularly in the east Asia region
○ Promotion of R&D to support developing countries for infrastructure buildup

Manufacturing Technology Area

1.Areas of Priority and Five-Year Objectives

○ Strengthening competitiveness through manufacturing technology innovations
Dramatic progress in productivity through high utilization of IT; changes to manufacturing processes through breakthroughs in technology; upgrading of quality control, safety, and maintenance technologies
○ Pioneering new areas of manufacturing technology
High value added commercialization technology (nanotechnology applications, etc.); technologies for cultivating new demand
○ Manufacturing technology to minimize the environmental burden
Manufacturing systems adapted to the formation of an environmentally-based society; minimization of harmful substances; prevention of global warming
* Five-year objectives have been established for the above items.

2.Promotion Measures

(1) Develop human resources; improve environments that encourage creativity
(2) Accumulate fundamental knowledge, technology, and know-how
(3) Intellectual property rights-related strategies
(1) Incentives for the acquisition of intellectual property rights; (2) Support measures for launching businesses based on patents; (3) A society and system that pay due recognition to inventors
(4) Review the status of collaboration among industry, academia, and government
(1) Collaborate and clarify the sharing of responsibilities among industry, academia, and the government from the initial stages of research; (2) Promote personnel mobility; (3) Promote matching funds at times of collaboration among industry, academia, and the government; (4) Clarification of the relations of rights in conflict of interest issues
(5) Promote the development and standardization of the intellectual infrastructure
(6) Promote practical applications such as through the formation of venture businesses
(1) Support measures for the market entry of venture business in the field of new manufacturing technologies; (2) Smooth the transfer of university research results into the manufacturing world through active utilization of TLOs; (3) Actively utilize subvention systems for practical applications

Frontier Area

1.Areas of Priority and Five-Year Objectives

○ Ensuring security Information-gathering technology using satellites (including transport capability); advanced positioning and surveying technology
○ Technology innovations enabling global market entry
Low-cost, reliable transportation technology; next-generation satellite technology; technology for the utilization of marine resources
○ International contributions to human intellectual creation, and securing international status
International projects that give people, and particularly the next generation, dreams, hope, and pride; construction of a worldwide network for global environmental information
* Five-year objectives have been established for the above items.

2.Promotion Measures

○ Restructure the space development and utilization scheme so that it can be promoted by the nation as a whole
○ Establishment of public-private burden sharing and cooperation systems needed for nurturing space-related activities into a key industry
○ Promotion of marine utilization through collaboration with other sectors
○ Return to society of the fruits of research activities on global environmental change
○ Strategic promotion of basic research and training/securing human resources
○ Continual and seamless acquisition, processing, and accumulation of information, and the establishment of a system to transmit it to the world
○ Establishment of R&D methods and systems incorporating the latest advanced information technology
○ Clarification of international relationships in each cooperative project in order to promote smooth interaction
○ Nurturing interpreters who can explain things to the public in an easy to understand manner, and the stimulation of public relations activities
○ Significant progress in the efficiency of R&D, especially in big projects

(Promotion of the Environmental Area)

"Strategy for Promotion of Earth Observation" (opinions presented on December 27, 2004)

Amid on-going international efforts to establish a global earth observation system, the Council conducted research and examination to identify Japan's efforts for earth observation and presented its opinions to relevant ministers. The report maintains that it is important to "establish an integrated earth observation system guided by use requirements" through cooperation among relevant ministries and organizations and that it is necessary to establish a promotion system and organization in order for the global earth observation system to be effective and efficient.

(Promotion of the Nanotechnology and Materials Area)

In order to promote R&D and industrialization in the nanotechnology and materials areas, the Council has been implementing projects for the "utilization of structural materials in the construction market" as "collaborative projects" among ministries and agencies based on the "Report on the Promotion of Industrial Development in the Nanotechnology and Materials Area" (opinions presented on July 23, 2003).

(Evaluations)

(1) Examination of the state of implementation of midterm evaluations of R&D (July 15, 2004)

The Minister of State for Science and Technology Policy and the eminent members of the Council examined the state of midterm evaluations by each ministry and agency regarding ongoing R&D projects with funding of 1 billion yen or more in the FY2004 budget and instructed to conduct midterm evaluations appropriately with regard to those R&D projects that have not been evaluated for a long time.

(2) Follow-up study of evaluations of large-scale R&D projects (August 4, 2004)

The Council conducted follow-up studies on the evaluations of large-scale R&D projects (regeneration medicine realization project, rice genome function analysis) implemented in FY2004 and presented improvements, etc. to relevant ministries.

(3) Regarding the follow-up results of the "Broad Guidelines Concerning National R&D Evaluation" and review of the broad guidelines (opinions presented on March 29, 2005)

The Council grasped the progress and problems involved in evaluation implementation by studying the state of overall implementation of R&D evaluations in Japan, identified challenges and improvement for future R&D evaluation, worked out a specific plan to revise the broad guidelines, and presented its opinion to relevant ministers.

(Management of Intellectual Properties)

"Report on the Management of Intellectual Properties" (opinions presented on May 26, 2004)

Taking the opportunity of the incorporation of national universities, the Council conducted research and examination with regard to problems, such as clarification of the treatment of intellectual properties and other research results held by universities, and presented its opinions to relevant ministers. The opinions were reflected in the "Intellectual Property Strategic Program 2004" compiled by the Intellectual Property Policy Headquarters in May 2004 (See Section 3.3.6.4).

(Fostering and Ensuring S&T Related Personnel Resources)

"On Utilization of Science-and Technology-Related Personnel Resources" (opinions presented on July 23, 2004)

Investigations and examinations were conducted in regards to fostering and ensuring the availability of the scientists, technologists, and specialists who are needed for promoting world-class research results and their utilization. The Council then presented its opinions to the relevant ministers. The report calls for ① fostering human resources capable of exercising international leadership, ② higher education of a world-class standard and elementary and secondary education that fosters children's diversity and creativity, and ③ establishment of research and education environments conducive to the creation of innovative values (See Section 3.3.4).

(Response to Bioethics)

"Basic Conceptual Approach Relating to the Treatment of Human Embryos" (July 23, 2004)

Based on Article 2 of the Supplementary Provisions of the "Law Concerning Regulation Relating to Human Cloning Technologies and Other Similar Technologies," the Council started a discussion on the basic conceptual approach relating to the treatment of human embryos. The Council then presented its opinions to the relevant ministers. While the report in principle prohibits treating human embryos in a way that would damage the embryos, it has set forth social norms concerning the treatment of human embryos, saying that there are cases where it is necessary to approve exceptional treatment of human embryos in order to respond to people's requests in the pursuit of happiness with regard to health and welfare (See Section 3.2.2.1.2).

(Promotion of Space Development and Utilization)

"Basic Strategy for Space Development and Utilization in Japan" (opinions presented on September 9, 2004)

The Council presented its opinions on the significance of space development and utilization in consideration of recent changes in the domestic and overseas situations surrounding space development and utilization, such as importance as a national strategic technology, contribution to overall national security, and sustainable development of the earth and mankind. The report also calls for promoting space development and utilization under the basic policy of strengthening basic technologies by maintaining Japan's capability of launching satellites when necessary and by giving top priority to ensuring reliability.

(Promotion of science and technology conducive to safety)

With various events that represent a threat to the safety of the public, such as large-scale disasters, various types of terrorism, violent crimes, and emerging and re-emerging infectious diseases becoming increasingly common in recent years, strengthening the country's crisis management system and building a safe society have become pressing national issues. For this reason, the Science and Technology Promotion Project Team, established under the Special Research Committee on Promotion and Strategy for Priority Sectors in October 2004, has been conducting research and examination on science and technology to construct a safe society where people can live without anxiety.

(Special Coordination Funds for Promoting Science and Technology)

The Special Coordination Funds for Promoting Science and Technology (Chosei-hi) is a competitive research fund for promoting the systematic reform of science and technology by taking on policies which become policy initiatives for each of the other administrative agencies, based on policies laid down by the CSTP. In FY2004, the Special Coordination Funds for Promoting Science and Technology supported two topics as meriting emergency R&D efforts, "Emergency Survey Research on the Chuetsu earthquake in Niigata Prefecture" (November 4, 2004) and "Emergency Survey Research on Damage Caused by the Sumatran Earthquake and the Indian Ocean Tsunami" (January 19, 2005) (See Section 3.3.1.1.5).

(4) Efforts towards Formulation of the 3rd Science and Technology Basic Plan

(Follow-up to the 2nd Science and Technology Basic Plan)

"Progress of Scientific and Technological Policies Based on the Science and Technology Basic Plan (FY2001~2005) (opinions presented on May 26, 2004)

With regard to the state of implementation of measures laid down in the Basic Plan, the Council conducted a detailed follow-up study mainly on the state of measures implemented during the three years from FY2001 to FY2003 and worked out a list of basic problems that should be dealt with in the future.

Also, as a follow-up study on the 1st and 2nd Science and Technology Basic Plan, the "Survey for Evaluation of Effects Achieved in the Basic Plan" was conducted by the National Institute of Science and Technology Policy by using FY2003~2004 Special Coordination Funds for Promoting Science and Technology (published in March 2005).

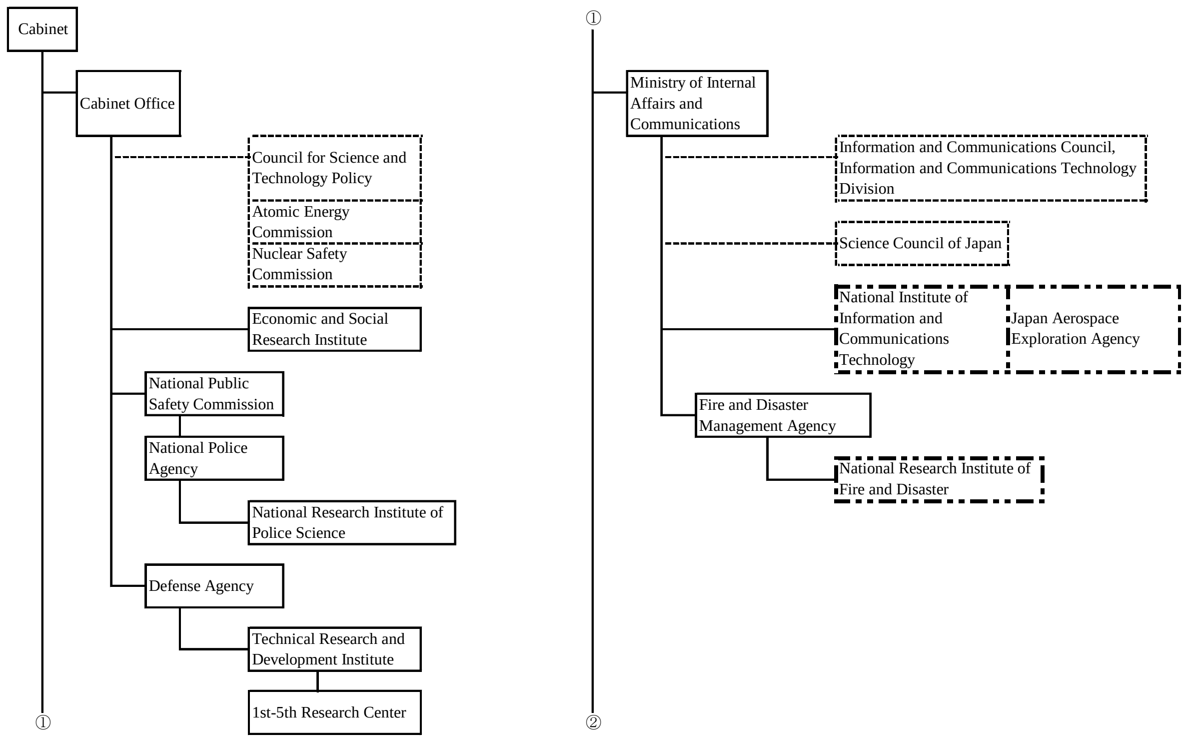
(Study and examination of Basic Policy)

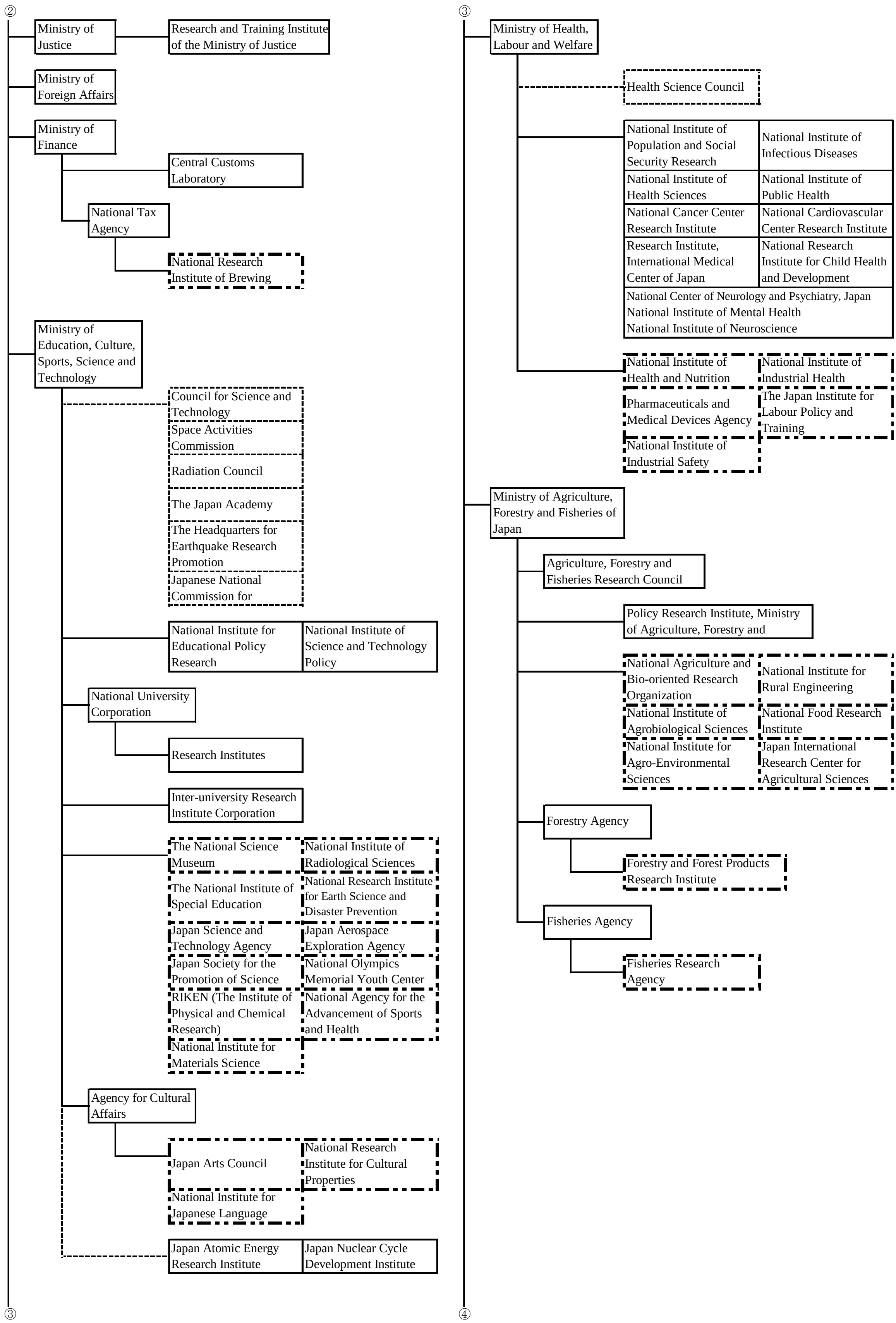
The Council for Science and Technology Policy, which is required to formulate basic policies on science and technology that serve as the basis for the Science and Technology Basic Plan, established a task force on basic policies in October 2004 to formulate the 3rd Science and Technology Basic Plan for five years starting in FY2006. The task force is composed of experts in various fields, including international politics, national security, economy, fiscal policy, laws, and business management as well as researchers. The task force has been conducting research and study on basic policies concerning science and technology after being instructed by the Prime Minister to study "basic policy on science and technology" in December 2004.

3.1.3 Administrative Structure and Budget for Science and Technology

3.1.3.1 Administrative Structure of Science and Technology

Japan's policy concerning science and technology is based on the Science and Technology Basic Law and on the Science and Technology Basic Plan, and is also promoted through programs of the administrative organs based on the various recommendations and advice offered by the former Council for Science and Technology, and now by the CSTP. Research is carried out at national research institutions, public corporations, independent administrative institutions, universities, and university joint research institutions, and various research programs are used to promote research, and carry out preparations for a research and development environment (Figure 3-1-5).




②
Ministry of Justice
Research and Training Institute of the Ministry of Justice
Ministry of Foreign Affairs
Ministry of Finance
Central Customs Laboratory
National Tax Agency
National Research Institute of Brewing
Ministry of Education, Culture, Sports, Science and Technology
Council for Science and Technology
Space Activities Commission
Radiation Council
The Japan Academy
The Headquarters for Earthquake Research Promotion
Japanese National Commission for
National Institute for Educational Policy Research
National Institute of Science and Technology Policy
National University Corporation
Research Institutes
Inter-university Research Institute Corporation
The National Science Museum
National Institute of Radiological Sciences
The National Institute of Special Education
National Research Institute for Earth Science and Disaster Prevention
Japan Science and Technology Agency
Japan Aerospace Exploration Agency
Japan Society for the Promotion of Science
National Olympics Memorial Youth Center
RIKEN (The Institute of Physical and Chemical Research)
National Agency for the Advancement of Sports and Health
National Institute for Materials Science
Agency for Cultural Affairs
Japan Arts Council
National Research Institute for Cultural Properties
National Institute for Japanese Language
Japan Atomic Energy Research Institute
Japan Nuclear Cycle Development Institute
③
③
Ministry of Health, Labour and Welfare
Health Science Council
National Institute of Population and Social Security Research
National Institute of Infectious Diseases
National Institute of Health Sciences
National Institute of Public Health
National Cancer Center Research Institute
National Cardiovascular Center Research Institute
Research Institute, International Medical Center of Japan
National Research Institute for Child Health and Development
National Center of Neurology and Psychiatry, Japan
National Institute of Mental Health
National Institute of Neuroscience
National Institute of Health and Nutrition
National Institute of Industrial Health
Pharmaceuticals and Medical Devices Agency
The Japan Institute for Labour Policy and Training
National Institute of Industrial Safety
Ministry of Agriculture, Forestry and Fisheries of Japan
Agriculture, Forestry and Fisheries Research Council
Policy Research Institute, Ministry of Agriculture, Forestry and
National Agriculture and Bio-oriented Research Organization
National Institute for Rural Engineering
National Institute of Agrobiological Sciences
National Food Research Institute
National Institute for Agro-Environmental Sciences
Japan International Research Center for Agricultural Sciences
Forestry Agency
Forestry and Forest Products Research Institute
Fisheries Agency
Fisheries Research Agency
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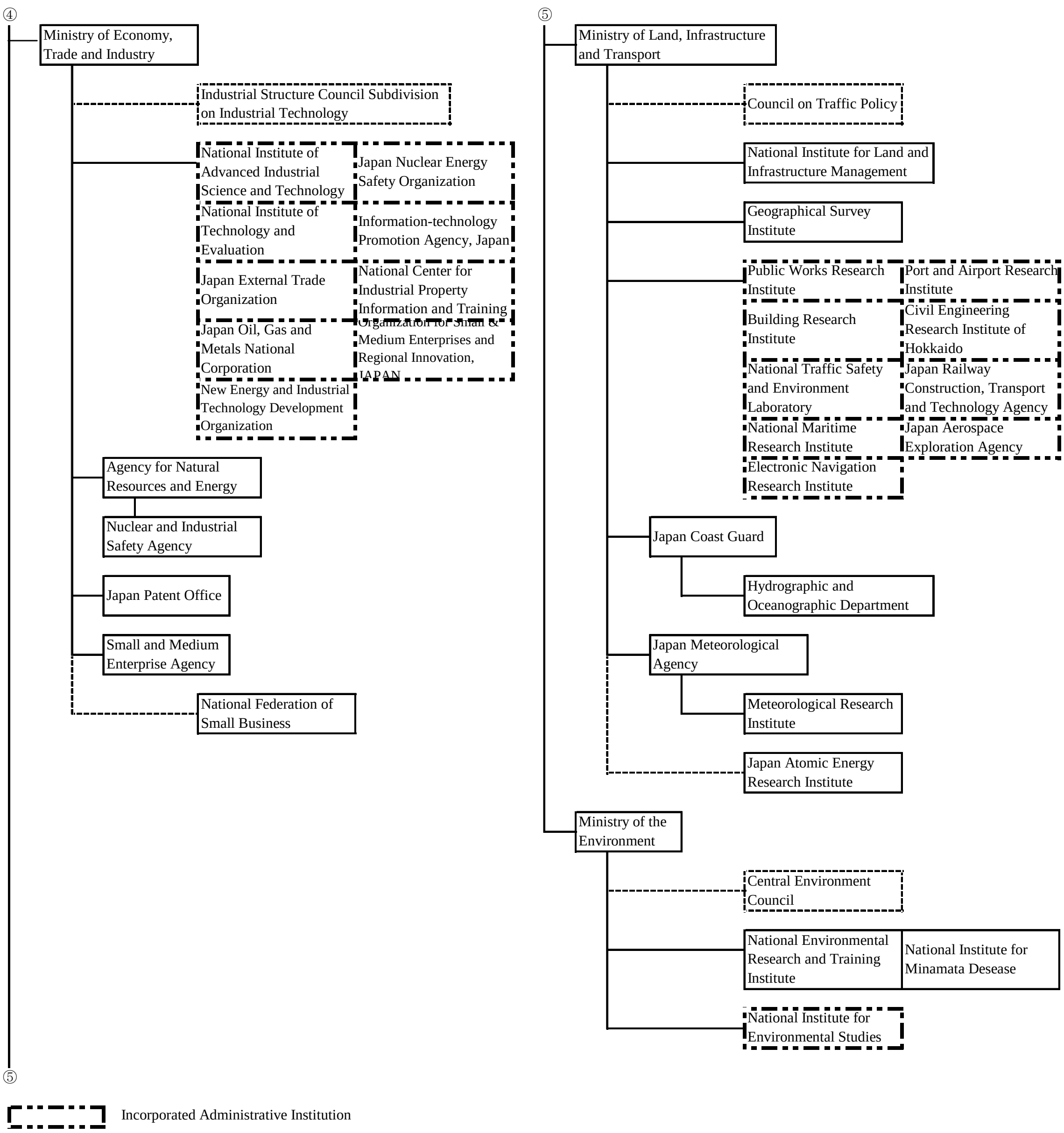

Figure 3-1-5 Japan's Science and Technology Administrative Structure (as of March 2005)

Notes: The Japan Atomic Energy Research Institute and the Japan Nuclear Cycle Development Institute are planned to be merged in October 1, 2005 to form the National Institute of Japan Atomic Energy Development.

The Council for Science and Technology Policy coordinates the science-and technology-related measures of relevant ministries and agencies by acting as a control tower under the leadership of the Prime Minister by examining and discussing the overall strategy and policies on allocation of budget, personnel and other resources related to science and technology. The Ministry of Education, Culture, Sports, Science and Technology acts in line with those strategies to prepare specific research and development plans for individual sectors, coordinates policies for estimating costs planned by test and research institutions, etc., and administers allocations of the Special Coordination Fund for Promoting

Science and Technology (SCF), in order to coordinate the management of science and technology with relevant administrative institutions. The Ministry comprehensively promotes the implementation of research and development in advanced and important science and technology fields, and the admi nistration of science and technology that advances and strengthens creative and basic research.

In recent years, cooperation between ministries and agencies has been strengthened with the establishment of roundtable groups and inter-ministerial liaison committees concerning various research sectors and related measures, including programs for the promotion of research in brain sciences, and for basic research conducted by public corporations through public canvassing methods. Depending on the character of the respective fields or policies, these programs are promoting lateral, long-term thinking between ministries and agencies and the adoption of priority guidelines on how to promote research and development, and also promoting cooperation through the promotion of information exchanges concerning the progress of research, etc., and researcher exchanges.

The Science Council conducts surveys and discussions on important issues regarding the comprehensive promotion of science and technology in response to inquiries posed by the Minister of Education, Culture, Sports, Science and Technology, and presents opinions on these issues to the minister.

The Science Council's recommendations are shown in Table 3-1-6.

Incidentally, in anticipation of the preparation of the next (3^{rd}) Science and Technology Basic Plan for five years starting in FY2006, councils, etc. of relevant ministries and agencies are conducting research and examination of basic policies to realize an advanced science-and technology-oriented nation.

Table 3-1-6 Recommendations of the Council for Science and Technology (FY2004)

Principal Reports

Date (m/d/y)	Principal Reports
	Subdivision on R&D Planning and
9/6/04	Overview of the Preliminary Evaluation Results for Priority Topics, Etc., in Budget Requests for FY2005
	Subdivision on Resources
1/24/05	STANDARD TABLES OF FOOD COMPOSITION IN JAPAN Fifth Revised and Enlarged Edition - 2005 -
1/24/05	STANDARD TABLES OF FOOD COMPOSITION IN JAPAN Fifth Revised and Enlarged Edition - 2005 - - FATTY ACIDS SECTION -
	Subdivision on Science
6/25/04	Ideal form of grants-in-aid for scientific research (interim report by Research Funds Section)
6/30/04	Promotion of future academic research (report by Special Committee on Basic Problems)
12/10/04	Ideal form of grants-in-aid for scientific research (report by Research Funds Section)
1/11/05	Measures for comprehensive promotion of diversified areas in academic research (progress report by Academic Research Promotion Section)
1/17/05	Academic research promotion measures that should be incorporated into the 3rd Science and Technology Basic Plan （Summary of opinions）
	Bioethics・Biosafety Section
12/24/04	Handling of personal information in medical research（Subcommittee on Handling of Human Genetic Code in Life Science Studies）
12/28/04	Ethical guidelines for human genome/gene analysis studies (revised)
12/28/04	Ethical guidelines for epidemiological study (revised)
12/28/04	Ethical guidelines for gene-related medical research (revised)
	Promotion of Internationalization Committee
1/19/05	Strategic promotion of international endeavors in science, technology and academic fields
	Committee on Human Resources
7/16/04	Human resources development from the viewpoints of science and technology and society (3rd proposal)

3.1.3.2 Budget for Science and Technology

The Basic Plan aims to expand the funding required for the promotion of the measures raised in the Basic Plan based on prioritized and efficient allocation of funding, taking into account future socioeconomic trends, as well as the need for the promotion of science and technology.

In FY2004, Japan’s budget for science and technology totaled 3.6084 trillion yen. Of this total, the general account budget was 2.9664 trillion yen, while the special account budget was 641.9 billion yen. In the general account budget, the amount singled out for the promotion of science and technology was 1.2841 trillion yen (Table 3-1-7).

Trends in the budget for science and technology by ministry or agency are shown in Table 3-1-8.

Since the administration of science and technology in Japan is not concentrated in a single ministry, but rather is spread among a large number of ministries and agencies, there is a need for the coordination of science and technology measures between the relevant ministries and agencies that can eliminate unnecessary duplication and promote stronger cooperation, so as to ensure consistency among ministries as a whole, and to efficiently and effectively promote science and technology.

For this reason, the Council for Science and Technology Policy conducts overall coordination to ensure that important measures stipulated in overall strategies or in the Science and Technology Basic Plan prepared based on the overall strategies are properly and firmly realized throughout Japan, by formulating resource-allocation policies and prioritizing science-and technology-related measures of relevant ministries and agencies after budget requests are made. In addition, the Ministry of Education, Culture, Sports, Science and Technology contacts the relevant ministries and agencies each fiscal year, before budget requests for science and technology related expenditures are made, to hear the reasoning behind their budget requests. The ministry then coordinates with the ministries and agencies to eliminate any duplication and to promote inter-ministerial cooperation, as part of government-wide efforts.

Table 3-1-7 Trends in the Science and Technology Expenditures

(Billion yen)

Item / Fiscal		2000	2001	2002	2003	2004
Science and Technology Promotion Fund	(A)	1,024.4	1,112.4	1,183.2	1,229.8	1,284.1
Percentage increase over the previous year	%	107.5	108.6	106.4	103.9	104.4
Other research appropriations	(B)	700.4	725.2	669.7	655.4	1,682.3
Percentage increase over the previous year	%	109.2	103.5	92.3	97.9	256.7
Science and technology appropriations from the General Account Budget	(C)=(A)+(B)	1,724.8	1,837.6	1,852.9	1,885.2	2,966.4
Percentage increase over the previous year	%	108.2	106.5	100.8	101.7	157.4
Science and technology appropriations from Special Accounts	(D)	1,561.2	1,630.9	1,691.5	1,712.2	641.9
Percentage increase over the previous year	%	99.9	104.5	103.7	101.2	37.5
Science and Technology Budget	(E)=(C)+(D)	3,286.0	3,468.5	3,544.4	3,597.4	3,608.4
Percentage increase over the previous year	%	104.1	105.6	102.2	101.5	100.3
General Account Budget	(F)	84,987.1	82,652.4	81,230.0	81,789.1	82,110.9
Percentage increase over the previous year	%	103.8	97.3	98.3	100.7	100.4
General Budget Expenditure	(G)	48,091.4	48,658.9	47,547.2	47,592.2	47,632.0
Percentage increase over the previous year	%	102.6	101.2	97.7	100.1	100.1

Notes: 1. Amounts shown for Other research appropriations (B) and Science and technology appropriations from Special Accounts (D) are MEXT's estimates.
2. All amounts represent initial budgets or appropriations for the respective fiscal year.
3. Since amounts have been rounded, the sum of the amounts and percentages for each column and the totals and percentages shown above do not necessarily agree.
4. Of the expenditures related to science and technology in the general accounts budget for FY2004, those for national university corporations, etc. were calculated from the aggregate of subsidies for administrative costs, grants for facility maintenance costs, and self generated income. (The amount corresponds to the science and technology budget in the National Schools Special Account (abolished at the end of FY2003)). The same in Table 3-1-8.
5. Based on policies of the Second Science and Technology Basic Plan, the subjects of calculation were revised starting in FY2001.

Table 3-1-8 Science and Technology Expenditure Breakdown by Ministry and Agency

(Million yen)

Ministry or agency	FY2003				FY2004			
	Science and Technology Promotion Fund	Other research appropriations from General Account Budget	Science and technology appropriations from Special Accounts	Total amount of Science and Technology Budget	Science and Technology Promotion Fund	Other research appropriations from General Account Budget	Science and technology appropriations from Special Accounts	Total amount of Science and Technology Budget
Diet	908	80	–	988	956	77	–	1,033
Cabinet Secretariat	–	64,440	–	64,440	–	63,169	–	63,169
Cabinet Office	4,163	4,285	–	8,448	6,416	3,536	–	9,952
National Police Agency	2,230	–	–	2,230	2,164	–	–	2,164
Defense Agency	–	160,812	–	160,812	–	185,522	–	185,522
Ministry of Internal Affairs and Communications	32,900	36,662	10,500	80,061	51,843	17,902	10,400	80,144
Ministry of Justice	2,178	–	–	2,178	2,167	–	–	2,167
Ministry of Foreign Affairs	–	10,403	–	10,403	–	10,345	–	10,345
Ministry of Finance	1,309	341	–	1,650	1,196	351	–	1,547
Ministry of Education, Culture, Sports, Science and Technology	785,237	285,322	1,219,634	2,290,193	810,041	1,318,787	155,164	2,283,991
Ministry of Health, Labour and Welfare	106,378	2,870	24,746	133,994	107,675	1,660	19,684	129,020
Ministry of Agriculture, Forestry, and Fisheries	112,162	5,095	1,520	118,777	113,436	4,088	1,518	119,042
Ministry of Economy, Trade and Industry	130,569	55,850	424,877	611,296	137,659	44,973	422,697	605,328
Ministry of Land, Infrastructure and Transport	29,601	20,961	30,098	80,659	28,525	25,058	30,116	83,699
Ministry of the Environment	22,148	8,288	800	31,236	22,036	6,866	2,334	31,236
Total	**1,229,782**	**655,409**	**1,712,175**	**3,597,366**	**1,284,115**	**1,682,333**	**641,913**	**3,608,361**

Notes: 1. All amounts represent initial expenditures or appropriations for the respective fiscal year.
2. Since amounts have been rounded off, the sum of the amounts for each column and the totals shown above do not necessarily agree.
3. Overlapping is avoided in total amounts, but some amounts include overlapping expenditures.

3.2 Priority Strategies for Science and Technology

3.2.1 Promotion of Basic Research

Basic research builds on the free thinking of researchers to discover new natural laws and principles, to build original theories, and to predict and discover unknown phenomena, thereby contributing to the expansion of humankind's intellectual assets and bringing about creation of research results of the world's highest standards and of innovative new technologies that support the economy. While the results of basic research do not always lead immediately to practical applications, they rather accumulate as the common property of all humankind, and should therefore be widely, steadily, and continuously promoted.

In promoting basic research, attention must be given to the fact that such research depends more on the capabilities of individuals than on those of groups. It is therefore necessary to support researchers so that they are able to carry out highly creative research based on their liberal and open ideas. There is also a need to promote cross-sectoral research whereby researchers from different areas of expertise step outside their respective areas for exchanges and, in the process, come up with new ideas. To this end, while keeping in mind global research trends and conditions in Japan, research is being actively promoted in areas that require organized and international promotion, and in areas that require large-scale facilities and equipment for expansion of the frontiers of knowledge.

In addition, universities and Inter-University Research Institutes, which play a core role in the academic research that contributes to the development of culture and the building of civilization, are comprehensively developing both research activities and education activities as integral parts of their entire systems.

3.2.2 Prioritization of Research and Development in Response to Issues Important to the State and Society

Aggressive and strategic investment in priority sectors and promotion of research and development are essential for ensuring sustained economic development through vitalization of the economy and industry, and for assuring people of safe, secure lives.

The following measures were taken in FY 2004 in line with the Priority Strategies stipulated in the Basic Plan and the "Promotion Strategy for Each Sector" (see Figure 3-1-4).

3.2.2.1 Life Sciences

(1) Promotion of Life Sciences

The life sciences aim at elucidating the complex and elaborate mechanisms of biological phenomena produced by living things, and their results contribute greatly to the improvement of people's lives and to development of the national economy, through dramatic advances in medicine, resolutions of food supply and environmental problems, and other areas.

(Efforts toward Industrialization, Etc)

To strengthen efforts toward commercialization of the life sciences, the heads of five ministries and agencies (Director-General of the Science and Technology Agency, Minister of Education, Minister of Health and Welfare, Minister of Agriculture, Forestry and Fisheries, and Minister of International Trade and Industry [all of them are at that time]) drew up the "Basic Policy for the Creation of Biotechnology Industries (January 1999)" and the "Basic Strategy for the Creation of Bio-technology Industries (July 1999)."Based on this Strategy, the "Millennium Project" was implemented from FY2000 to FY2004 to pro- mote revolutionary advances in personalized medi- cine for individual characteristics in response to the Aging Society, and to promote environments that offer prosperous and healthy eating habits and sec- ure living. Moreover, an evaluation and support council consisting of third-party experts has pro- vided annual evaluations of the state of the project.

Furthermore, the Prime Minister's Office establishhed the BT (Biotechnology) Strategy Council in July 2002. This strategy council issued the "Strategies for Development of Biotechnology" in December 2002, detailing three strategies focused on 2010, including: (1) revamping research and development; (2) enhancing the process of industrialization; and (3) ensuring public understanding, and specific action plans for achieving those strategies. Follow-ups were implemented for the status of implementation of the strategies in March 2005.

(Strategic Life Sciences Fields)

(1) Genome-Related Research

On April 14, 2003, the International Human Genome Sequencing Consortium, a grouping of six countries and 24 institutions from Japan, North America, Europe, and China engaged in sequencing the human genome containing all human genetic information, announced completion of detailed sequencing of the human genome.

Based on the result, the Ministry of Education, Culture, Sports, Science and Technology started the "Genome Network Project" in FY 2004. This project aims to elucidate basic problems relating to life sciences, elucidate the mechanisms of disease development, and develop new treatment methods by clarifying the network that establishes vital activity mainly through comprehensive analysis of the function of regulating gene expression and interactions of biological molecules, including proteins. In addition, post-genome research has been steadily promoted in such fields as the analysis of protein structures and functions related to genome-based drug discoveries, etc., and the development of revolutionary medical technologies that make use of individual genome information. In addition, basic research in this sector at universities and colleges has been intensively promoted through the Grants-in-Aid for Scientific Research, the Research for the Future Programs and other related programs.

Since FY2000, the Ministry of Health, Labour, and Welfare has been involved in the Millennium Project, using the elucidation of genes related to dementia, cancer, diabetes, high blood pressure, asthma, and other ailments of the elderly, to promote R&D for the establishment of methods for the prevention and treatment of disease and the development of revolutionary new drugs. Moreover, as part of research for the promotion of incipient advanced medical technologies, especially those that build on the rapid advances in genomic sciences seen in recent years, research and development commenced in FY2002 into basic technologies (toxicogenomics) that allow rapid and effective prediction of the safety (toxicity, side effects, etc.) of compounds that are candidates for medical products.

The Ministry of Agriculture, Forestry and Fisheries, in research performed mainly by the National Institute of Agrobiological Sciences, isolates genes from rice plants, silkworms, and animals to be used for improving agricultural production, develops DNA utilization technology, and systematically collects, accumulates and distributes the DNA utilization results. In the Rice Genome Project, Japan has assumed a leading role, particularly in sequencing the full length of the rice genome. Although the project's international consortium consisted of 10 countries and regions, Japan played a central role, accounting for about 60% of the total sequence on its own. The sequencing of all 370 million base pairs that can be sequenced by existing technologies, including parts difficult to sequence, was completed in December 2004. Regarding genome sequencing of the silkworm, about 80% of the entire base sequence was sequenced and made public in February 2004.

Furthermore, the Ministry of Economy, Trade and Industry engaged in genome function research and technology development at the National Institute of Advanced Industrial Science and Technology, performed DNA analysis, etc., of industrially useful microorganisms at the National Institute of Technology and Evaluation, and worked through the New Energy and Industrial Technology Development Organization to utilize private-sector vitality to pursue technology development for the analysis of genetic information. In FY2001, analysis of the complete human cDNA[2] structure led to the identification of about 30,000 new human genes, and these genes are now distributed by the National Institute of Technology and Evaluation, with analysis of those genes now in progress.

2 cDNA: abbreviation for "complementary DNA (or complementary deoxyribonucleic acid)." The term denotes DNA synthesized by using reverse transcriptase in a template for messenger RNA (m-RNA). cDNA consists only of the gene regions of the DNA, so that a complete cDNA encompasses all information about a single gene.

a) Promotion of protein structural and functional analyses

Analysis of protein structure and molecular function is one of the most important fields in post-genome research, because the research results can link directly to applications in medicine or to uses in industry.

Toward the goal of developing genome-based drugs in Japan, the Ministry of Education, Culture, Sports, Science and Technology utilized such facilities as the world's largest NMR (Nuclear Magnetic Resonance) facility and SPring-8 (the Large-Scale Synchrotron Radiation Facility) to bring together researchers from industry, academia, and government into the "Protein 3000 Project," to elucidate the structures and functions of one-third (about 3,000) of the approximately 10,000 basic protein folds known to exist, and to transfer the research results, to include patenting the results to industry in FY2002. By October 2004, a total of 1,640 structures had been confirmed.

The Ministry of Health, Labour and Welfare is promoting research and development as part of its Medical Frontier Strategy into the elucidation of the functions and interactions of proteins affiliated with disease, in order to improve prevention and treatment performance for cancer and heart attacks, the two main causes of death for employment age Japanese, as well as for such illnesses as strokes, dementia, and bone fractures that are a major source of demand for nursing care.

The Ministry of Agriculture, Forestry and Fisheries has been promoting research into the comprehensive elucidation of rice proteins as one aspect of its research into the rice genome, while the genome analysis center of National Institute of Agrobiological Sciences is engaged in researching the expression of proteins from genes and prediction of their functions by comparing their three-dimensional structures with those of already known proteins.

The Ministry of Economy, Trade and Industry has brought researchers from industry, academia, and government to its Japan Biological Information Research Center to engage in "analysis of the three-dimensional structures in biological molecules," specifically, R&D into the structural analysis of membrane proteins believed to play particularly important roles in the body, and into the "analysis of protein functions" for the analysis of newly discovered human genes using results obtained from analysis of the total human cDNA structure.

b) Promotion of bio-informatics

Recent research into the genome sciences has made available vast volumes of genome-related in-formation, necessitating the appearance of the new field of bio-informatics, an integration of the life sciences and IT (Information Technology) sectors, as a way to utilize this information.

In the Ministry of Education, Culture, Sports, Science and Technology, the Institute for Bio-informatics Research and Development (BIRD) at the Japan Science and Technology Agency is actively engaged in the upgrading, standardization, and expansion of databases required for the development of bio-informatics, as well as in the development of genome analysis tools with the cooperation of researchers in both the biology and information technology sectors. The ministry is also promoting the development of the DNA Data Bank of Japan (DDBJ), one of the three largest of its kind in the world, under the operation of the National Institute of Genetics, and other genome-related databases, and is using Grants-in-Aid for Scientific Research for the priority promotion of basic research in this sector at universities and colleges. Furthermore, the Special Coordination Fund for Promoting Science and Technology is being utilized to implement programs related to personnel development in the bioinformatics field, with funding targeted at universities and colleges. Also, a project has been implemented since FY2003 for the development of biosimulation for drug development using the vast amounts of data obtained in genome sequencing.

At the Ministry of Agriculture, Forestry and Fisheries, research into "development of the rice genome simulator" is progressing as part of research into the rice genome. The simulator is being developed as a virtual testing system that will collect base sequence data obtained from rice genome research and data from analyzing useful gene functions, and add in related information from conventional rice breeding and culturing research data, etc., to enable computer-based simulations of improvements to rice and other crop varieties.

In FY2000, the Ministry of Economy, Trade, and Industry commenced building a H-invitational database (comprehensive database), which includes independently obtained data and advanced search and analysis tools, to enable utilization in research and industrialization of the vast amounts of bio-technology-related data and achievements obtained from the Millennium Project. The database has been made public and renewed since FY2004. In addition, the ministry commenced the "Project for Analysis of the Gene Diversity Model" in FY2000 (based on the supplementary budget) to implement the development of software that will make it possible to conduct efficient searches for genes related to disease, based on micro-satellites, SNPs[3], and other polymorphic gene information.

c) Promotion of gene polymorphic research

Various ministries are engaged in the promotion of research and development for the elucidation of genes related to specific diseases, toward the goal of more effective medicine suited to specific individuals.

At the Ministry of Education, Culture, Sports, Science and Technology, for example, the SNPs Research Center at RIKEN is engaged in the search for genes related to specific diseases as part of Millennium Project activities, while the Institute of Medical Science, the University of Tokyo, and the Japan Science and Technology Agency are cooperating in the search for SNPs in healthy people. By March 2005, the joint group had published SNP data for 200,000 locations, via the JSNP database[4] Also, the "Project for Realization of Medicine in Response to Individual Genetic Information" was launched in FY2003 mainly at the Institute of Medical Science of the University of Tokyo, and with the cooperation of many other medical institutions, to perform collection of DNA/serum samples and clinical information, from targeted patients for the development of a bio-bank, and to engage in research for the elucidation of the relationship between SNPs and the effects and side-effects of drugs. Furthermore, the Ministry of Education, Culture, Sports, Science and Technology is using Grants-in-Aid for Scientific Research and similar programs for the priority promotion of basic research in this sector at universities and colleges.

In the Ministry of Economy, Trade and Industry, joint examination of the SNPs data by the Institute of Medical Science of the University of Tokyo and the Bio-Industrialization Consortium (JBiC), in the form of analysis of gene polymorph frequencies (allele frequency analysis), was completed in FY2002. Currently, data about SNP locations is being issued from both the JBiC bio-data base system and the JSNP database.

The Ministry of Health, Labour and Welfare is promoting searches for gene polymorphs for disease-related genes and drug-reactive genes related to dementia, cancer, diabetes, high blood pressure, asthma, and other ailments, all as part of the Millennium Project.

In FY2002, the Ministry of Agriculture, Forestry and Fisheries commenced the development of SNP markers in agricultural crops for the purpose of developing effective crop breeding and nurturing systems that make use of gene polymorphs.

3 SNPs: abbreviation for Single Nucleotide Polymorphisms. It refers both to the expression of base sequences on the genome that vary according to race or individual (such as the difference between a healthy individual and a sick person), and to the corresponding area on the genome.

4 JSNP database: a database set up for the Millennium Project, jointly promoted by the Human Genome Analysis Center at the University of Tokyo's Institute of Medical Science, and the Japan Science and Technology Agency, for SNPs scattered throughout the human genome's gene regions (http://snp.ims.u-tokyo.ac.jp)

(2) Promotion of Brain Sciences Research

Brain science is expected to lead to results that improve the quality of life, as well as to improved medical science and to the creation of new technologies and industries. In this regard, the Council for Science and Technology's Life Sciences Division Committee of Brain Science issued a "Long-Term Strategy for Research and Development on the Brain" in May 1997, a long-term plan for the promotion of brain sciences research in Japan. The resulting efforts have greatly strengthened Japan's brain sciences research, which were divided broadly into the three fields of "understanding the brain," "protecting the brain," and "creating the brain," through research and development that makes maximum use of the many universities and national research institutions that extend beyond the bounds of individual ministries and agencies.

At the Ministry of Education, Culture, Sports, Science and Technology, "understanding the brain," "protecting the brain," "creating the brain," and "nurturing the brain" are being promoted as fields of research at the Brain Science Institute at RIKEN, through the utilization of competitive research funds by the Special Coordination Fund for Promoting Science and Technology, and by the Japan Science and Technology Agency, for the priority promotion of brain science research at universities and colleges. Brain research is also being performed at the Japan Science and Technology Agency for the purpose of contributing to education, etc.

Activities in other ministries and agencies include the Ministry of Health, Labour, and Welfare's efforts to promote research on the elucidation of mental and nervous system disorders such as Alzheimer's disease and Parkinson's disease, and on the development of methods of treatment, while the Ministry of Agriculture, Forestry, and Fisheries is engaged in research on brain and nervous system functions in animals, and the Ministry of Public Management, Home Affairs, Posts and Telecommunications is engaged in research into the elucidation and application of info-communication functions in living organisms.

Furthermore, the "Human Frontier Science Program" (HFSP), which was first proposed by Japan at the Venice Summit of advanced nations in June 1987, operates based on the principles of "internationality," "interdisciplinarity," and "encouragement of young scientists," to provide subsidies within an international framework for research that contributes to the elucidation of brain functions and other complex.

(3) Promotion of Research on Development, Differentiation, and Regeneration Science

Research into development, differentiation, and regeneration in biological system aims to elucidate the mechanisms, etc. relating to the process in which one cell differentiates into various tissues or organs to form and maintain an individual. This serves as a basis for regenerative medicine, which is expected to lead to treatment for diseases that are now difficult to cure. The research of this field brings about rapid advances in stem cell research and establishment of technology for producing Embryonic Stem (ES) cells in recent years.

The Ministry of Education, Culture, Sports, Science and Technology is implementing Research for Future Programs and conducting research at the RIKEN Center for Developmental Biology, as well as promoting basic research at universities and colleges by Grant-in-Aid for Scientific Research, etc. Moreover, in FY2003, the ministry launched the "The Project for Realization of Regenerative Medicine" and has been promoting research towards developing a stem cell bank as a research infrastructure and applying the result of basic research to a clinical aspect.

Furthermore, to contribute to the realization of regenerative medicine, the Ministry of Health, Labour, and Welfare is promoting research focusing on clinical aspects in transplant and regenerative medicine as a part of the Millennium Project.

The Ministry of Economy, Trade and Industry is promoting development of equipment in support of practical applications of regenerative medicine.

(4) Promotion of Plant Science Research

Advances in genome science have also led to progress in the analysis of plant genome structures and functions. Control of plant functions based on these results is expected to lead to the development of plants that can contribute to improvements in eating habits, etc.

Rice genome research is important for laying the foundations for research into the major cereals and other crops. The Ministry of Agriculture, Forestry and Fisheries is currently promoting the Second Phase of the "Rice Genome Project," which involves the reading of all DNA base sequences for the rice genome, and the elucidation and patenting of the functions of useful genes, which are efforts that have attracted worldwide acclaim.

For the entire genome base sequence for rice, sequencing data by the international consortium is open to the public on the website. The data sequenced by the international consortium is available on the Web, and is now being examined by researchers around the world as the optimum information resource (Golden Reference) for crop genome research.

The Ministry of Agriculture, Forestry and Fisheries commenced post-genome sequence research even as the base sequence readings were continuing. In FY2003, the ministry launched new research into the elucidation of gene functions, with emphasis on five particular characteristics (quality, photosynthesis capability, functional substance production, resistance to disease, and resistance to adverse environments) of importance to agriculture and other industries, and accelerated efforts to patent useful genes.

The Ministry of Education, Culture, Sports, Science and Technology is promoting the genome sequencing of rice and Arabidopsis thaliana etc., discovery of candidate useful genes, collection of complete cDNA and maintenance of variant resources at the RIKEN Plant Science Center, as part of the Millennium Project. Also in plant research, full-scale foundation for functional analysis, network analysis and metabolome analysis has been developed, and Japan has caught up with the United States and Europe in terms of research levels.

The Ministry of Economy, Trade and Industry is implementing analysis of routes and functions of substance production systems using plants and development of basic technologies including multigene transfer technology at the New Energy and Industrial Technology Development Organization.

(5) Preparation of Bioresources

The field of bioresources is not limited to the mere preservation of genetic resources, but also plays an important role in exploring new areas of research. The national interest is served in the development, collection, storage, and provision of bioresources.

In FY2002, the Ministry of Education, Culture, Sports, Science and Technology instituted the "National BioResource Project" for the purpose of establishing a system facilitating the systematic collection, storage, and provision of bioresources that are of particular strategic importance to the nation, such as experimental animals and plants (such as mouse clones), human cells, and genetic data from various life forms.

At the Ministry of Health, Labour, and Welfare, the National Institute of Health Sciences (responsible for cells) and the National Institute of Infectious Diseases (responsible for genes) joined to establish a Master Bank (in FY2001, these two institutions began setting up the Pharmaceuticals Basic Technology Research Facility toward an eventual merger) for the collection and preservation of human and animal-derived cultured cells and genes needed for use in research in medical and pharmaceutical fields. The supply of cultured cells and genes is made through the Japan Health Sciences Foundation to researchers and other personnel. The foundation has also commenced distribution of human tissue with careful consideration for bio-ethics issues. It also collects, stores, and supplies medicinal plants, and breeds and supplies kanikui-zaru monkeys and other animals used for medical testing.

In the Agriculture, Forestry, and Fisheries Ministry, the Gene Bank Project collects, classifies, and identifies all plants, animals, microorganisms, trees, marine life, and other bioresources utilized in the agricultural, forestry, and fisheries industries. The project also conducts evaluations of characteristics, and propagates and preserves specimens. It provides bioresources and information about those resources to the national research institutes, the independent administrative institutions, the private sector, universities, etc. The ministry also promotes maintenance of genome resources that are the results of rice genome research, as well as storage and provision to the private sector, universities and colleges.

In addition, the Ministry of Economy, Trade and Industry established the NITE Biological Resource

Center at the National Institute of Technology and Evaluation as Japan's core bioresource organization for microorganisms, etc. The Center engages in the search, isolation, collection, and identification of biogenetic resources, as well as their preservation. It also collects and sorts information related to bioresources (systematic identification, base sequence information, and information about genes, etc.). The Center has also implemented a project to create a gene resource library for unknown microorganisms. It is also implementing the development of a system for collecting and utilizing various microorganisms overseas, including conclusion of agreements with Asian countries and launch of an Asian consortium for utilization of microbial resources with ASEAN countries, etc. in accordance with the Convention on Biological Diversity to ensure access to biogenetic resources in Southeast Asia.

The Ministry of Environment instituted the "Environmental Sample Time Capsule Project" in FY2002 for the purpose of preserving the cells of wildlife threatened with extinction. In addition, the independent National Institute for Environmental Research is engaged in the collection, preservation and supply of algae, and in building an algae database.

(6) Promotion of R&D in Food Sciences

Building a stable and sustainable production and distribution system for agricultural, forestry, aromoting the development of functional foods that can contribute to improving the people's health are essential if Japan is to be able to maintain food security and to guarantee an abundant food supply.

For this purpose, the Ministry of Agriculture, Forestry and Fisheries continues to promote the quality of wheat, soybeans, and vegetables, to improve food self-sufficiency, and as a response to the recent sharp rise in imports of raw vegetables, to develop superior new crops resistant to diseases and pests and rich in nutrition and functional constituents, and new agricultural, distribution methods and processing technologies, as well as to develop cloning and other animal husbandry-related technologies. Moreover, to promote food safety and security, the ministry is upgrading technologies for the detection of toxic microorganisms, and developing technologies for DNA identification of species types. For control of Bovine Spongiform Encephalopathy (BSE), the ministry is engaged in the elucidation of the shape and characteristics of prion proteins, and in the development of diagnostic technologies. Moreover, the ministry is engaged in the development of basic technologies useful for the diagnosis and prevention of outbreaks within Japan of diseases shared by humans and animals, both to assuage the people's concerns, and to reduce the effects of such outbreaks on the livestock and poultry industries. In addition, the ministry is accelerating research into the elucidation of bio-regulatory functions through combinations of foodstuffs capable of contributing to the development of new functional foods, as well as supporting the development of technologies for the use of bio-markers (simple biological indices) in the scientific evaluation of food efficacy, and the development of production technologies for food that is efficacious at maintaining health. Furthermore, beginning in FY2004, the ministry is promoting the development of technologies that strengthen disease and pest defense functions already available in crops, or that share them between life forms, to reduce the agricultural burden on the environment.

The Ministry of Health, Labour and Welfare is continuously conducting surveys and research into the securing of food safety through the application of biotechnology.

(7) Promotion of Cancer-Related Research

Since cancer accounts for about 30% of total deaths in Japan, the "Third Comprehensive Ten-Year Strategy for Cancer Control" (ratified by the Minister of Education, Culture, Sports, Science and Technology and the Minister of Health, Labour and Welfare in June 1993) was formulated as a new 10-year strategy that started in FY2004. Based on this strategy, researchers in Japan are promoting the elucidation of the essential elements of cancer, and of new prevention, diagnostic, and treatment methods that utilize these research results.

Under this 10-year strategy, since FY 2004, the Ministry of Education, Culture, Sports, Science and Technology has been promoting the "Cancer Translational Research Program" as bridging research to apply the excellent results of basic research relating to cancer immunotherapy and molecular-targeted therapy clinically. Futhermore, the National Institute of RadiologicalSciences is acting under this 10-year strategy to perform clinical trials of a heavy ion medical accelerator that is expected to become a revolutionary new treatment method for particularly difficult-to-treat cancers. In addition, Grant-in-Aid for Scientific Research promotes priority research at universities and colleges.

The Ministry of Health, Labour and Welfare, meanwhile, is engaged in the development of a helical CT that will be useful in the early detection of lung cancer, and in the development of safe cancer treatment methods using endoscopes that reduce the burden on the patient.

(8) Promotion of Research on Immunologic and Allergic Diseases

It is necessary to comprehensively promote research in the area of the immune system, allergies, and infectious diseases with the aim of achieving eradication of hay fever, rheumatoid arthritis, and other immunologic and allergic diseases, which many people desire, and coping with infectious diseases, which are still a national health threat.

The Ministry of Education, Culture, Sports, Science and Technology engages in research for the basic and comprehensive elucidation of immune systems at the RIKEN Research Center for Allergy and Immunology. In addition, since FY 2004, the ministry has been promoting research and development that leads to the suppression of Severe Acute Respiratory Syndrome (SARS) and other infectious diseases by utilizing the Special Coordination Funds for Promoting Science and Technology. At the time of the Sumatra Earthquake in Indonesia and subsequent tsunami, the ministry conducted field surveys necessary to appropriately predict and respond to the proliferation of infectious diseases in the afflicted areas, as well as consideration of research contents and systems that are required in the future. Moreover, the ministry is intensively promoting basic research in this sector at universities and colleges by using Grant-in-Aid for Academic Research Program.

The Ministry of Health, Labour and Welfare is strengthening the national health risk management network and promoting research in the sectors of emerging and reemerging infectious diseases, measures against HIV/AIDS, measures against hepatitis, and immunologic and allergic diseases. The ministry is also conducting research on broad-ranging infectious diseases in a leading, unique and comprehensive manner at the National Institute of Infectious Diseases. In addition, the ministry established a clinical research center at the National Hospital Organization Sagamihara National Hospital, aiming at the elucidation of immunologic and allergic diseases, and the development of treatment methods. The center’s research is currently concentrated on clinical aspects.

Incidentally, the RIKEN Research Center for Allergy and Immunology and the National Hospital Organization Sagamihara National Hospital has made a joint research agreement, and are promoting efficient research through collaboration between the basics and clinical applications.

The Ministry of Agriculture, Forestry and Fisheries is promoting comprehensive research on the control of Bovine Spongiform Encephalopathy (BSE), highly pathogenic avian influenza (Bird Flu) and other infectious diseases shared by humans and animals at the National Agriculture and Bio-oriented Research Organization.

(9) Promotion of Other Research and Development

Because living things are generally efficient at energy conversion, consuming little energy for reactions at normal temperatures and pressures, the Ministry of Economy, Trade and Industry has promoted the “Program for Creation of Recycling-Type Industrial Systems Using Bio-Functions” to develop the basic technologies required for effective utilization of bio-functions based on genome information, and for their expanded use in industrial systems.

In regard to research on sugar chains, which are believed to play important roles in a vast array of biological functions, the Ministry of Education, Culture, Sports, Science and Technology is using the Grant-in-Aid for Scientific Research and Basic Research Programs to promote sugar chain research at universities and colleges. The Ministry of Economy, Trade and Industry is promoting research and development into automatic devices for synthesizing sugar chains as well as structure analysis devices, and of the analysis of functions for the general acquisition of genes related to sugar chain synthesis.

Utilizing and strengthening the excellent research capabilities of certain regions can be effective for promoting research and development in the life sciences sector. In this regard, the government’s

Urban Renewal Office decided in August 2001, in "Urban Renewal Project No.2," on the "formation of an international center for life sciences in the Osaka region." This action was followed in July 2002, in "Urban Renewal Project No.4," with the "formation of an international center for genome sciences in the Tokyo region." In line with these decisions, the Ministry of Education, Culture, Sports, Science and Technology has expanded related facilities and equipment at universities and colleges, and promoted translational research that bridges the gaps between basic research and applied research through cooperation between industry, academia, and government to form life science research sites and to build systems that link the re-search sites with each other. In addition, the Ministry of Health, Labour and Welfare is promoting the development of core research institu-tions in the Osaka region for infrastructure technology toward the development of revolutionary new pharmaceutical products, etc.

The major life science research projects implemented in FY2004 are shown in Table 3-2-1, by ministry or agency.

Table 3-2-1 Major research subjects in life sciences (FY2004)

Ministry or Agency	Research institute or program	Subject
National Police Agency	National Research Institute of Police Science	· Study into a new personal identification system using information obtained from biological samples
Ministry of Internal Affairs and Communications	Program for Promoting Strategic Information and Communications Research and Development	· Research into elucidating and applying the info-communications functions of living organisms
	National Institute of Information and Communications Technology	· Research into a communication-friendly society
Ministry of Finance	National Research Institute of Brewing	· Research, etc., into genetic analysis and the regulatory control of gene expression of filamentous fungi

Ministry or Agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	RIKEN (The Institute of Physical and Chemical Research)	· Promotion of bioresource projects · Promotion of comprehensive research into brain science · Promotion of comprehensive research into genome science · Promotion of plant science research · Promotion of comprehensive research into developmental and regenerative science · Promotion of varied genetic research · Promotion of immunological and allergy research
	Japan Science and Technology Agency	· Promotion of bio-informatics · Promotion of research using competitive funding
	National Institute of Radiological Sciences	· Promotion of research and development for upgrading heavy particle therapy of cancer
	Japan Agency for Marine-Earth Science and Technology	· Promotion of Frontier Research System for Extremophiles, etc.
	Japan Aerospace Exploration Agency	· Research into medical science, etc., related to space
	Universities and colleges	· Research into the overall promotion of cancer research · Basic research into carcinogenesis and the prevention of carcinogenesis · Research into the biological aspects of cancer · Diagnosis and treatment of cancer · Research into human cancers, and epidemiological research into host factors · Strategic and advanced research into cancer · Comprehensive genome research toward the elucidation of living systems · Genomic analysis of hereditary factors, and the elucidation of abnormal molecule conditions in human diseases · New developments in genomic biology toward the elucidation of cellular systems · New developments in genome informatics · Advanced research into brain science · Molecular foundations for the appearance of infection, and host response
	Special coordination funds for promoting science and technology	· Cooperative strategy for suppressing emerging and reemerging infectious diseases · Development of an automatic antibody selection system · Postgraduate education research unit for agricultural and life information science · Research supporter development system for animal experimental medicine · Promotion of rice genome annotation
	HFSP (Human Frontier Science Program) (Note)	· International joint research for the elucidation of the complex mechanisms of living organisms
Ministry of Health, Labour and Welfare	Health and labour sciences research grants	· Third comprehensive research on strategy against cancer · Comprehensive research on aging and health · Research on the human genome, tissue engineering · Research on psychiatric and neurological diseases and mental health · Research on emerging and re-emerging infectious diseases · Research on HIV/AIDS · Research on sensory and communicative disorders · Research for the eradication of intractable diseases · Research on food safety · Research on health sciences focusing on drug innovation · Research on allergic disease and immunology · Research on proteomics · Research on advanced medical technologies · Research on medical devices for analyzing, supporting and alternative · Translational research
	National Institute of Infectious Disease	· Research into gene recombinant vaccines, etc. · Research into the development of vectors related to gene treatment, safety evaluations, etc. · Research into AIDS, Hansen's disease, etc. · Research into methods for the diagnosis, prevention, and treatment of SARS and other infectious diseases
	National Institute of Health Sciences	· Research into standard test methods, quality evaluation methods, etc., for pharmaceuticals · Research into assuring the safety of food and chemical substances, etc.
	National Institution of Industrial Health	· Study on work environment management for irregular work using organic solvents · Comprehensive research on occupational stress of elderly workers · Research on genetic factors that determine sensitivity to adverse factors in the work environment

Ministry or Agency	Research institute or program	Subject
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Bio-oriented Research Organization, National Institute of Agrobiological Sciences, etc.	· Integrated research for providing fresh and delicious "Brand Nippon" agricultural-products · Development of technology for reducing the impact on the environment using · Development of technologies for the suppression of Bovine Spongiform Encephalopathy (BSE), and diseases shared by humans and animals · Development of a comprehensive management system of hazardous chemicals in agricultural, forestry and fisheries ecosystem · Elucidation of the entire rice genome DNA sequence · Isolation of useful genes in the rice genome, and elucidation of their functions · Development of DNA marker-aided selection technology for plants and animals · Development of a rice genome simulator · Research into animal genomes for the utilization of useful genes · Insect Technology Research for Utilization of the Greatest Unused Resources of the 21st Century · Comprehensive research into food safety and functionality · Development of isolation and utilization technologies for useful genes obtained through animal genome analysis · Assurance of Safe Use of Genetically Modified Organisms · Development of stable production technology of cloned animals by somatic cell nuclear transfer · Elucidation of animal (livestock, insect) behavioral mechanisms, and the development of control technologies · Surveys and research into local agricultural methods using special resources · Expenses required for the promotion of research into the prevention of invasive insect pests · Elucidation of the effects of climate warming on crops and animal husbandry, and the development of technologies to control those effects · Evaluation of the effects of organic farming on the soil environment, and the certification of environmental conservation effects · Elucidation of the mechanism for outbreaks of mastitis, and the development of preventive technologies · Comprehensive research into the creation of new agriculture, forestry, and fisheries products by modifying morphological and physiological functions · Comprehensive research into the creation of new agriculture, forestry, and fisheries products by modifying morphological and physiological functions · Development of new weed control technologies that utilize plant metabolism genes · Establishment of useful substance production systems using plants, animals, and insects · Gene bank project
	Private sector, universities, etc.	· Development of technologies for assuring food safety and security · Development of technologies for the promotion of "Brand Japan" processed food supplies · Development of efficient plant breeding and growing systems that utilize genetic information · Development of new separation and extraction technologies in the food industry · Development of health-oriented food evaluation and production technologies using the life sciences · Development of next-generation fermentation technologies in the food industry

Ministry or Agency	Research institute or program	Subject
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization	· Development of basic technologies for production processes using biological ·Elucidation of useful protein functions, utilizing human genome information and its analysis tools · Development of information technology required for DNA analysis, disease prevention, etc. · Development of technologies for the synthesis and structural analysis of sugar chains · Construction of a gene resource library for unknown micro-organisms based on genome information · Development of tools for analysis of biomolecules through the use of nanotechnology · Development of high-safety technologies for the differentiation and cultivation of a mass volume of artificial cells and tissues enabling regenerative medicine · Analysis of the three-dimensional structures of physiological macromolecules of membrane proteins · Development of technologies for the analysis of intracellular network dynamism · Development of bioinformatics-related databases · Development of technology for model analysis of gene diversity · Behavior-based human environment creation technology
	National Institute of Advanced Industrial Science and Technology	· Construction of a neural network and development of new information processing technology based on its functions · Age dimension technology programs for healthcare · Elucidation of organism responses to stress and the identification and practical application of stress markers
	HFSP (Human Frontier Science Program) (Note)	· International joint research for the elucidation of the complex mechanisms of living organisms
Ministry of the Environment	National Institute for Environmental Studies	· Research into the elucidation of higher-order physiological memory functions for organic chemical substances, and the development of risk evaluation methods · Development of a method of assessing the influence of environmental pollutants on human and organisms using toxicogenomics

Note: Funding provided by the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Economy, Trade and Industry.

(2) Efforts for Bioethical Issues and Safety

(Efforts for Bioethical Issues)

Rapid developments in the life sciences in recent years have given rise to expectations of revolutionary achievements in the fields of medicine and elsewhere.

Therefore, to cope with these issues appropriately, the Special Research Committee on Bioethics, established under the Council for Science and Technology Policy (CSTP), and Special Committee on Guidelines in the 21st Century for the Life Science and Bioethics, Science Council of Japan, are now engaged in surveys and examinations of specific important issues concerning bioethics, while the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Health, Labour and Welfare and other ministries are preparing the relevant laws, regulations, and guidelines and conducting other activities.

Regarding human cloning technology, the Ministry of Education, Culture, Sports, Science and Technology has taken measures prohibiting the production of human clone individuals under the Law Concerning Regulation Relating to Human Cloning Techniques and Other Similar Techniques (Year 2000, Law No.146) and prohibiting the creation and utilization of human clone embryos for the time being under the guidelines based on the said law.

The Expert Panel on Bioethics under the CSTP has discussed the handling of human fertilized embryos and human clone embryos since August 2001 according to the provisions of the said law. Consequently, in July 2004, the CSTP compiled a statement of opinions to related office and ministries concerning the “Basic Conceptual Approach Relating to Treatment of Human Embryos.” Regarding the creation and utilization of human clone embryos and human fertilized embryos, which are permitted in the statement with limitations, the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare started consideration toward formulating guidelines for ensuring appropriate handling.

Furthermore, in the United Nations, considerations toward formulating a convention against the reproductive cloning of human beings started in 2001 have not reached an international consensus in terms of the utilization of human clone embryos for therapeutic andresearch purposes. A nonbinding declaration that prohibits such utilization was adopted by a vote in March 2005[5].

In the area of human Embryonic Stem (ES) [6] cell research, the Ministry of Education, Culture, Sports, Science and Technology has carried out examination of research plans under the guidelines formulated in 2001 and has reviewed one derivation plan and 21 utilization plans so far.

Elsewhere, in the areas of human genome and gene sequencing research, epidemiological research[7] or clinical research, respect of human dignity and suitable management of personal information are required. Therefore, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Health, Labour and Welfare and other related ministries are cooperating for the appropriate promotion of research based on the guidelines[8].

(Efforts to Ensure Safety in the Life Sciences)

Recombinant DNA technology is applied to a broad range of fields, from basic biological research to the production of pharmaceuticals and improvement of agricultural crops, however, one of its characteristics is its application of new properties to living organisms. For this reason, the ensuring of appropriate use of living modified organisms, etc. has been aimed at based on the Law Concerning the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Year 2003, Law No. 97), which stipulate the measures necessary to prevent adverse effects on biodiversity due to the utilization of living modified organisms.

For clinical research aimed at the establishment of gene therapy[9], the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare are making efforts for the appropriate promotion of research based on the Guidelines for Gene Therapy Clinical Research, and revised the guidelines based on the Law Concerning the Protection of Personal Information in December 2004.

3.2.2.2 Information and Communications

Promotion of research and development in the information and communications sector not only brings about innovative results in many other areas of research and development but also contributes to the creation of new industries and development of existing industries. In addition, as can be seen from the dissemination of mobile phones and computers, information and communications technology has become essential for a wide variety of activities in our daily life, and is an important foundation that enables people to live safely, comfortably and with confidence.

(A Society Served by Ubiquitous Networks, and Building a High-Speed, Highly Reliable Information Communication System for the Creation of a World Market)

Society demands that Japan swiftly return research results to society and to the economy by constructing a "high-speed, highly reliable information communication system" with unified hardware and software and strong cooperation among industry, academia, and government ahead of the rest of the world, centered around superior technologies (mobile, optical, device technologies, etc.)

5 Affirmative votes: 84 Dissenting votes: 34 (including Japan) Abstention: 37 Non-participation: 36

6 Human Embryonic Stem (ES) cells: these primordial cells have attracted high expectations for medical applications because of their capability of differentiating into all parts of the human body. At the same time, however, sacrificing human embryos would raise ethical concerns.

7 Epidemiological Research: scientific research that clarifies causes of a disease by investigating the frequency and geographical distribution of disease incidence and other factors related to human health

8 Ethical Guidelines for Human Genome and Gene Analysis, Ethical Guidelines for Epidemiological Research, and Ethical Guidelines for Clinical Research

9 Gene therapy: a treatment method that involves the insertion of genes, or cells containing genes, into the bodies of patients for the purpose of treatment of disease. It is not an established method of treatment at present, but is practiced as one aspect of clinical research

For specific research and development topics, the Ministry of Internal Affairs and Communications is engaged in "R&D on ubiquitous network technologies," involving research and development into technologies for real-time verification from extremely large numbers of terminals, and into technologies for the control of network channels.

The Ministry of Education, Culture, Sports, Science and Technology is working on the "Establishment of software technology infrastructure to support electronic storage and utilization of intellectual assets," in which research and development is conducted for electronic storage of intellectual assets in the cultural and arts sectors as well as for software technology necessary for utilizing digital contents in the educational sector.

The Ministry of Economy, Trade and Industry is engaged in the "business grid computing project," which aims for the development of infrastructure software allowing multiple network-linked computers or memory devices to function as if they were a single computer, toward the realization of the goal of a highly reliable, safe-to-use social IT infrastructure.

(Information and Communication Technologies that Lead to Next-generation Breakthroughs and the Seeds of New Industries)

Society demands the promotion of research and development into advanced information and communication technologies carried out in cooperation with interdisciplinary sectors, like next-generation human interface technologies, next-generation information and communication technologies that make use of quantum engineering and other new princeples and technologies, such as space development (communications),nanotechnology, and bioinformatics.

A specific research and development topic in this area is the "Quasi-Zenith Satellite System Plan" being developed through the cooperation of the Ministry of Internal Affairs and Communications, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Economy, Trade and Industry, and the Ministry of Land, Infrastructure and Transport, that will be able to provide high-quality communications, broadcasting, and positioning services to virtually 100% of the country without being affected by narrow mountain valleys or tall buildings.

(Infrastructure Technologies for Research and Development)

Society demands the development of science and technology databases, an area in which Japan lags behind Europe and North America, the development and equipment of technologies for supercomputer net-works, and virtual research institutes that allow joint research over long distances by linking research institutions with universities via high-speed net-works.

In the Ministry of Education, Culture, Sports, Science and Technology, specific research and development topics being carried out include the "National Research Grid Initiative (NAREGI)," which involves the development of infrastructure software of sufficient quality to become an international standard, for the purpose of constructing an ultra-high speed research grid computing environment capable of linking distributed high-performance computers into a high-speed network.

The main research topics in the information and communications sector during FY2004 are as shown in Table 3-2-2.

Table3-2-2 Major research subjects in the information and communications sector (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	·Research and development on ubiquitous network technologies ·R&D on Techonologies for Sophisticated Use of RFID ·Promotion of transition to Internet IPv6 ·Research and development into Asian broadband satellite infrastructure technologies ·Comprehensive research and development into network human interface ·R&D on time-stamping platform techonologies ·Promotion of network security infrastructure technologies · Research and development relating to the technology for an advanced network certification infrastructure ·Comprehensive support for the development of electrical communication systems that form the foundation for the merger of communication and broadcasting services ·Research and development into quantum information communication technologies · Research and development of photonic network technologies ·Comprehensive research and development of IPv6 for (digital) Information consumer electronics, etc.
Ministry of Education, Culture, Sports, Science and Technology	Universities, Japan Science and Technology Agency, National Institute for Materials Science, RIKEN (the Institute of Physical and Chemical Research), Japan Atomic Energy Research Institute, Japan Aerospace Exploration Agency, National Research Institute for Earth Science and Disaster Prevention, Japan Agency for Marine-Earth Science and Technology, National Institute of Informatics, etc.	· Establishment of software technology infrastructure to support electronic ·National Research Grid Initiative (NAREGI) ·Comprehensive software development for e-Society infrastructure ·Priority research and development project for realization of the world's most advanced IT nation ·e-Science realization project ·Development of Super SINET, etc.
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Bio-oriented Research Organization, etc.	·Construction of an agricultural, forestry, and fisheries research information digital community, etc.
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization, Information Technology Promotion Agency, etc.	·Business grid computing project ·Development of an Extreme Ultraviolet (EUV) exposure system ·Semiconductor application chip project ·Cutting edge system LSI design project ·Digital information device interoperability infrastructure project ·Energy-saving next-generation PDP project ·Development of next-generation semiconductor materials and process technology (MIRAI project), etc.
Ministry of Land, Infrastructure and	Engineering Affairs Division, Minister's Secretariat	·Development of robotic and other IT implementation systems, etc.
Ministry of Internal Affairs and Communications Ministry of Education, Culture, Sports, Science and Technology Ministry of Economy, Trade and Industry Ministry of Land, Infrastructure and Transport	National Institute of Information and Communications Technology, Japan Aerospace Exploration Agency, New Energy and Industrial Development Organization	

3.2.2.3 Environment

The field of the environment is an essential area of science for the preservation of the natural environment, including ecological systems with their diverse forms of life, for the maintenance of human health and the preservation of the living environment, and for maintaining the foundations for the future survival of mankind. At present, there is an increasing need for efforts in science and technology to resolve global environmental problems, and Japan is actively moving ahead in this area, through the research and development projects detailed below.

(1) Research into Earth Observation and Change Forecasts, and Other Solutions for Global Environmental Problems

In recent years, global warming and other global-scale environmental issues have become imminent, and these issues urgently require international cooperation in their resolution.

In response to the "science and technology for sustainable development" action plan agreement reached in June 2003 at the G8 Evian Summit in France, the First Earth Observation Summit was held in the United States in July 2003. Following that, the Second Earth Observation Summit was held in Tokyo in April 2004, and a framework for a 10-year implementation plan for the establishment of Global Earth Observation System of Systems (GEOSS) was adopted with the participation of 43 countries. Based on those results, the 10-year implementation plan was adopted at the Third Earth Observation Summit in Belgium in February 2005.

In regards to global warming issues, the Kyoto Protocol, which incorporated commitments to reduce the amount of greenhouse gas emissions in advanced nations and other countries, went into effect in February 2005. In December 2004, the Tenth Conference of Parties to the Framework Convention on Climate Change (COP 10) was held in Argentina to give consideration to the steady introduction of the Implementation Plan for the Global Climate Observing System (GCOS).

(R&D and Related Measures for Understanding Phenomena on a Global Scale)

Since phenomena relating to global environment problems go beyond national borders, global cooperation is crucial in promoting research and development. Therefore, Japanese researchers are participants in the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), and other international research programs, continuing to advance joint research.

Promoting the international sharing of global observation information is important for the elucidation of various global-scale phenomena. Japan hosted the Second Earth Observation Summit in April 2004, and is an active participant in and contributor to the Committee on Earth Observation Satellites (CEOS) and the Integrated Global Observing Strategy Partnership (IGOS-P).

The Ministry of Education, Culture, Sports, Science and Technology is promoting research and development into the highly trustworthy projection of global change using the "Earth Simulator" system, one of the world's fastest supercomputers. The "Earth Simulator" won the "Gordon Bell Award," the most prestigious award in the high-performance computer technology sector, for three consecutive years from 2002 to 2004. As research and development using the "Earth Simulator," the ministry implemented the Intergovernmental Panel on Climate Change (IPCC), which provides scientific information regarding climate change and the "Project for Sustainable Coexistence of Humans, Nature and the Earth," which aims to achieve high-precision predictions of global warming that will contribute to the Fourth Assessment Report (AR4) and the forecast of water resources and water-based disasters in the future. In addition to contributing to the 10-year implementation plan prepared by the Earth Observation Summit, the ministry established the Earth Observation Promotion Committee under the Council for Science and Technology, in accordance with the Basic Strategy for Efforts Regarding Future Earth Observation (December 2004).

The Japan Agency for Marine-Earth Science and Technology is promoting research on global environment prediction, including climate variation research, hydrological cycle research, global warming research, atmospheric composition research, ecosystem change research, and integrated modeling. In addition, regarding research on global environment observation, the agency is promoting observation of climate change, observation of the hydrological cycle, observation of global warming and observation of ocean general circulation. Moreover, research cooperation with the United States is carried out at the International Pacific Research Center (IPRC) located at the University of Hawaii, and the International Arctic Research Center (IARC) at the University of Alaska.

The Japan Science and Technology Agency's Basic Research Programs promote research and development related to the "Mechanism of Global Change" and "Hydrological System Modeling and Water Resources System."

The Ministry of Internal Affairs and Communications' National Institute of Information and Communications Technology (NICT) is currently engaged in international joint research with the United States, primarily with the University of Alaska, within the framework of the Japan-U.S. Science and Technology Cooperation Agreement, to promote comprehensive research into technologies for the observation and measurement of the arctic atomsphere.

Japan's Antarctic research program is centered in the National Institute of Polar Research, in cooperation with relevant governmental agencies. The Headquarters for the Japan Antarctic Research Expedition (JARE) has been established within the Ministry of Education, Culture, Sports, Science and Technology (MEXT), under the chairmanship of its Minister. In FY2004, the 45th wintering expedition and the 46th expedition carried out regular observations of ocean and atmospheric phenomena around Showa Station, and also performed monitoring observations, etc., for the purpose of elucidating environmental changes on a global scale.

(Earth Observation Technology Using Satellites)

Satellite-based Earth observation is an extremely effective method for repeated and continuous acquisition of various information covering wide areas. Japan is currently engaged in comprehensive promo tion of this activity toward the resolution of global environmental problems, in cooperation with related organizations in Japan and abroad.

The National Institute of Information and Communications Technology (NICT) is promoting the development of superconducting submillimeter wave rim radiation sounders mounted on the exposed part of the station's Japanese Experiment Module (JEM; also known as "Kibo") on the International Space Station. NICT is also studying technology to enable the measurement of global environmental changes from space.

The Japan Aerospace Exploration Agency (JAXA) processes data collected from a Precipitation Radar (PR) mounted on the Tropical Rainfall Measuring Mission (TRMM) satellite of the National Aeronautics and Space Administration (NASA), the Advanced Microwave Scanning Radiometer for EOS (AMSR-E), mounted on the NASA Earth Observing System (EOS) Aqua satellite and other satellites, to provide data to researchers and users. To improve the precision of weather forecast, JAXA started using data obtained from AMSR-E in FY 2004. Moreover, JAXA is engaged in the development of the Advanced Land Observing Satellite (ALOS), in development research on the Greenhouse Gas Observing Satellite (GOSAT), and in research on the Global Precipitation Measurement/ Dual-frequency Precipitation Radar (GPM/DPR), and is also proceeding in cooperation with the relevant organizations on these research efforts. Regarding the future plan of earth observation satellites, the Special Committee for Earth Observation in the Space Activities Commission is now carrying out-deliberations.

The Ministry of Economy, Trade and Industry is currently engaged in joint operations with the Japan Aerospace Exploration Agency for the operation of the Advanced Spaceborne Thermal Emission and Reflectance (ASTER) radiometer, a resource exploration sensor mounted on the NASA global observation satellite (Terra), and for the development of the next-generation Phased Array Type L-Band Synthetic Aperture Radar (PALSAR), to be mounted on ALOS. It is also engaged in the development of the ground-based processing and analysis technologies required for the observation data obtained from the satellite sensors.

The Japan Meteorological Agency developed the Multi-functional Transport Satellite (MTSAT-1R) and launched it on February 26, 2005, as a follow-on satellite to the Geostationary Meteorological Satellite (GMS-5).

The Ministry of Agriculture, Forestry and Fisheries has created a database of imaging data obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) mounted on the Terra and

Aqua NASA global observing satellites, and has made it available on the Internet.

The Ministry of the Environment is using valuable observation data on the ozone layer and other phenomena obtained from the Improved Limb Atmospheric Spectrometer-II (ILAS-II) mounted on "Midori II" to promote observation, monitoring, and research of the global environment, and is cooperating with the Japan Aerospace Exploration Agency and the National Institute for Environmental Studies for research and development of the greenhouse gas monitoring sensor mounted on GOSAT.

To promote the use of the data obtained in this way from satellites, the Japan Aerospace Exploration Agency's Earth Observation Research and Application Center is promoting the development and operation of satellite data information systems that promote the use of satellite data in earth observations, disaster monitoring, resource management, etc., the mutual utilization of data, and research into data analysis and utilization. Furthermore, the agency uses a web page to publish satellite data, etc., to deepen peoples' understanding of the current state of the global environment.

(Ocean Observation Technology)

The oceans occupy about 70% of the Earth's surface, and are strongly related to many global-scale phenomena on earth, so that the elucidation of the roles that they play is an important issue. To advance knowledge in this area, the Japan Agency for Marine-Earth Science and Technology promoted research and development into ocean observation technologies, including the next-generation JAMSTEC-Compact Arctic Drifter (J-CAD) and Argo float for establishing a global ocean intermediate water observation system.

The Ministry of Internal Affairs and Communications developed an extended-range marine radar, which realizes continuous long-term observation of the flow field of the Kuroshio Current, etc. at the shore at the National Institute of Information and Communications Technology, and started observing the flow field of Kuroshio Current in the south of the East China Sea by installing the radars at Ishigaki Island and Yonaguni Island.

To observe the global ocean in real time, the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Land, Infrastructure and Transport have been engaged in the development of an Advanced Ocean Observing System (Japan ARGO[10]) since FY2000. In this project, profiling floats are being deployed under international cooperation all around the world to measure temperature and salinity to an ocean depth of 2,000m.

In addition, the Ministry of Economy, Trade and Industry is promoting research on the mechanism for CO2 circulation in the Pacific Ocean.

The Ministry of the Environment is promoting research into the utilization of satellite remote sensing technology, a special method for monitoring the ocean environment, as a part of the Northwest Pacific Regional Ocean Action Program (NOW-PAP) promoted by the United Nations Environment Program (UNEP) in the Sea of Japan and part of the Yellow Sea.

(Research and Development of Stratospheric Platforms)

The Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Internal Affairs and Communications have implemented research and development into stratospheric platforms, which are large unmanned airships positioned in the stratosphere and equipped with observation sensors and radio transmitters, etc., for use in Earth monitoring, telecommunications, broadcasting, etc.

10 ARGO is named after the ship of the Greek mythic hero Jason, which is the name of the earth observation satellites series.

(Technology Development to Restrain the Emission of Carbon Dioxide Accompanying Energy Use)

Carbon dioxide accompanying energy use accounts for about 90% of the total emission of greenhouse gases that cause global warming. Therefore, it is necessary to develop, practically apply, introduce and disseminate technologies for restraining the emission of carbon dioxide.

In FY 2004 the Ministry of the Environment started promoting development for practical application of basic mitigation techniques and development of mitigation techniques that can be commercialized in a short period of time.

Incidentally, the major research subjects conducted during FY 2004 are as shown in Table 3-2-3.

Table 3-2-3 Elucidation of various global-scale phenomena, and major research topics in the Earth sciences and technology sector (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	· International joint research on advanced electromagnetic technology for the global environment · Research and development of technologies for the measurement of subtropical Earth environments · Research on global environment measurement and forecasting technology, using 3-D high-resolution imaging radar · Promotion of international information networks for conservation of the Earth's environment
Ministry of Education, Culture, Sports, Science and Technology	Special Coordination Funds for Promoting Science and Technology	· Aeolian dust experiment on climate impact · International research project on the interaction between the sub-vent biosphere and geo-environment · Unzen Volcano: International cooperative research with scientific drilling for understanding eruption mechanisms and magmatic activity
	National Research Institute for Earth Science and Disaster Prevention	· Study on extreme weather events and water-related disasters due to Climatic Change · Research on earthquake and volcanic eruptions
	National Universities and Other Institutions	· International cooperative research project on the arctic environment · Academic research into earthquake and volcanic eruption prediction
Ministry of Agriculture, Forestry and Fisheries	National Institute for Agro-Environmental Sciences	· Assessment and mitigation techniques of global warming effects on the agriculture, forestry and fisheries sector
	National Institute for Rural Engineering, National Institute for Agro-Environmental Sciences, Japan International Research Center for Agricultural Sciences, Forestry and Forest Products Research Institute	· Assessment of the impact of global-scale change in wate cycles on food production and alternative policy scenarios
Ministry of Economy, Trade and Industry	National Institute of Advanced Industrial Science and Technology	· Evaluation of the impact of carbon dioxide sequestration on the dynamics of global warming substances · Research into land-based monitoring of oceanic air mass regions · Evaluation of long-term carbon dioxide absorption, based on the analysis of intermediate- and deep-ocean water in the Pacific Ocean

Ministry or agency	Research institute or program	Subject
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	· As part of data and information for Hydrographic and Oceanographic activities, comprehensive ocean research in jurisdictional sea areas, ocean positioning using satellites, geological surveys of sea bottoms for the detection of volcanic eruptions, and surveys of water temperatures, ocean currents, waves, and other aspects of the Western Pacific ocean region
	Japan Meteorological Agency Meteorological Research Institute	· Study of the prediction of regional climate changes over Japan due to global warming · Development and improvement of a materials circulation model and research on assessment of the effect on the global environment · Observational research to enhance the radiative process
	Geographical Survey Institute	· Study on geodynamics using precise Earth measurement technology · Plate motion and deformation in the East-Asia and Pacific region
	Port and Airport Research Institute	· Use of tide-level observation to monitor rising sea levels
Ministry of the Environment	Global Environment Research Fund	· Development of greenhouse gas sink and source control technologies, through the utilization and preservation of land ecological systems mid- and long-term policies toward the stabilization of greenhouse gases in the atmosphere · Research into the maintenance of sustainable national territories for island nations formed from coral atolls · Elucidation of the dynamics of global-scale ocean pollution caused by toxic substances, and research into their prediction · Research into gene migration due to the release of gene recombinant organisms, and evaluation of the impact on biological diversity · Integrated study for the terrestrial carbon management of Asia in the 21st century based on scientific advancements · Research on the explanation of long-term trends, and prediction of future change ozone layer · Development of monitoring system for the halocarbon inventory in East · Studies on the effects of organic aerosols on regional and global climate · International co-operative survey to clarify Trans-boundary Air Pollution Across the Northern Hemisphere
	Global Environment Research Coodination System	· Research into the mechanisms for the carbon dioxide cycle in ocean surface layers, using radioactive nuclides as multi-tracers · Evaluation of the impact of carbon dioxide marine isolation on the ocean material cycling process
	Technology Development Program for Mitigating Global Warming (competitive funding)	· Development toward practical application of basic technology to restrain emission of carbon dioxide
	Open-Type Project to Subsidize Development of Technologies Directly Connected to the Marketing of Competitive Global Warming Mitigation Measures	· Development of technologies to restrain emission of carbon dioxide, which can be commercialized in a short period of time

(2) Research into Building a Recycling Society

In order to secure sustainable growth of Japan's economy and society in the future, it is absolutely essential to carry out research and development for creating a recycling-based society that promotes the recycling of resources through effective utilization of resources and restriction of the generation of wastes, etc.

Efforts for the utilization of biomass will be improved in accordance with the Biomass Nippon General Strategy (decided by the Cabinet in December 2002).

The Ministry of Education, Culture, Sports, Science and Technology is currently engaged in the "The Project to Design a Sustainable Management and Recycling System for Biomass, General and Industrial Wastes," a tie-up between industry, academia, and government for the promotion of the detoxification disposal or recycling of wastes, and also for research and development into the impact and safety assessments and design of social systems, to encourage the commercialization and dissemination of recycling.

The Ministry of Economy, Trade and Industry is working on automobile recycling measures, measures for articles difficult to recycle, and development of technologies for construction materials recycling measures, and is also implementing practical application support projects to disseminate these technologies and develop an intellectual basis for surveys concerning dissemination of recycle technologies and recycled products.

The Ministry of Agriculture, Forestry and Fisheries is promoting the development of recycling and utilization technologies for biomass, the developpment of system technologies for the efficient recycling and utilization of local biomass resources, and the development of new energy production technologies that utilize organic resources in place of fossil fuels. In addition, the ministry started development of technologies to reduce production costs for biomass plastic in FY 2004. Furthermore, the ministry is engaged in the development of technologies for the sorting and transport of recycled foodstuffs, an area that has long been a bottleneck, preventing the promotion of foodstuff recycling, as well as the development of reproduction and conversion technologies, and of constituent and quality evaluation technologies, needed for the promotion of advanced uses.

The Ministry of Land, Infrastructure and Transport is promoting the development of new geo-materials made from various wastes, and research into the applications of these to port and harbor facilities, the development of methods for strategic stock management of housing and social infrastructure capital, the development of technologies for the restricting and recycling of wastes generated during construction projects, the formation of logistic systems that promote the utilization of recycled resources, and research into the recovery of biomass from sewer sludge, livestock manure, etc.

The Ministry of the Environment is carrying out the research and development of processing technologies for the detoxification of toxic chemical substances generated in the course of waste processing, of technologies for the safe recycling of plastics, etc., and technologies for the proper management of final disposal sites, research into elucidation of the mechanisms for the generation of micro-pollutants at waste disposal facilities, etc. and control of their emissions, as well as research on the control of risks attendant with micro-pollutants. In addition, the ministry is promoting research for the establishment of a recycling-based society, including analysis and assessment of social systems to promote formation of a recycling-based society and technologies for reducing the generation of waste at the production and consumption stages and for establishing a resource recycling system.

The Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications is implementing research and study on safety measures for fire prevention in relation to the utilization of biomass energy.

The major research subjects conducted during FY 2004 are as shown in Table 3-2-4.

Table 3-2-4 Major research subjects for building a recycling-oriented society (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Special Coordination Funds for Promoting Science and Technology	· Development of an integrated urban liquid and solid waste treatment system incorporating technologies for transforming kitchen garbage to biodegradable plastics
Ministry of Agriculture,	National Agriculture and Bio-oriented Research Organization, Private sector, universities, etc.	· Development of new technology for the treatment and local recycling of biomass · Development of technology for assessments of and countermeasures for effects on agriculture, forestry, and fisheries by global warming · Development of technology for reducing the production cost of biomass plastics
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization, Private sector, universities, etc.	· Development of fundamental technologies for manufacturing environmentally harmonious hyperfine steel particles · Development of technologies for the detoxification and materials recycling of aluminum impurities · Development of recycling technologies for building materials, glass, etc. · Development of technologies for resource-recycling-type housing · Development of recycling technology for iron and plastic compounds, using an electric furnace technology · Development of cement manufacturing technology utilizing recycled resources containing large amounts of chlorine · Development of maintenance technology for extending the life of structures · Support of 3R for practical uses (Request for Proposal)
	National Institute of Advanced Industrial Science and Technology	· Research on renewable plastic with free categorization · Research on a support system for green process manufacturing technology · Research on materials technology for easy dismantlement and simple recycling · Research on recycling technology with high efficiency for resources · Research on an evaluation method for recycling technology · Research on chemical recycling technology · Research on environmental technologies that effectively use biomass
Ministry of Land, Infrastructure and Transport	Technology Research Division, Minister's Secretariat	· Development of housing and urban infrastructure management technology for sustainable society and safe environment · Development of management technology for infrastructure and building stocks · Development of evaluation method and technical measures of environmental impact throughout a building's life cycle
	National Institute for Land and Infrastructure Management	· Research recycling systems for construction waste reduction · Life cycle analysis on disposal and reuse of food wastes in sewerage systems
	Public Works Research Institute	· Research into social infrastructure development using new materials, unutilized materials, and recycled materials · Research into technology for effective utilization of plant waste materials as green materials · Study on technology for the exploitation of resources and the recycling of organic waste materials utilizing sewage sludge · Study on a method for efficient use focused on inorganic characteristics of sewage sludge ash
	Building Research Institute	· Research and Development Project on Timber-based Hybrid Building Structures · Development of dissemination and support systems for housing with independent recycling of energy resources · Research and development into the effective utilization of existing buildings
	National Maritime Research Institute	· Research into the application of environmental labels of ships by LCA · Research into the recycling of ships
	Port and Airport Research Institute	· Research into recycling technology in coastal areas
	Civil Engineering Research Institute of Hokkaido	· Environmentally friendly resource circulation project for cold,snowy region · Experimental study on developing a regional system of biogas-derived hydrogen energy supply, including the technology for such a system
Ministry of the Environment	National Institute for Environmental Studies	· Evaluation of policies for the promotion of resource recycling from the lifestyle perspective · Research into methods for the analysis of recycling systems' local adaptability

(3) Research Related to Building a Society that Co-Exists with Nature, Research Related to the Comprehensive Management of Chemical Substances, and Research Related to Other Sectors

(Research and Development Related to Biological Diversity)

With the extinction of wildlife species proceeding at a speed never seen before, the "Convention on Biological Diversity," which is aimed at conserving the diversity of living things on Earth and their habitats and conducting sustainable use of biological resources, and the National Strategy of Japan on Biological Diversity, which is based on the said convention, call for the promotion of basic surveys for the purpose of scientific and objective data collection and facilitation regarding the current state of the natural environment and how it is evolving over time, the expansion of ecological and taxonomic knowledge of living things, and basic research for the purpose of elucidating the structure and maintenance mechanisms of ecosystems.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) is participating in the Global Biodiversity Information Facility (GBIF), which is an international scientific cooperation project. The aim of this project is to distribute biodiversity data scattered in countries and utilize it worldwide via the Internet. MEXT is now advancing the creation of a biodiversity online database in Japan as part of the project.

The Ministry of Agriculture, Forestry and Fisheries is promoting research into the development of biofunction-based technologies for reducing the burden on the environment, the analyses of the mechanisms that enable plants to resist environmental stress, and research and development of technologies that encourage human coexistence with wild animals and birds, while reducing their damage to agriculture and forestry.

The Ministry of the Environment is promoting research related to strategies for preservation of wild plants based on gene maps and individual base models.

(Research and Development Related to Antipollution Measures)

In the area of pollution prevention, the government is promoting the priority of research and development that utilizes pollution prevention testing and research funding. In recent years, in order to contribute to measures for mitigating environmental risks posed by chemical substances such as dioxins and endocrine disrupters, the relevant ministries and agencies are currently actively engaged in surveys, research and development, and establishment of an intellectual basis, including the development of methods for testing and measuring these substances and the collection and provision of information on chemical substances.

In the Ministry of Education, Culture, Sports, Science and Technology, the Japan Science and Technology Agency is promoting research and development into endocrine disruptors in its Basic Research Programs.

(Other)

The Ministry of Internal Affairs and Communications is promoting research into an international information network technology for the protection of the global environment, to facilitate the effective distribution of global environmental data.

The Ministry of Agriculture, Forestry and Fisheries is promoting research into assessment methods based on environmental accounting systems, in order to enable the comprehensive evaluation of agriculture's diverse functions, and of the positive and negative influence on the environment, and is also engaged in the development of nature-friendly control technologies for the hydrological cycle, and for agricultural, forestry, and fishery ecologies in drainage basins, to encourage agriculture, forestry, and fisheries industries that co-exist with nature.

The Ministry of Land, Infrastructure and Transport is promoting the development of drainage basin restoration and recovery technologies that take the entire drainage basin into account for comprehensive hydrologic cycle management, as well as the development of land and infrastructure technologies offering co-existence with nature.

The Ministry of the Environment uses the Global Environment Research Fund to promote research into forecasts of the effects of global warming, and into their countermeasures. In addition, the Environmental Technology Development Fund is being used to support the topic of technologies for the rejuvenation of drainage basins and major cities that are co-existent with nature, to promote research into the design and presentation of scenarios for coexistence with nature in major cities and drainage basins.

Incidentally, major research subjects conducted during FY 2004 are as shown in Table 3-2-5.

Table 3-2-5 Major Research Subjects for Research Related to Building a Society that Co-Exists with Nature, Research Related to the Comprehensive Management of Chemical Substances, and Research Related to Other Sectors (FY 2004)

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Japan Atomic Energy Research Institute	· Development of flue-gass radiation treatment
Ministry of Health, Labour and Welfare	Health and Labour Sciences Research Grants	· Research into the safety and health effects, etc., of dioxins and other microscopic chemical substances, and of microorganisms
	National Institute of Public Health	· Research into the conservation of drinking water sources
	Research funding for the project for the environmental sanitation	· Study for the produce of guidelines for waterworks to prevent global warning
Ministry of Agriculture, Forestry and Fisheries	National Institute of Agrobiological Sciences, National Institute for Agro-Environmental Sciences, National Institute for Rural Engineering, Forestry and Forest Products Research Institute, and others	· Development of comprehensive management system of hazardous chemicals in agricultural, forestry and fisheries ecosystem · Development of technologies for the management of agricultural and forest ecologies to reduce damage to agriculture and forestry by wild animals and birds · Development of eco-friendly management technology of water and agro-forested-aqua-ecosystem in watershed and estuary areas · MAFF gene bank project · Advanced evaluation of CO2 balances in forests and oceans, etc.
	Project for the Development of the Agriculture, Forestry, and Fisheries Industry, Foodstuffs Industry, and Other Advanced Industrial Technologies	· Development of technology for recycling-based use of marine resources using advanced technology · Development of low-cost basic technologies for the production of organic fertilizers, etc.
Ministry of Economy, Trade and Industry		· Environmental technology development · Development of technology for CO2 fixation and effective utilization · Development of environmentally friendly processing technology · Development of materials that put low stress on the environment · Development of environmentally friendly recycling technology

Ministry or agency	Research institute or program	Subject
Ministry of Land, Infrastructure and Transport	Technology Research Division, Minister's Secretariat	· Development of thermal environment evaluation and countermeasure technologies for urban space
	National Institute for Land and Infrastructure Management	· Research into environmental management technologies for enclosed bays · Study on risk evaluation of chemical substances in water environment · Projects for the restoration of tidal flats in urban seaside areas · Proper reuse of treated wastewater · Research on the influence of soil and groundwater contamination on the watersheds
	Geographical Survey Institute	· Geoecological research and survey using airborne LIDAR data - Case study in Shirakami Mountains
	Public Works Research Institute	· Research on evaluating water quality risks · Research on techniques for conserving the ground environment · Research on comprehensive hydrologic models for rivers · Research on techniques for controlling water quality and soil at dam reservoirs and in the downstream sections of rivers · Research on techniques for controlling water quality and soil at dam reservoirs and downstream sections of rivers · Research on techniques for treating bottom sediment in enclosed water areas · Research on evaluating heat island phenomena reduction alternatives
	Building Research Institute	· Mechanisms for the emission of indoor pollutants from construction materials · Research into quantification of the effectiveness of heat island countermeasures
	National Maritime Research	· Actual sea area tests of deep-sea carbon dioxide reservoirs · Research into measures for the prevention of large-scale oil spills by tankers · Joint Japanese-French research into the prevention of marine pollution · Research into monitoring of environmental pollution when toxic liquid substances leak into the environment · Research into the development of technologies for real-time 3-dimensional measurement systems · Research into the reduction of compound pollution caused by ships' generation of toxic volatile gases
	Port and Airport Research Institute	· Research on the assessment of the effect of toxic chemical substances in the coastal area and measures to mitigate those effects · Research on oil-spill cleanup technology for the coastal area · Comprehensive environmental monitoring of the Tokyo Bay and research on the environmental forecasting model
Ministry of the Environment	Global Environment Research Fund	· Research into the selection of coral reef biodiversity preservation districts · Research on the rehabilitation the landscape level of degraded tropical forest
	Environmental Technology Development Fund	· Research into wildlife and plant preservation strategies based on gene maps and individual base models · Research into the restoration of hydro and material cycles that co-exist with nature in cities and drainage basins, and the development of ecology evaluation standards · Research into the development of methods for diagnosing the degradation of multidimensional functions in natural drainage basin environments, and of integrated modeling for the effective evaluation of the soundness of restoration policies
	Research Funding for the National Research Institute engaged in Environmental Pollution Research	· Theoretical research for appropriate lake utilization that takes the mutual interactions of life-forms into account, toward integrated protection of lakes
	Survey and Research Funds for the National Organization for Pollution Prevention	· Research into elucidation of changes and behavior in the natural environments of world natural heritage districts
	National Institute for Environmental Studies	·Research into the evaluation of technologies for natural restorations of marshland ecologies · Assessment of the possibility of recovering the marshy ecosystem by the re-routing of rivers flowing into the Kushiro Wetlands · Assessment of the lake environment based on organic linkage and preparation of a scenario for improvement

3.2.2.4 Nanotechnology and Materials

Nanotechnology and materials are key technologies for rapid developments over a wide range of scientific and technological areas. Nanotechnology is expected to become a major support element of all science and technology fields in the 21st century, and to lead to a new industrial revolution in the 21st century.

(1) Materials Fields

Japan has to date maintained a high standard of research and development in materials, and will need in the future to take the lead over the rest of the world in technological innovation.

In view of the wide-ranging and diverse demands for materials science and technology, relevant ministries and agencies are actively engaged in research and development in many different areas of materials science and technology.

At the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology (Subdivision on Research and Development Planning and Evaluation) prepared the "Basic Strategy for Promotion of the Nanotechnology and Materials Sectors in the Ministry of Education, Culture, Sports, Science and Technology (interim report)" in June 2002.

In response to this, the National Institute for Materials Science generally and widely promotes basic and fundamental R&D for materials science and technology, including "structural materials for the 21st century" and "superconducting materials." Research into materials science and technology is also being promoted through the administration of the "Special Coordination Funds for Promoting Science and Technology," and other similar programs including "Creative Research for Evaluation Science and Technology Program of the Japan Science and Technology Corporation (JST)", and the Frontier Research System, at RIKEN. The ministry is also encouraging the development of creative and advanced materials research at the Institute for Materials Research and the Institute of Multidisciplinary Research for Advanced Materials at Tohoku University, the Institute for Molecular Science at the National Institutes of Natural Science, and the Institute for Chemical Research at Kyoto University, as well as using the "Grant-in-Aid for Scientific Research Program" for basic research into materials science and technology, in order to promote creative science research at universities and in others, so that they can serve as sources of free imagination and research inspiration for researchers.

Part of three-dimensional structures of proteins which were analyzed through joint research with the RIKEN Genomic Sciences Center

Source: RIKEN

The Ministry of Agriculture, Forestry and Fisheries is using "Insect Technology Research for Utilization of the Greatest Unused Resources of the 21st Century" to engage in research and development for the wider utilization of biomaterials such as fibroin, a silk protein, as a new material with active anti-thrombosis properties, or the development of materials utilizing the compound capabilities of the bone constituents of silk to form artificial bone or artificial ligaments.

The Ministry of Economy, Trade and Industry is promoting the Program to Create an Innovative

Components Industry to strengthen the international industrial competitiveness of Japan while sufficiently using the functions and characteristics of substances to establish a high-value added material industry that creates new markets and employment. In FY 2004, the ministry has implemented the Integrated Development of Materials and Processing Technology for High Precision Components, which aims to develop innovative technology for manufacturing processes in which material creation technology and processing technology are integrated, the Production, Analysis and Measurement System for Microchemical Technology Project, which aims to speed up the process from the research and development stage to the production stage, and the Next-Generation Semiconductor Nanomaterials Advanced Evaluation Project, which aims to achieve efficient searching for the optimum combination of multiple materials.

(2) Nanotechnology

(Major Policy Proposals for Nanotechnology)

The Ministry of Internal Affairs and Communications is engaged in the research and development of optical functional devices and information memory elements, etc., as basic research on information communications. In addition, under the “Strategic Information and Communications R&D Promotion Programme,” the ministry started the Research and Development on Ultrahigh-Functional Network Technology Utilizing Nanotechnology in FY 2003 as well as promoting research and development on new information and communications functions and device technologies. Moreover, the National Institute of Information and Communications Technology is promoting Research and Development of New Functions and Extreme Technologies, and thereby implementing basic research into ultra-compact, ultra-high speed, and ultra-low power consumption information and communications devices, including the development of optical devices for the high-speed control and processing of large-capacity signals.

The Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications is promoting development of methods of assessing corrosion and deterioration for dangerous facilities, and preparing the necessary databases for creating an environment for developing and introducing methods of assessing corrosion and deterioration for dangerous facilities.

At the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology (Subdivision on Research Planning and Evaluation) prepared the “Promotion Policies for R&D in Nanotechnology Materials” prepared in June 2002. In response to this report, the ministry is promoting, in its R&D projects (Leading Project) for economic revitalization, the “development of artificial organs and artificial sense organs using nanotechnology,” the “development of devices based on new principles derived from nanotechnology,” etc., through cooperation between industry and academia in sectors where the life sciences, information and communications, environment, and energy sectors merge together, and in technologies in which they share common foundations. In particular, under the “development of measurement, analysis, and evaluation tools leading the way to next-generation science and technology,” the ministry carried out newly-adopted subjects for the purpose of promoting development for practical application of nano-tech measurement and processing technologies. In addition, the “Nanotechnology Comprehensive Support Project” provides broad, cross-cutting and integrated support that goes beyond the bounds of existing research institutions and sectors, such as fostering human resources through seminars and international exchanges of young researchers, offering opportunities for the utilization of large and special facilities and equipment to outside researchers, collecting and publishing relevant information, and convening symposiums.

In addition, the Japan Science and Technology Agency implement the research and development of “virtual laboratories by nanotechnology field” from mid-and long-term viewpoints, in close cooperation with researchers by nanotechnology field” utilizing the Basic Research Programs.

The National Institute for Materials Science is engaged in the development of new materials for nano-devices, research into nano-scale materials for energy and environmental applications, and other nano-materials research. RIKEN is engaged in basic research, which will form the foundation of nano-science technology for future generations. This includes the measurement and control of nano-level properties and functions, simple quantum manipulation toward the development of new information processing devices, and space-time function materials for manufacturing auto-changing, auto-reacting materials, and materials that can change over time. Moreover, many universities and colleges, and independent administrative institutions are engaged in basic research spanning a wide range of fields. Furthermore, various research funding support programs, including the ministry's Special Coordination Funds for Promoting Science and Technology, and the "Grant-in-Aid for Scientific Research Program," are being used for nano-technology research themes.

The Ministry of Agriculture, Forestry and Fisheries is utilizing information about biological functions obtained at the molecular and cellular level, and cooperation from industry, academia, and government, as well as from different technology fields, to promote the development of revolutionary new functional materials through the use of nano-level structural controls, the development of technologies for the utilization of innovative biological functions, and the construction of a micro-bioreactor.

The Ministry of Economy, Trade and Industry is intensively promoting development of "nanotechnology" that may bring about innovative developpment in the broad areas of industrial technologies. The ministry is also promoting the "Nanotechnology Materials Program" to establish the technological foundation that contributes to the sustainable economic development as a source of industrial competitiveness of Japan, through systematization of results obtained and other knowledge. In FY 2004, the ministry implemented the development of nanomaterials with new functions to increase international competitiveness of the manufacturing industry, development of common technologies, including nano-processing and nanomeasurement such as MEMS[11] research and development for practical application using nanotechnology (Focus 21), such as the Carbon Nanotube FED[12] Project, and the standardization of nanomeasurement technology (intellectual basis).

The Ministry of the Environment is implementting the development of environmental technologies that make use of the nanotechnology merits of miniaturization and improved function. In FY 2004, the minister started the development of environmental measuring equipment using new carbon materials.

The major research topics in the nanotechnology and materials science and technology sector con-ducted during FY2004 are shown in Table 3-2-6.

11 MEMS : Micro-Electro-Mechanical System: Accumulation of machine elements, sensor, actuator and electronics on the silicon substrate by using micro molding techniques.

12 FED : Field Emission Display: Display unit based on the principle of having fluorescent materials emit light by emitting electrons from electron emitters on a flat surface and hitting the fluorescent materials with the electrons: Promoting research for achieving high-quality images and low power consumption by using carbon nanotube, a new material, for electron emitters.

Table 3-2-6 Major research subjects in the nanotechnology and materials sectors (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology, etc.	· Research and development of ultra functional network utilizing · Research and development on new functions and ultimate technologies
	Fire and Disaster Management Agency	· Development of methods of assessing corrosion and deterioration of dangerous facilities
Ministry of Education, Culture, Sports, Science and Technology	Special coordination funds for promoting science and technology	· Research into the development of nanohetero metallic materials by elucidating their nanostructure-property relationships · Research into the creation of new functional materials using ceramics integration technology · Research into active atom array networks for a new information processing platform · Practical development of opto-media crystals for information technology · Application of ultra-fine grained steel sheets for automobiles · Radiant-control directly excited microchip lasers · Development of a high-speed atomic force microscope for capturing nanometer-scale dynamic behavior of biological molecules · Development of a new-type X-ray photoemission electron microscope · Development of continuous fiber reinforcements for pre-stressing and smart bonding technology · Creation of bio-conjugate photosensitive nanomaterial · Nano-spintronics design and manufacturing · Combinatorial computative chemistry for the revitalization of Japan · Kyoto University personnel development unit for computative materials researchers · Development of new crystal material for the terahertz range · Use of nano-boundary control for the manufacture of magnetic recording materials · Development of next-generation display media using self-organization of molecules · Research and development into generation of high-polymer particles using micro-chemical reactors · SNDM strong dielectric probe memory · Development of SiO2 glass-metal slope function material as a light source · International exchanges of nanotechnology researchers · Comprehensive research on nano devices for elucidation of the structures and functions of chromosomes
	National Institute for Materials Science	· Development of novel materials for nano-devices · Nanosynthesis and nanostructural materials for energy and environmental applications · R&D of new superconducting materials · High Temperature Materials 21 · Project for the promotion of biological materials · Ultra-Steel Products for New High Safety Infrastructures · Combinatorial Materials Exploration and Technology (COMET) · Development of virtual experimental platform for material design using computational science and technology · Development of a carrier material for an innovative nano drug delivery system (DDS)
	RIKEN (The Institute of Physical and Chemical Research)	· Nano-scale science and technology · Study on the genesis of matter · Coherent science research (Phase II) · Advanced technology research (physical science research) · Material science research (Quantum Materials Research) · Spatio-Temporal Function Materials Research · Single Quantum Dynamics Research ·Research on exotic particle beams

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Japan Science and Technology Agency	· Creation of ultra-fast, ultra-power-saving high-performance nanodevice systems, creation of bio-elements and systems utilizing medical-oriented chemical and biological molecules, and other projects for the promotion of strategic creative research · Project for the promotion of nano-space, spin superstructures, and other creative science and technology
	New Century Priority Research Creation Plan (RR2002)	· Nanotechnology Researchers Network Center
	Research and Development Project for Economic Revitalization (Leading Project)	· Development of measurement, analysis, and evaluation equipment leading to next-generation science and technology · Development of artificial organs and artificial senses using nanotechnology · Development of devices operating on new principles based on nanotechnology · Commercialization of extreme ultraviolet (EUV) light source technology and other advanced semiconductor manufacturing technologies · Next-generation fuel cell project
Ministry of Agriculture, Forestry and Fisheries	National Institute of Agrobiological Sciences	· Insect technology project
	National Food Research Institute	· Development of nanotechnology and materials technology for the innovative utilization of biological functions
Ministry of Economy, Trade and Industry		· Carbon nanotube FED project · High-strength nanoglass display monitor project · High-function nanoglass device project · Full-color rewritable functional capsule paper project · Diamond ultimate function project · Next-generation semiconductor nanomaterial advanced evaluation project · Nanocarbon application product manufacturing project · Micro-analysis and production system project · Project for the development of semiconductors for high-efficiency UV luminous elements
Ministry of the Environment		· Project for the promotion of environmental technology development using nanotechnology

3.2.2.5 Energy

The “Basic Energy Plan” (by the Cabinet in October 2003) based on the Basic Law on Energy Policy (enacted in June 2002) revealed the energy R&D policies meriting priority promotion for the long-term comprehensive, planned promotion of policies related to energy supply and demand. In particular, it is necessary to promote research and development of energy that contributes to mitigating global warming, in line with the entry into force of the Kyoto Protocol.

(1) Research, Development, and Utilization of Nuclear Energy

Research, development, and utilization of nuclear energy in Japan have been carried out strictly for peaceful uses, in accordance with the Atomic Energy Basic Law. In regard to its basic and promotion policies, the Atomic Energy Commission adopted the “Long-Term Program for Research, Development, and Utilization of Nuclear Energy” (hereafter called the “Atomic Energy Long-Term Plan”), and is steadily moving ahead under this plan. The Atomic Energy Commission has been holding the New Plan Formulation Council since June 2004 to formulate a new Atomic Energy Long-Term Plan. The Commission is conducting deliberations with the aim of formulating the plan by the end of 2005.

Today, nuclear power generation plays an important role in energy supply as a major source of energy accounting for more than one-third of electric power supplies and also as an energy source that contributes to mitigating global warming. Moreover, accelerators and other results of atomic energy science and technology continue to provide new knowledge in basic science sectors, and offer essential research tools for the life science and materials science and technology sectors. In addition, use of radiation has spread to a wide range of sectors, including medicine, agriculture, manufacturing, and environmental protection. Thus, nuclear energy has greatly contributed to assuring stability in the nation's energy supplies and improving the lives of the people.

Meanwhile, in regards to the atomic energy R&D structure in Japan, the "Reorganization and Rationalization Plan of Public Corporations," adopted by the Cabinet in December 2001, called for abolition of the Japan Atomic Energy Research Institute and the Japan Nuclear Cycle Development Institute, and for their merger through the establishment of a new incorporated administrative agency for the comprehensive implementation of atomic energy research and development. In response to these, the Law for the Japan Nuclear Energy Research and Development Organization was enacted at the 161st extraordinary Diet session, and the ministry is currently engaged in promoting operations toward the establishment of the new entity in October 2005.

(Ensuring Safety, and Emergency Preparedness)

Safety is the indispensable prerequisite for the research, development, and utilization of nuclear energy. Enforcement of stringent regulations and safety management, and execution of safety research, are essential to ensuring safety. Moreover, in recognition of the impossibility of eliminating the occurrence of accidents to 0%, there is also a need to prepare countermeasures in the case of an accident to ensure that damage to the lives and health of local residents, etc., is held to the absolute minimum.

Because of these viewpoints, the government imposes stringent safety regulations on nuclear facilities in the design, construction, and operation stages of nuclear energy research, development and utilization, to a degree unseen in any other Industrial sector in Japan. In addition to regulations, the government also has adopted various kinds of measures to ensure safety, such as environmental radiation monitoring and emergency preparedness.

Regarding ensuring safety of nuclear facilities, consideration has been given on the strengthening of a system to protect nuclear materials, introduction of the clearance system[13] and enhancement of the regulation system concerning the dismantlement and abolishment of nuclear facilities, from an expert viewpoint based on domestic and international trends. The Ministry of Economy, Trade and Industry gave considerations at the Nuclear Safety and Security Subcommittee of the Advisory Committee for Natural Resources and Energy. The following three reports were compiled in 2004: "Concerning the Strengthening of Measures to Protect Nuclear Materials at Nuclear Facilities," "Concerning the Establishment of a Clearance System at Nuclear Facilities," and "Concerning Regulations on the Abolishment of Nuclear Facilities." In addition, the Ministry of Education, Culture, Sports, Science and Technology gave consideration at the Study Meeting on Safety Regulations for Research Reactors and compiled a report titled "Concerning Desirable Safety Regulations for Nuclear Reactor Facitilities for Experiment and Reesarch" in January 2005. Based on these reports, the Ministry of Economy, Trade and Industry and other related administrative organizations gave consideration to establishment of specific laws and ordinances, and a bill was submitted to the 162nd session of the Diet.

Regarding nuclear emergency countermeasures, efforts to expand and strengthen nuclear disaster measures are now being promoted based on the Special Law of Emergency Preparedness for Nuclear Disaster established in 1999, including the dispatch of the Senior Specialists for Nuclear Emergency Preparedness, designation of base facilities for emergency measures in urgent situations (off-site centers), etc., preparation of radiation measurement equipment and other necessary materials and equipment, preparation of disaster prevention plans for nuclear energy companies and implementtation of emergency drills.

13 Clearance: Excluding radioactive materials, of which radiation level is sufficiently small compared to the radiation levels in the natural world and of which effect on human health is negligible, from the subject of regulations of radiation protection as "those which do not require treatment as radioactive materials"

For surveys of environmental radiation, the Ministry of Education, Culture, Sports, Science and Technology and other relevant ministries and agencies, prefectural governments, and atomic energy enterprises continue to conduct radiation surveys in areas surrounding nuclear energy facilities. In addition, surveys are conducted of Japan's environmental radioactive materials, as well as radiation surveys of nuclear-powered military vessels when they enter port.

Enterprises engaged in handling radioactive materials reacted to the simultaneous multiple terrorist attacks that occurred in the United States in September 2001 by strengthening their controls of radioactive materials and reviewing their emergency communication procedures.

To introduce the international standard value (lower limit of the subject of regulations) set by the International Atomic Energy Agency (IAEA) and streamline the regulations of radioactive isotopes along with their introduction, the Law for the Prevention of Radiation Sickness Caused by Radioactive Isotopes[14] was amended in 2004 so as to incorporate provisions for regular confirmation of methods of using radioactive isotopes, disposal of waste by burial and other matters.

Also, in ensuring nuclear safety, it is always important to reflect the latest scientific and technological knowledge in safety regulations. To this end, the Nuclear Safety Commission is coordinating the "Five-Year Safety Research Program (FY2001 to FY2005)."

In the area of safety research related to nuclear facilities, the Japan Atomic Energy Research Institute (JAERI) conducted evaluative and analytical research of light water reactors, regarding the high burn-up of fuel, advanced aging, severe accidents, and other accidents and incidents, and also conducted research into criticality safety at nuclear fuel facilities. In addition, the Japan Nuclear Cycle Development Institute (JNC) conducted safety research on accident prevention and mitigation, accident evaluations, severe accidents, etc., in Fast Breeder Reactors (FBRs), as well as safety research on the safety of criticality, shielding, confinement, etc., in nuclear fuel facility-ies. Other incorporated administrative agencies and other organizations also engaged in basic safety res-earch.

For safety research related to environmental radiation, the National Institute of Radiological Sciences, working with JAERI, JNC, and other independent administrative agencies, conducted safety research on the dose evaluation of radiation exposure, as well as basic safety research into radiation effects.

Concerning safety research for radioactive waste management, safety research including near surface disposal and geological disposal, as well as clearance level verification technology, was conducted by JAERI and JNC.

In regards to the Five-Year Safety Research Program, in view of the changes in the structures of the institutions engaged in safety research, the Nuclear Safety Commission compiled in July 2004 the "Priority Safety Research Program" that presents research into safety issues to be conducted in FY2005 and beyond.

(Efforts by Nuclear Experts toward Assuring Trust and Coexistence with Communities)

In order to promote the smooth research, development, and utilization of nuclear energy, it is extremely important first to obtain public confidence in the government and nuclear power operators. For this purpose, nuclear power operators must build up a record of safe operations, and strive to obtain people's understanding. To this end, public hearings and public relations programs are being promoted to ensure two-way communication and transparency with people, as well as activities to further their understanding, such as support for education on nuclear energy or lending out simplified radiation detectors.

14 The following amendments were made through amendments to the Law for the Prevention of Radiation Sickness Caused by Radioactive Isotopes in 2004:
(1) creation of a system of design certification by the equipment manufacturer
(2) rationalization of sales and leasing services from a license system to a notification system
(3) creation of a regular confirmation system to improve the safety of establishments
(4) creation of a regular training system to improve the ability of radiation protection supervisors
(5) preparation of provisions concerning disposal of waste by burial.

Furthermore, to promote coexistence between nuclear power research facilities and local candidate sites, the Power Source Grant program, of which use was expanded to non-construction projects, is being utilized in response to the needs of the local candidate sites.

(Nuclear Power Generation and the Nuclear Fuel Cycle)

(1) Nuclear Power Generation

With nuclear power generation being an important energy source for ensuring stable energy supplies in Japan, and also a superior energy source in terms of protection of the global environment, since it emits no carbon dioxide or nitrogen oxides in the course of power generation, its research, development, and utilization is being steadily promoted, predicated on the assurance of safety and on peaceful utilization.

For the light water reactors that are the main form of nuclear reactor currently in use in Japan, the government, electrical power companies, manufacturers of atomic power equipment, etc., have been cooperating to improve working efficiency, and reduce employee exposure to radiation on the premise of securing the safety of light water reactors by Japan’s own technologies. In view of operational experiences to date, the parties have striven to make the light water reactor technology more economical, while maintaining high levels of reliability and safety.

(2) Research and Development of the Nuclear fuel Cycle

Japan, which must rely on imports for the vast majority of its energy resources, is steadily promoting efforts to establish the fuel cycle through effective utilization of the recovered plutonium, etc., from the reprocessing of spent nuclear fuel, in order to secure long-term energy supply stability in view of the future energy supply and demand in the world, and to reduce the load on the environment. It is important, therefore, to continue to promote research and development on the nuclear fuel cycle, and to steadily develop the Rokkasho Reprocessing Plant, the plutonium utilization program in light water reactors, and the interim storage of spent fuel.

In promoting plutonium utilization, Japan strives to ensure the transparency of plutonium use by disclosure of information regarding plutonium inventories, not only from the viewpoint of rigorous management of nuclear materials, but also in clear observation of the principle of never holding excess plutonium that is not required to implement current programs, so as to avoid arousing international concerns regarding the proliferation of nuclear weapons. Specifically, Japan adopted international plutonium guidelines for improving the transparency of its plutonium use, and annually announces its Plutonium management state through the International Atomic Energy Agency (IAEA).

Concerning the enriched uranium used as fuel in nuclear power generation, Japan is promoting the development of domestic uranium enrichment projects to secure independence over the entire nuclear fuel cycle, and endeavoring to maintain economy.

While some reprocessing of spent fuel from nuclear power plants is conducted at the Japan Nuclear Cycle Development Institute’s Tokai Reprocessing Plant, most is consigned by contract to reprocessing by British Nuclear Fuel Limited (BNFL) and COGEMA, the French nuclear fuel company.In view of the principle that spent fuel should be reprocessed domestically in Japan, construction is underway on a private-sector reprocessing facility (with an annual reprocessing capacity of 800 tons) in Rokkasho-mura, Aomori Prefecture, and a series of tests are currently underway toward a projected completion date of May 2007. The aim is the firm establishment of reprocessing technology on a commercial scale through the successful construction and operation of a private-sector reprocessing plant, toward the eventual establishment of the nuclear fuel cycle.

In this regard, the Tokai Reprocessing Plant has contracted with electrical power companies for the reprocessing of spent uranium fuel used in light water reactors, and about 1,060 tons has already been reprocessed. There are no plans to renew the contract when the period of the current contract is completed.

In addition, research and development of MOX fuel fabrication in Japan is now in progress at the

Japan Nuclear Cycle Development Institute, and about 170 tons of MOX had already been produced by the end of December 2004.

Intermediate fuel storage is important as a means to provide flexibility for the whole nuclear fuel cycle because the time period until the fuel is reprocessed can be adjusted through the storage. A law concerning intermediate storage was enacted in 1999, and utility companies are preparing for the facilities to be commissioned by 2010.

The "Fugen" advanced thermal reactor, which was undergoing independent development as a nuclear reactor with the ability to flexibly and efficiently utilize plutonium, recovered uranium, and other fuel, terminated its operations in March 2003, and the project ends as of 30 September 2003 with the completion of a report summing up the project results. The research and development necessary for decommissioning is now in progress.

(3) Radioactive Waste Management

One of the most important issues from the viewpoint of executing coherent policies for the promotion of nuclear power utilization, and of obtaining the people's understanding and trust, is the management of the disposal of radioactive waste, and the decommissioning of nuclear facilities. Since radioactive waste varies in radioactivity and the types of radioactive materials contained in it, radioactive waste is now classified not by its sources, but by its disposal methods, and specific measures are taken.

The Japan Nuclear Cycle Development Institute, acting as the core institution working in close cooperation with the Japan Atomic Energy Research Institute, the National Institute of Advanced Industrial Science and Technology, and university-affiliated research institutions, is now engaged in research and development on the disposal of high-level radioactive wastes. In addition, the Japan Nuclear Cycle Development Institute is developing two underground research laboratory programs in Mizunami, Gifu Prefecture (crystalline rocks) and in Horonobe, Hokkaido Prefecture (sedimentary rocks) as key facilities for promoting its research and development.

Low-level radioactive waste generated at nuclear power plants has been disposed of at the Japan Nuclear Fuel, Ltd.'s Low-Level Radioactive Waste Disposal Center in Rokkashomura, Aomori Prefecture since December 1992, with about 170,000 -200 liter drums of waste already having been transferred to the center as of the end of January 2005.

The Ministry of education, culture, sports, science and technology started the "Roundtable discussion on disposal enterprises for radioisotope and research institute wastes" to consider the basic policies of disposal management on the primary contractor in February 2002 and published the final report in March 2004. Following the results, the Japan Atomic Energy Research Institute and the Japan Nuclear Fuel Development Institute have been progressing further study of disposal realization in cooperation with the Japan Radioisotope Association.

"The Law Concerning Prevention from Radiation Hazards due to Radioisotopes, etc." was amended to add an article about near surface disposal of solidified radioisotope wastes in June 2004.

The Japan Atomic Energy Research Institute and the Japan Nuclear Fuel Development Institute have continuously researched and developed decommissioning technologies of nuclear fuel cycle facilities including the "Fugen" reactor.

(Research and Development of Fast Breeder Reactors and Related Nuclear Fuel Cycle Technology)

FBRs and related nuclear fuel cycle technology can greatly boost the efficiency of uranium resource utilization. When this technology is put to practical use, it will become possible to continue using nuclear energy for several hundred years even if we only depend on the uranium resources known today to be technologically and economically utilizable. The use of FBR cycle technology could further reduce the environmental burden by minimizing long-lived radioactivity in high-level radioactive wastes. In terms of preparation for an uncertain future, and for assurance of an effective future energy option, development effort in this area is plainly important.

The "Monju" prototype fast breeder reactor uses technology based on MOX fuel and sodium cooling, the most advanced of the FBR cycle technologies, and it is the only fast breeder reactor plant with power generating capabilities in Japan. "Monju" is positioned in the Atomic Energy Long-Term Plan as the core for Japan's research and development into fast breeder reactor cycle technology

"Monju" ceased operations following a sodium leak accident in December 1995. In response to this situation, the Japan Nuclear Cycle Development Institute decided to implement plant modifications to reinforce countermeasures for a sodium leak accident to further increase safety toward resuming operations and obtained government approval. In February 2005, the institute obtained approval for the commencement of the plant modifications from Fukui Prefectural government and Tsuruga City municipal government, and then started preparation for the plant modifications.

However, regarding an administrative suit initiated by the local residents to nullify the construction license of "Monju," the government appealed the ruling up to the Supreme Court of Japan in response to the high court decision against the government in January 2003, and the appeal was accepted. In March 2005, oral proceedings were held at the Supreme Court.

In addition, since July 1999, the Japan Nuclear Cycle Development Institute has been collaborating with electric power companies to promote a "Feasibility Study on Commercialized Fast Reactor Cycle Systems," to propose appropriate concepts for FBR cycle technology to be commercialized in the future and develop research and development plans toward its realization, and is engaged in research and development to clarify the comercialization candidates that improve safety and economy, reduce the burden on the environment, and offer assurances for nuclear nonproliferation.

(Promotion of Nuclear Fusion Research and Development)

Promotion of nuclear fusion research and the development of nuclear fusion are important because they expand available energy options for the future and increase the feasibility of fusion energy. In Japan, fusion research and development is promoted based on the "The Third Phase Basic Program for Fusion Research and Development" and the "Atomic Energy Long-Term Plan," which were adopted by the Atomic Energy Commission, by JAERI, the National Institute for Fusion Science, and universities and colleges through mutual cooperation, while aiming at prioritization based on "The Future of Nuclear Fusion Research in Japan," decided upon in January 2003 by the Science and Technology Council's Working Group on Nuclear Fusion Research. In addition, bilateral and multilateral international cooperation is being actively promoted.

JAERI is promoting R&D on a tokamak-type reactor toward the realization of a practical reactor. In particular, the large "JT-60" tokamak device has achieved significant results, which led the physics R&D toward the implementation of ITER, and demonstrated the feasibility of a steady-state nuclear fusion reactor. Further research is being promoted to achieve the long pulse operation of high pressure plasma through the improvement of plasma confinement performance.

The National Institute for Fusion Science constructed the large helical device (LHD) that is based on a unique idea originating in Japan and is the largest helical device in the world. Its research into new plasma regions leads the world. In December 2004, LHD achieved the world's largest input energy value into plasma, 1.3 billion joules.

In addition, the Institute of Laser Engineering at Osaka University, other universities and independent administrative institutions, etc., are engaged in basic research into various magnetic confinement and inertial confinement methods, and in research into essential technologies related to reactor engineering.

The ITER is an international cooperation project that aims for verification of the scientific and technological feasibility of nuclear fusion energy, and Japan promotes it actively. At the present time, six parties, specifically, Japan, China, the EU, South Korea, Russia, and the United States, participate in the project. In Japan, the Cabinet agreed on May 31, 2002 on a policy that Japan would propose Rokkasho-mura, Aomori prefecture as a candidate site with the aim of hosting ITER, based on the conclusion of the Council for Science and Technology Policy. In addition to Rokkasho-mura, Cadarache in France is proposed by the EU as a candidate site for the place to build an ITER. On the understanding of the above-mentioned policy, the Japanese government is making its best effort to host ITER in cooperation with local government authorities, industry and academia.

Based on the assumption that ITER is actually sited in Japan, the Ministry of Education, Culture, Sports, Science and Technology established the

ITER Safety Regulations Review Working Group to perform specific expert studies into safety regulations for ITER, and a “Report on ITER Safety Regulations,” was released in November 2003. The ministry is promoting operations for confirmation of the necessary safety measures and, based on the above report, is proceeding with further studies in preparation for the legal framework.

(Promotion of Nuclear Science and Technology)

Nuclear science and technology uses the development and utilization of accelerators and high intense lasers to identify the ultimate components of matter and shed light on the laws of nature. The contribution of nuclear science and technology has two major aspects. The first is fundamental, theoretical research that supports science and technology development in the life sciences and materials-related scientific and technological sectors. The other is research and development that addresses the needs of the economy, society, and consumers by offering options for stable energy supplies in the future by means of nuclear fusion and innovative nuclear development. The promotion of nuclear science and technology requires the development of an environment conducive to creative research, and necessitates efficient and balanced development of the supporting fundamental, theoretical research.

Accelerator science is constantly affected by international competition, and its technology-intensive character means that post-proposal and evaluation results should be reflected without delay in the next steps of research. The Japan Atomic Energy Research Institute (JAERI) and the High Energy Accelerator Research Organization (KEK) are jointly promoting the High Intensity Proton Accelerator Project that aims at the construction of a proton accelerator with the highest beam power in the world, and new development over a wide range of research fields, including life science, materials science, nuclear physics and particle physics. The project was evaluated in August 2000 by the Advisory Committee on Evaluation of the High Intensity Proton Accelerator Project, which had been established under the Atomic Energy Commission (AEC) and the Science Council Accelerator Science Subcommittee. In addition, the Assessment Operations Division of the High Intensity Proton Accelerator Project, a part of the Council for Science and Technology, conducted an interim assessment and started construction of a Neutrino Facility in FY 2004.In addition, RIKEN (The Institute of Physical and Chemical Research) is currently engaged in construction of the RI Beam Factory, an accelerator facility for generating beams of all types of radioactive isotopes (RI), from hydrogen to uranium, at the highest intensities in the world.

The outlook for the 21st century is for innovative new reactors with excellent economy and safety that are suited for thermal utilization and other diversified energy supplies, and to the spread of nuclear reactor use, as well as for the advent of innovative nuclear fuel cycle systems that can alleviate the problem of how to dispose of spent fuel and radioactive wastes and also improve the nonproliferation situation.

Beginning in FY2002, the Ministry of Education, Culture, Sports, Science and Technology has entertained various new ideas, using links between industry, academia, and government to perform research and development into public canvassing methods for selection between proposals related to innovateive nuclear power technologies.

Since FY 2000, the Ministry of Economy, Trade, and Industry has been conducting research and development for innovative, creative, and practical nuclear power technologies by inviting proposals, to ensure that there will be a variety of choices regarding future nuclear power generation and the nuclear fuel cycle.

JAERI has been conducting a rise to power test for the High Temperature Engineering Test Reactor (HTTR) to establish a high-temperature, gas-cooled reactor technology that explores the possibilities for diversification of energy supplies, such as high-temperature thermal supplies, and to promote research and development in hydrogen production and other heat utilization. In April 2004, JAERI succeeded in removing high-temperature gases of 950℃, which marked the highest temperature of an outlet of a nuclear reactor in the world.

Basic research in nuclear science and technology nurtures the seeds that lead to the diversification of nuclear power usage and future technological revolutions, and contributes to project research in the field of nuclear energy and the development of other scientific and technological sectors. JAERI is making efforts to conduct fundamental research for the renewed development of nuclear energy, with advanced basic research into the science in radiation fields being conducted at the Advanced Science Research Center. On the other hand, the Kansai Research Establishment, which is in Kansai Science City, is engaged in the development of the X-ray laser, as well as other advanced laser science. In addition, JAERI and RIKEN commenced operation of a large synchrotron radiation facility (SPring-8) in October 1997, built in Harima Science Park City, for the purpose of promoting utilization and research by researchers from both Japan and abroad. Furthermore, national experimental research institutions under the control of each office and ministry are promoting leading-edge basic research in the four areas of fundamental technology, i.e. substances and materials, biological and environmental effects, computation technologies, and disaster prevention and safety. In addition, basic crossover research on nuclear energy is also being conducted by organically combining the potential capabilities of incorporated administrative agencies, universities, national experimental research institutions and other research institutions through their active cooperation in research.

(Promotion of Radiation Utilization)

One use for nuclear energy is the application of radiation in a wide range of sectors from basic research to utilization in medicine, engineering, agriculture, and other sectors; promotion of research and development toward the widespread use of radiation is also important.

As for the state of radiation utilization, the medical sciences already make wide use of diagnostic technology employing X-ray Computerized Tomography (CT) and X-ray or gamma ray radio-therapy for the treatment of cancer, while research is being conducted on the use of protons and heavy ion beams, etc., for the treatment of cancer. In particular, the National Institute of Radiological Sciences (NIRS) is engaged in research on cancer therapy using heavy ion beams, which was approved as highly-advanced medical treatment with high expectations for its clinical effectiveness against cancer. In addition, the institute is promoting research to downsize equipment in accordance with the Third Comprehensive Ten-Year Strategy against Cancer. In universities, as well, such as at the Tsukuba University's Proton Medical Research Center, research is progressing into the diagnosis and treatment of cancer using proton beams. In the agricultural sector, radiation is used for the improvement of crop varieties, the eradication of vermin without recourse to agricultural chemicals, the prevention of budding in potatoes, etc. In the industrial sector, radiation is used for non-destructive testing of industrial products, for industrial measurements, and for quality improvements of rubber, plastics, and other polymer materials. In the research area, research using ion beams and gamma radiation is being conducted at the Japan Atomic Energy Research Institute for the creation of new functional materials and biotechnology useful for preserving resources or cleaning up the environment, and using electron beams in environmental protection technologies for the elimination of toxic substances from smoke emissions.

(Nuclear Non-Proliferation Policies and International Nuclear Energy Cooperation)

To smoothly carry on with nuclear energy research, development, and utilization requires that Japan clearly explain to international society its stance underlying nuclear power policies, and to obtain their understanding and trust. In addition, in order to resolve international concerns related to nuclear energy, such as the issues of nuclear safety and disposal of radioactive wastes, it is important that Japan actively make use of its technology and experience in cooperation with international society, so as to obtain the understanding and trust of the international community.

(1) Nuclear Non-Proliferation Policies

In order to ensure smooth implementation of the peaceful use of nuclear energy, the maintenance of the international nuclear nonproliferation regime, along with safety assurances, is extremely important. Several international frameworks, including the Treaty on the Nonproliferation of Nuclear Weapons (NPT), the comprehensive safeguards by the International Atomic Energy Agency (IAEA) based on the NPT, and the Comprehensive Nuclear Test Ban Treaty (CTBT), have been established. In addition to these frameworks, Japan reinforces the international nuclear nonproliferation regime with its technologies and skilled personnel in relation to the peaceful utilization of nuclear energy.

Japan is promoting the development and utilization of nuclear energy strictly for peaceful purposes, as stipulated in the Atomic Energy Basic Law. For many years, Japan has accepted “safeguards” to ensure the peaceful use of nuclear materials, based on the Safeguards Agreement with the IAEA, and implemented “physical protection” to prevent theft of nuclear materials or attempts to sabotage nuclear facilities. Japan is also promoting the necessary technology development for the implementation of the above measures. In FY 2004, the IAEA concluded that Japan shows no sign of diversion of nuclear materials under safeguards or of undeclared nuclear materials or nuclear activities. Through this, the Integrated Safeguards, which are efficient safeguards that enable a reduction in the number of inspections, were started.

In response to the start of uranium experiments at the Rokkasho Reprocessing Plant, an important facility to be safeguarded, the government started operation of the Rokkasho Safeguards Analytical Laboratory (on-site laboratory). The government also organized an international training course for the improvement of technologies for nuclear materials accounting.

In addition to responsibilities imposed under the NPT, it is important for Japan to ensure transparency by employing rational and consistent plans, while adhering strictly to the principle of non-possession of surplus plutonium. Therefore, in line with international plutonium guidelines designed to boost transparency of the nuclear fuel cycle program, Japan discloses through the IAEA the conditions of its plutonium management, and independently discloses more detailed data, to ensure that transparency is maintained at as high a level as possible. Furthermore, Japan actively promotes the development of technologies related to non-proliferation policy, and undertakes research and development activities with full consideration of nuclear non-proliferation in fields such as advanced recycling technologies.

Additionally, Japan in July 1997 swiftly ratified the CTBT banning all nuclear weapon test explosions and all other nuclear explosions, a historic step towards a world that is free of nuclear weapons, and is now engaged in development of an international monitoring system toward the treaty’s eventual enforcement.

(2) International Nuclear Power Cooperation

In the area of international nuclear cooperation, it is important to promote international cooperation activities for common issues or R&Ds, such as those for the research, development and utilization of nuclear non-proliferation, as well as to respond positively to the expectations of developing nations.

Japan participates in the Generation IV International Forum (GIF), members of which are the United States, France, and eight other countries and one institution. In February 2005, the governments of five countries, the United States, France, the United Kingdom, Canada and Japan, concluded a framework agreement related to the development of next-generation nuclear energy technology.

For nuclear cooperation with Asian countries, exchanges of information, opinions, and technology are being promoted under the framework of the Forum for Nuclear Cooperation in Asia (FNCA) for the peaceful utilization of nuclear power, in such areas as research reactors and the medical utilizetion of radiation. The Fourth FNCA Ministerial Level Meeting was held in Okinawa in December 2003, at which time opinions were exchanged between member nation ministers in charge of nuclear power on such issues as how to promote nuclear power cooperation, strategies for fostering human resources, sustainable development, and nuclear power energy.

Japan also participates in the Regional Cooperative Agreement for Research, Development & Training Related to Nuclear Science and Technology (RCA), a grouping since 1978 of IAEA member countries in the Asia-Pacific region hosting study seminars and other events in the industrial, medical, and radiation protection fields, as well as making technology transfers through the dispatch of Japanese experts, providing equipment and materials, offering funding and personnel assistance, and contributing to the social and economic development of developing nations.

For cooperation in nuclear energy with the countries of the former Soviet Union and of Central and Eastern Europe, Japan offers research cooperation for the decommissioning of nuclear facilities, bilateral cooperation for quality improvement of plant operators through training projects, and provision of multilateral support through extra-budgetary contribution funding to the IAEA. In addition, regarding the management and disposal of Russia's surplus weapons-grade plutonium, Japan is determined to utilize its technologies for the peaceful use of nuclear energy developed over many years in Japan to cooperate in the disposition program of Russia's surplus weapon-grade plutonium, as part of its contribution to nuclear disarmament and nonproliferation, in close cooperation with the principal countries of the United States and Russia, and with other involved countries. In particular, the Japan Nuclear Cycle Development Institute (JNC) is engaged in research cooperation with Russia's Institute of Physical Energy Research and other institutes, such as the Research Institute for Atomic Reactors and the Institute of Physics and Power Engineering.

Finally, for nuclear cooperation with Europe countries and the United States, Japan exchanges experts and information regarding the peaceful use of nuclear energy, and the receipt and supply of nuclear materials and related services. Specifically, this includes research cooperation by the Japan Atomic Energy Research Institute (JAERI) and the Japan Nuclear Cycle Development Institute (JNC) with the U.S. Department of Energy (DOE) and the French Atomic Energy Commission (CEA), research cooperation between RIKEN and the U.S.-based Brookhaven National Laboratory, and also with Britain's Rutherford Appleton Laboratory.

(2) New Energy Research and Development

While new energy can contribute to addressing global warming, and to stable energy supplies, it also faces problems of economy, such as low energy densities and high electricity generating costs, and of stability, meaning that output can fluctuate in accordance with the surrounding natural conditions. Research and development into fuel cells, photovoltaic cells, biomass energy, and other forms of new energy need to be aggressively promoted, in order to address these problems and promote the introduction and broader diffusion of these technologies.

(Fuel Cells and Hydrogen Energy Utilization)

Because fuel cells, which generate electricity through a chemical reaction between hydrogen and oxygen, are very efficient and do not emit NOx or SOx, they are expected to be a key energy and environmental technology. While the development of fuel cell vehicles and stationary fuel cell systems is well-advanced, there still remain some hurdles to be addressed, such as durability and performance in order to make them commercially feasible. For this reason, the Ministry of Education, Culture, Sports, Science and Technology is promoting the development of new components and materials that can improve fuel cell performance. The Ministry of Economy, Trade and Industry is promoting research and development into fuel cell elements and hydrogen energy utilization technologies, including the manufacture, transport, and storage of hydrogen fuel, and the demonstration of fuel cell vehicle and hydrogen supply facilities. The Ministry of Land, Infrastructure and Transport is demonstrating prototype fuel cells for residential use.

(Photovoltaic Power Generation)

Photovoltaic power generation has been spreading as its price has fallen. Nevertheless, development of technologies that further lower costs is essential for the establishment of a truly independent market. For this purpose, the Ministry of Economy, Trade and Industry is promoting the development of technologies that achieve lower costs and higher levels of efficiency, as well as the development of recycling and reuse technologies.

(Biomass Energy)

Based on the Biomass Nippon Strategy (ratified by the Cabinet in December 2002), the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, and Transport, and the Ministry of the Environment are promoting research and development into technologies for the efficient conversion of animal wastes, wood residues, organic sewage, food wastes, and other unusable biomass sources into universally acceptable fuel forms, such as methane and other gaseous fuels (gasification), or methanol and other liquid fuels (liquefaction), and into technologies for these fuels' efficient utilization.

(3) Clean Fossil Fuel Energy R&D

From the perspective of global warming prevention, the promotion of research and development into cleaner and more efficient fossil fuel utilization technologies is a necessity.

(Petroleum)

People are demanding further reductions in the environmental burden due to the use of petroleum products. In particular, the Ministry of Economy, Trade and Industry is promoting the development of technologies for cleaner, higher quality gasoline, diesel oil, and other motor fuels, toward further reductions in nitrogen oxides, particulates, and other automobile gas emissions.

(Coal)

Coal offers excellent supply stability comparedto petroleum and other sources. But since coal emits the highest carbon dioxide of all fossil fuels, research and development is needed to reduce its burden on the environment. For this purpose, the Ministry of Economy, Trade and Industry is promoting the development of high-efficiency power generation technologies and other clean coal technologies, such as the high-efficiency power generation technologies by the Integrated coal Gasification Combined Cycle (IGCC) and the Integrated coal Gasification Fuel cell Combined Cycle (IGFC).

(Natural Gas, etc.)

Because natural gas has lower carbon dioxide emission than other fossil fuels, the promotion of research and development into its utilization is therefore of importance in order to reduce the environmental burden. Consequently, the Ministry of Economy, Trade and Industry is promoting research into technologies for the manufacture and utilization of liquid fuels (GTL, or Gas-to-Liquid) and dimethyl ethyl (DME), obtained by converting natural gas into liquid fuel, which should lead to the expansion of natural gas use. The ministry is also promoting the research and development of new exploitation technologies for the utilization of methane hydrates, believed to be available as an energy source in relatively large quantities from the seas around Japan.

(4) Energy Conservation and Energy Efficiency R&D

From the viewpoint of preventing global warming and effectively utilizing limited energy resources, it is important to carry out research and development not only to improve efficiency in specific individual devices, but also to improve the energy supply and utilization efficiency of all energy systems in society, for example by the introduction and use of distributed systems, and the utilization of unused energy. It is also necessary to promote research and development from a point of view of reducing all energy (life cycle energy) that is directly or indirectly consumed in the process of the production, use, re-use, and disposal of products.

To this end, the Ministry of Economy, Trade and Industry is strategically promoting research and development of the hydrate slurry air conditioning system[15] to overcome problems on the demand side in the process from the identification of seed technologies to the practical application thereof with the aim of increasing the effectiveness of development of energy-saving technologies.

In addition, the Ministry of Education, Culture, Sports, Science and Technology is promoting research and development into ultra-heat resistant materials for more efficient gas turbines, etc.

Table 3-2-7 shows a summary of the major research topics in the energy sector (excluding nuclear power) implemented during FY2004.

15 Hydrate slurry air conditioning system: A system in which a multiphase media of hydrate and water solution is used as a heat carrier to conduct cold latent heat carrying in high density thereby reducing the carrying power required.

Table 3-2-7 Major research subjects in the non-nuclear energy sector (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	· Consideration of necessary safety measures for installing an outlet within a gas station that supplies fuel cell vehicles with hydrogen
Ministry of Education, Cuture, Sports, Science and Technology	National universities and other institutions	· New energy and energy efficiency R&D · The Project to Design a Sustainable Management and Recycling System for Biomass and General and Industrial Wastes · Next-generation fuel cell project
	National Institute for Materials Science	· New century heat-resistant materials project · Research into the development of highly efficient advanced structural materials with superior processability
Ministry of Agriculture, Forestry and Fisheries	National Institute for Agro-Environmental Sciences, etc.	· Assessment and mitigation techniques of global warming effects on the agriculture, forestry and fisheries sector · Development of new technology for the treatment and recycling of biomass
Ministry of Economy, Trade and Industry		· Photovoltaic power generating technology · Development of technologies for the stabilization of wind power generating systems · Biomass energy technologies · Hydrogen energy technologies · Fuel cell technologies · GTL and DME-related technologies · Development of methane hydrate technologies · Research and development into clean coal technologies · Development of entrained bed coal gasification power plants · Development of energy conservation technologies - SiC and other power electronics - Technologies for the analysis of the optimum utilization of energy between multiple industrial users (pinch technology) - Development of high-efficiency white light-emitting diodes (LEDs) - Research and development into high-efficiency organic EL technology
	National Institute of Advanced Industrial Science and Technology	· Development of technology for distributed energy network systems · Development of technology for performing the comprehensive evaluation of energy systems
Ministry of Land, Infrastructure and Transport		· Promotion of technology development for the introduction of fuel cells and other new energy sources into residences
	Hokkaido Bureau	· Survey for supporting utilization of unused wood biomass energy and other energy sources
Ministry of the Environment	National Institute for Environmental Studies	· Development of technologies for the manufacture of hydrogen from bioresources and biowastes, etc. · Development of technologies for the manufacture of hydrogen using offshore wind power generation
	Global Environment Research Fund	· Total adaptation of advanced energy saving technologies to a CCRH research institute building

3.2.2.6 Manufacturing Technology

Manufacturing technology is the source of Japan's economic power and can even be called its lifeline, standing at the highest levels in the world. These technologies will continuously need to be advanced further, and the development of innovative technologies will be important. Based on this recognition, the Science and Technology Basic Plan positioned manufacturing technology as one of the eight areas meriting special priority.

To actively promote the fundamental technologies for manufacturing that support the growth of the manufacturing industry, the Manufacturing Fundamental Technology Promotion Basic Plan was adopted in September 2000, based on the Basic Law to Promote Fundamental Technologies for Manufacturing (1999 Law No.2), and comprehendsive and planned implementation of measures for promoting such technologies is now in progress (see Section 3.3.6.6).

The Ministry of Education, Culture, Sports, Science and Technology is engaged in the development of next-generation fundamental technologies, such as, for example, the Japan Science and Technology Agency's R&D for an "evaluation system for ultra-precise semiconductors," which is aiming for the establishment of fundamental technologies for next-generation semiconductor manufacturing processes.

In addition, RIKEN is promoting the development of an "Integrated Volume-CAD System Using Advanced IT," based on technologies for utilizing the new concept of "volume data,[16]" for the purpose of integrating geometric modeling, simulation, testing, manufacturing and other kinds of information technologies in production engineering, and is also engaged in the development of an advanced measurement technology that utilizes a multidimensional quantum detector, toward the goal of establishing a cutting-edge measurement technology based on new detection technologies.

The Ministry of Economy, Trade and Industry is promoting various projects, including the "MEMS Project," which aims to strengthen international competitiveness in key devices in the information and communications sector and other sectors by establishing manufacturing technology for MEMS (Micro Electro Mechanical System), the "Project for a Computer Aided Engineering System for MEMS," the "Digital Meister Project," which uses information technology to convert manufacturing workplace skills and know-how into software and databases, the "IMS International Joint Research Project," in which new production systems are developed through international joint research, the "Project for the Practical Application of Next-Generation Robots" to develop technologies for putting robots with high-level safety and flexible motion, which move near specific people, into practical application and to conduct demonstration tests thereof, the "Development of a Software Infrastructure for Robot Systems" for the purpose of promoting development of next-generation robots, the "Digital archive of human body properties," which promotes the development and designing of products through accumulation of data concerning the measure and shape of the human body and development of an automatic measuring system, and the "Knowledge support system for field operators at oil refinery," in which support system using ergonomic techniques is developed to conduct the maintenance and checkup of oil refineries during operation efficiently and with high reliability.

The Ministry of Agriculture, Forestry and Fisheries is engaged in the development of production technologies of new functional constituents, based on fermentation methods, and of technologies for improving the quality and capacity for production of fermented foods, to meet consumer demands for high-quality foods. The ministry is also engaged in the development of technologies that help to promote the utilization of Japan's own domestic agricultural produce, such as technologies for the improvement of processing rationality, as well as the development of new isolation and extraction technologies that can form the foundation for sustainable growth in the food industry.

16 Volume data : digital data describing a material body which maintains geometry, internal structure and distributed physical properties, all in a unifiedform

3.2.2.7 Infrastructure

Infrastructure is a basic sector that supports people's lives. In order to achieve a prosperous, secure, safe, and comfortable society, research and development is promoted to reduce the risks inherent in society, and to improve the people's conveniences so they can achieve a quality life.

(1) Science and Technology for Disaster Prevention

Japan has experienced many natural disasters in its history, and has adopted many disaster prevention measures in response. In order to protect human life and property, and to mitigate the damage from natural disasters, it is important to make full utilization of scientific and technological knowledge in the course of preventing disasters before they happen, for limiting the spread of damage when disasters occur, and for recovery from disasters. The major scientific and technological research issues on disaster prevention at each ministry and agency are shown in Table 3-2-8. The contents of the research are wide-ranging. In particular, earthquake disaster prevention research includes the "Special Project for Earthquake Disaster Mitigation In Urban Areas," with participants including disaster prevention research institutions from industry, academia, and government, and the development of a three-dimensional full-scale earthquake testing facility (called "E-Defense") by the National Research Institute for Earth Science and Disaster Prevention. In addition, the Earthquake Research Institute at the University of Tokyo, the Disaster Prevention Research Institute at Kyoto University, other university institutes throughout Japan, the National Institute for Land and Infrastructure Management, the National Institute for Rural Engineering, and others are engaged in research into the prevention or mitigation of damage from various types of natural disasters.

Table 3-2-8 Major research subjects in (natural) disaster prevention science and technology (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and	National Research Institute for Fire and Disaster	· Survey on the methods of predicting the risk of a second failure at the site of a slope failure
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	· Development of a real-size, three-dimensional vibration destruction test simulation system
	National universities	· Basic research on natural disasters · Basic research into sand barriers, coastal disasters, and disaster prevention materials, and research into forecasting the advent of snow/ice-related disasters
	National Research Institute for Earth Science and Disaster Prevention	· Development of a real-size, three-dimensional vibration destruction test simulation system
Ministry of Land, Infrastructure and Transport	Engineering Affairs Division, Minister's Secretariat	· Development of technologies for prompt disaster prevention and alleviation measures utilizing disaster information and consideration of promotion policy
	Policy Bureau	· Development of an Emergency Transportation System in a Disaster Situation
	National Institute for Land and Infrastructure Management	· Research into managed-waste protective levee performance designs that take major earthquake movements into account · Study for mitigation of disaster caused by large-scale earthquakes and tsunamis · Study on earthquake disaster prevention measures utilizing seismic risk assessment technology
	Public Works Research Institute	· Research on economical seismic retrofit technologies for civil infrastructures · Research on enhancing techniques for mitigating damage caused by slope collapse and fluidization
	Building Research Institute	· Development of seismic safety design policies for RC buildings with soft-first stories · Development of firefighting performance evaluation methods in built-up areas
	Japan Meteorological Agency Meteorological Research Institute	· Study on an evaluation methods for volcanic activity · Development of nonhydrostatic model (NHM) and improvement of assimilation techniques · Research into technologies for diagnosing the risk of severe
	Geographical Survey Institute	· Study and development of a monitoring system for volcanic deformation detection · Study to improve the monitoring methods of the crustal deformation in the Tokai region · Study on the characteristics of crustal deformation around the Tonankai and Nankai Regions · Study for optimizing numerical crustal deformation models relating to seismic and volcanic activities
	Port and Airport Research Institute	· Research into the mechanism for the generation of long-cycle waves, and into countermeasures for long-cycle waves in ports and along coastlines · Research into the prevention of high tide and tsunami disasters related to global warming

In the area of international cooperation, Japan is taking part in bilateral research on science and technology for disaster prevention within the framework of science and technology cooperation agreements with the United States, Russia, Italy, and others, and the "U.S.-Japan Cooperative Program in Natural Resources" (UJNR). In addition, in the Hyogo Framework for Action 2005-2015 formulated at the U.N. World Conference on Disaster Reduction held in January 2004, Japan is required to provide support for the improvement of science and technology as well as capacity for risk assessment, monitoring and early warning.

(2) Earthquake Surveys and Research

In light of the Great Hanshin-Awaji Earthquake Disaster that occurred in 1995, the Special Measure Law on Earthquake Disaster Prevention was passed for the purpose of promoting comprehensive earthquake prevention measures all across Japan. The law stipulates the system of responsibility for earthquake surveys and research that impinge directly on administrative policies, and the Headquarters for Earthquake Research Promotion (Chairman: Minister of Education, Culture, Sports, Science and Technology) was established based on that law to facilitate these activities, a Policy Committee and an Earthquake Research Committee was also established under the Headquarters for Earthquake Research Promotion based on it. Based on "The Promotion of Earthquake Research – a basic comprehensive policy for the promotion of earthquake observation, measurement, surveys and research," adopted in April 1999, the Headquarters for Earthquake Research Promotion serves as the point of contact and cooperation between relevant ministries and agencies for the promotion of earthquake surveys and research (Figure 3-2-9).

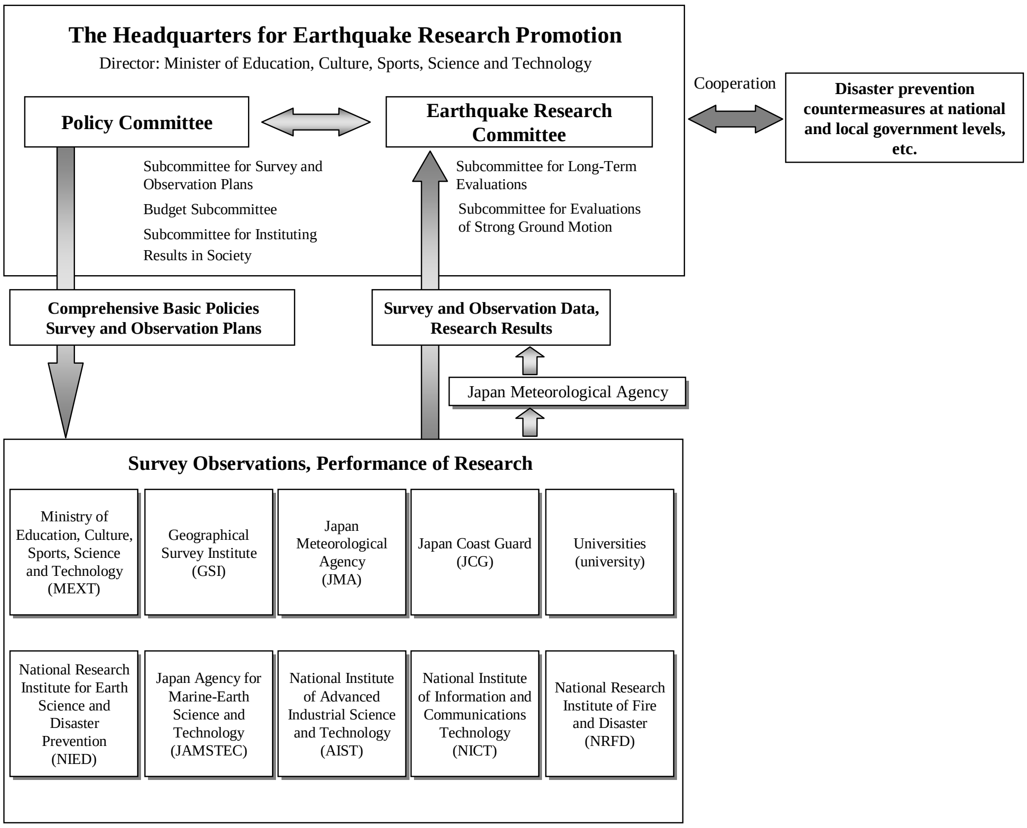

Figure 3-2-9 The structure of the headquarters for earthquake research promotion

The Policy Committee intended to perform administrative adjustments of budgets related to earthquake surveys and research in the relevant ministries and agencies. In August 2004, the Headquarters adopted the “Estimate of Budget Requests Related to Earthquake Surveys and Research for FY2005,” and called upon the Prime Minister and other relevant ministers to respect its content when drawing up the government budget.

The Earthquake Research Committee holds regular meetings on a monthly basis, and at other times when an earthquake does particular damage. At these meetings, the committee makes comprehensive evaluations of earthquake activities in Japan by collecting information and results of analysis related to them and publishes them immediately to ensure their utility in disaster prevention activities. In addition, extra meetings were held to evaluate the occurrences of the earthquakes at off-shore of the Kii Peninsula on September 5, 2004, the Niigata Chuetsu Earthquake on October 23, the earthquake off-shore of Kushiro on November 29 and the earthquake off-shore west of Fukuoka Prefecture on March 20, 2005, to prepare evaluations.

On the other hand, the Earthquake Research Committee performs a series of long-term evaluations of the probabilities of future earthquake occurrence, and published the results for 98 major active fault zones (including 10 provisional evaluations) throughout the country and subducion-zone earthquakes at 7 sea areas around Japan. In addition for the purpose of enhancing the strong ground motion estimation method, the committee selected some fault zones and ocean trench earthquakes subject to long-term evaluations as model cases and predicted strong ground motions gave by these earthquakes by use of this method, and also published these evaluation results. At the end of FY 2004, the committee published the “General Seismic Hazard Maps” based on these results (Figure 3-2-10).

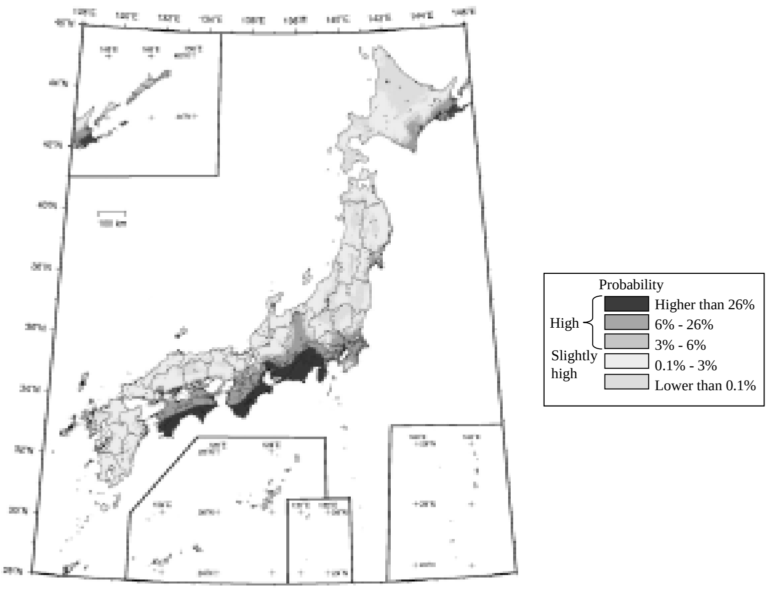

Figure 3-2-10 Probability Seismic Hazard Map (Distribution map of probabilities of having an intensity of 6 Lower or greater* quakes in the next 30 years)

Note: 1. Regarding figures for the classifications of the “high” possibility having an intensity 6 Lower or greater quake in the next 30 years,
it is shown that 26% will experience an earthquake about each 100 years on average, 6% about each 500 years, and 3% about each1,000 years, respectively.
2. Base date: January 1, 2005
* 6 Lower or greater: Japanese standard quake scale

The major measures related to earthquake research and surveys of related ministries and agencies are as shown in Table 3-2-11.

Based on the policies laid down by the Headquarters for Earthquake Research Promotion, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) promotes research and surveys of active fault zones, and is also performing much more detail research and surveys at some regions where the probability of earthquake occurrence is high. In addition, as a part of the "Special Project for Earthquake Disaster Mitigation in Urban Areas", it also promotes the research and survey into the crustal structure in major metropolitan areas, as well as research into the improvement of prediction accuracy for the Tonankai and Nankai earthquake zones and ocean trench earthquakes around the Japan Trench and Chishima Trench. On the other hand, the national universities are also promoting fundamental study for earthquake prediction. The National Research Institute for Earth Science and Disaster Prevention (NIED), acting in accordance with the "Fundamental Seismic Survey and Observation Plan," is promoting the development of high sensitivity seismic observation stations and of wide-area earthquake observation facilities, and is also engaged in collecting data from earthquake observation networks now under development that will eventually cover the entire nation, and in processing and disseminating that data. The institute is also engaged in research into methods for the preparation of general seismic hazard maps. In addition, the Japan Agency for Marine-Earth Science and Technology is promoting the development of a comprehensive real time deep sea-floor observation network system. The Geographical Survey Institute operates 1,229 (as of March,2005) continuous GPS stations throughout the nation as well as Very Long Baseline Interferometry (VLBI) and other advanced survey technologies, to make observations and analysis of crustal deformation and plate motion, and hence promotes earthquake research. The Japan Meteorological Agency (JMA) analyzes seismic wave data including that of other relevant institutes, and promotes the development of observation facilities and research for earthquake prediction. Furthermore, JMA plans to disseminate Earthquake Early Warning, which provides information including the hypocenter and magnitude of an earthquake before the principal motion to mitigate the earthquake's damage, and is engaged in research for upgrading this information in cooperation with the National Research Institute for Earth Science and Disaster Prevention.The Japan Coast Guard promotes marine research on earthquakes such as seafloor geodetic observation, surveys of seafloor topography and active faults.

The national research for earthquake and volcanic eruption prediction is comprehensively promoted according to the plan based on "The Second New Program of Research and Observation for Earthquake Prediction" adopted in July 2003 by the Council for Science and Technology as a five-year promotion plan (2004-2008) and "the Seventh Program for Prediction of Volcanic Eruptions," with universities, the National Research Institute for Earth Science and Disaster Prevention, the Japan Meteorological Agency, and other institutions proceeding in the spirit of cooperation while utilizing their particular functions and capabilities.

Incidentally, related ministries and agencies, research institutes, universities, etc. cooperatively conducted studies and research on the Niigata Earthquake in October 2004 and the Sumatra Earthquake and tsunami in Indonesia in December 2004, as an emergency research funded by the Special Coordination Funds for Promoting Science and Technology.

Table 3-2-11 Measures for earthquake surveys and research (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and	National Research Institute of Fire and Disaster	· Research into the creation and systematization of disaster prevention information at the time of an earthquake
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	· Basic earthquake-related survey grants · Promotion of prioritized surveys and observation · Regional characterization of the crust in metropolitan areas under the Special Project for Earthquake Disaster Mitigation in Urban Areas · Surveys and research into Tonankai and Nankai earthquakes · Project for the realization of an advanced instantaneous quake information transmission network
	National universities	· Promotion of research and observation of the processes in the earth's crust leading to earthquakes · Operation of geophysical observation stations
	National Research Institute for Earth Science and Disaster Prevention	· Development of basic survey and monitoring facilities for earthquakes · Research into methods for the preparation of general seismic hazard
	Japan Agency for Marine-Earth Science and Technology	· Development and preparation of a comprehensive sea bottom network monitoring system
Ministry of Economy, Trade and Industry	National Institute of Advanced Industrial Science and Technology	· Research into the use of active faults and old earthquakes for quake occurrence forecasting
Ministry of Land, Infrastructure, and Transport	Japan Coast Guard	· Observations for the elucidation of activities in the Earth's crust leading up to an earthquake · Observations for precise monitoring activities in the Earth's crust · Promotion of marine geodetic sites
	National Institute for Land and Infrastructure Management	· Study for mitigation of disaster caused by large-scale earthquakes and tsunamis
	Japan Meteorological Agency	· Earthquake monitoring networks, and earthquake and tsunami monitoring systems
	Meteorological Research Institute	· Improvement of the accuracy of prediction of the Tokai Earthquake and research on preparatory process of the Tonankai and Nankai Earthquakes · Research into advanced use of seismic and crustal movement observation
	Geographical Survey Institute	· Japanese archipelago precise geodetic network survey · Strengthening of crustal movement observation · VLBI(Very Long Baseline Interferometry)survey · Gravity survey and geomagnetic survey

(3) Aviation Science and Technology

R&D in aviation science and technology is knowledge-intensive and makes use of advanced technologies. As a result, it not only brings about the development of air transport, but also spills over into many other sectors.

In Japan, technology has accumulated through the independent development of the YS-11 commercial transport aircraft and other projects, international joint development of the Boeing 777 and other aircraft, and international joint development of the V2500 jet engine for commercial aircraft. The nation's technology is steadily increasing its role in the world's aviation industry. In particular, Japan's application of composite materials and other advanced materials in its structural design and manufacturing technologies is recognized as top-class around the world.

To actively promote the development of aircraft and their engines, it is necessary to even further improve the technological levels. In the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology decided the "Promotion Policy for Research and Development into Aerospace Science and Technology" in FY2003, thereby indicating desirable ways of research and development. In addition, in the Ministry of Economy, Trade and Industry, Aircraft and Space Industry Committee's Aircraft Subcommittee under the Industrial Structure Council is holding discu-ssions on the possibility of joint international deve-lopment of civil aviation aircraft and engines, and on other directions in aircraft industry policy.

In response to the above-mentioned promotion policy, the Ministry of Education, Culture, Sports, Science and Technology will intensively promote R&D that can contribute to the development of a domestic aircraft and domestic jet engine, and R&D into transportation safety and environmental prote-ction under the leadership of the Japan Aerospace Exploration Agency. Elsewhere, the agency is pro-moting research into numerical simulations and basic technologies for assessment of advanced com-posite materials. The agency also develops wind tu-nnels, engine testing facilities, and other large-scale testing and research facilities, encouraging their joint use by other institutions, to play a leading role in improving the level of aviation science and tech-nology in Japan.

The Ministry of Economy, Trade and Industry is promoting research and development for low-cost small aircrafts with little environmental burden and environment-adopted high-performance small aircr-aft that demonstrate the entire integration techno-logy for engines, as well as research and develop-ment of engines for environment-adopted small air-crafts. In addition, the ministry is promoting the development of technologies for manufacturing and processing of next-generation structural parts and materials, which realize a reduction in the cost of and increasing reliability of composite materials for aircrafts and magnesium alloy parts and materials, and the development of technologies related to engine structures and materials based on "MGC (Melt-Growth Composite) materials," as well as the development of next-generation technologies rela-ted to accessories, such as incorporating maneu-vering and air conditioning into electrical operation.

The Electronic Navigation Research Institute under the Ministry of Land, Infrastructure and Transport has been conducting research in the field of communications, navigation, monitoring and air traffic control to develop technologies for securing and facilitating air traffic safety. This research is expected to be important for the further advance-ment of air transportation.

(4) Development of Other Social In fra-structure

Society as a whole is becoming increasingly complex, with advancing urbanization and the general impro-vement of society through the development of tran-sport, shipping, and communications systems, etc. On the other hand, however, rural communities face problems of population outflow and aging, reduced vitality in industry and society, a decline in public transport and shipping functions, and a general multifaceted decline in such important functions as land conservation, water source cultivation, and con-servation of the natural environment. Moreover, in order to achieve a higher quality for people's lives, where leisure and prosperity can be experienced, the development of the socio-economic infrastructure has come to be demanded.

In this sector, a number of documents have estab-lished priorities for the promotion of research and development, including the "Basic Plan for the Ministry of Land, Infrastructure and Transport Tec-hnology," adopted in November 2003 by the Mini-stry of Land, Infrastructure, and Transport, the "Ba-sic Plan for Research and Development in Informa-tion and Telecommunications," adopted in February 2000 by the Ministry of Posts and Telecommuni-cations' Council for Telecommunications Technology (Ministry of Internal Affairs and Communications), and the "Items Related to Pollution Prevention that Require Experimental Research Priority," adopted in April 2003 by the Ministry of the Environment.

Specifically, the Ministry of Land, Infrastructure and Transport and other ministries and agencies are promoting comprehensive land use through the development of advanced national land use mana-gement technology, and research and development into disaster prevention evaluations and counterme-asure technologies in city renewal projects, and into other local disaster prevention activities. The mini-stry is also promoting research and development into technologies for a superconducting magne-tically levitated train, and of other advanced transp-ort and shipping systems.

The Ministry of Internal Affairs and Communi-cations and other ministries and agencies are prom-oting research and development into ultra-high speed network technologies, advanced information resource transmission and accumulation technologies, and other advanced information and communication systems, as well as research and development for fire fighting and disaster prevention, including research on technologies for alleviating damage by disaster and disaster response technologies.

In addition, the Ministry of Agriculture, Forestry and Fisheries is engaged in the development of technologies for the restoration and improvement of agriculture, forestry, and fisheries ecologies, and of methods for managing drainage basin environments.

The Ministry of Economy, Trade and Industry promotes research and development of "human lifestyle engineering for quality life" for the development of universal design products and systems.

The Ministry of Land, Infrastructure and Transport offers subsidies and other support for the Railway Technical Research Institute to promote research and development toward the practical realizetion of a superconducting magnetically levitated train, for the objective of high-speed transport in the future. In addition, publication of the "Development Vision for Technologies Related to Deep Underground Use" has served to promote the development of technologies with broad general applications for projects that require traversal of the deep underground. Furthermore, guidelines for ensuring safety in public use of the deep underground, and guidelines for protection of the environment, were issued in February 2004, and technology research and development is now being promoted for utilization of the deep underground that takes safety and environment into consideration.

The major research topics in FY2004 for socioeconomic infrastructure, safety assurance, etc., are as shown in Tables 3-2-12 and 3-2-13.

Table 3-2-12 Major research subjects in the improvement of the socioeconomic foundation area (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and	National Institute of Information and Communications Technology	· Research into basic information and communication technologies
Ministry of Education, Culture, Sports, Science and	Japan Aerospace Exploration Agency	· Technologies for higher performance domestic passenger aircraft · Research into aviation safety and environment protection technologies
Ministry of Agriculture, Forestry	National Institute for Rural Engineering	· Development of eco-friendly management technology for water and agro-forested-aqua-ecosystems in watershed and estuary areas
Ministry of Economy, Trade and Industry		· Supersonic transport propulsion system · Behavior-based human environment creation technology
Ministry of Land, Infrastructure, and Transport	Engineering Affairs Division, Minister's Secretariat	· Development of housing and urban infrastructure management technology for sustainable society and safe environment
	Subsidy for the development of railway technologies	· Development of a superconducting magnetically levitated train
	Grants-in-aid for advanced research on ship technology	· Research and development of environmentally-friendly ocean vessels (green ships)
	National Institute for Land and Infrastructure Management	· Research for the International Harmonization of Building Codes and Standards · Research into airport pavement design and repair to accommodate ultra-large air-craft loads that take life-cycle costs into account · Research on desirable environment in urban area for urbanized · Development of effective evaluation and management methods for cost reduction of public works
	Geographical Survey Institute	· Development of the technology to use precise three-dimensional spatial data for the regeneration of cities
	Public Works Research Institute	· Research on improving the durability of structures and evaluating their performance · Research on evaluating the soundness of infrastructure stock and its remedial techniques · Research on the efficient construction and redevelopment of dams considering the surrounding environment · Research on reducing the construction costs of super-long highway structures
	National Maritime Research	· Research into more advanced distribution simulations
Ministry of the Environment	Research Funding to the National Research Institute engaged in Environmental Pollution Research	· Comprehensive research on waste disposal and the recycling of wastes · Comprehensive research on advanced treatments for effluents

Table 3-2-13 Major research subjects in the safety area (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	· Survey and research on the desirable ways of comprehensive fire control safety measures for various subjects of fire control · Survey and research on the desirable ways of fire control safety measures that correspond to the practical application of fuel cells
	National Research Institute of Fire and Disaster	· Advancement of firefighting, emergency services and rescue techniques · Safety measures for those who need help during disasters, such as elderly people · Safety evaluation for hazardous materials and facilities handling hazardous materials
Ministry of Health, Labour and Welfare	National Institute of Industrial Safety	· Research on prevention of human errors as causes of industrial accidents in the construction sector · Research on basic safety technology for work systems based on human-machine collaboration · Research on the prevention of explosions and fire disaster in the process of industrial recycling · Development of a method of assessing the wind resistance of temporary structures
Ministry of Agriculture, Forestry and Fisheries	Fisheries Research Agency	· Development of a method of assessing the safety of fishing vessel structures in consideration of human influence
Ministry of Economy, Trade and Industry		· Development of technologies for the safe management of liquefied petroleum gas supplies
Ministry of Land, Infrastructure and Transport	National Maritime Research Institute	· Research on FSA method to formulate safety standards –Development of a method of assessing the fire risk of passenger ships
	National Institute For Sea Training	· Research on human errors in accidents at sea
	Marine Technical College	· Basic research on the cutting of mooring ropes at the fair leader · Detection of leakage and abnormality in machines, equipment and plants

3.2.2.8 Frontier Science

(1) Space Development and Utilization

Space development and utilization not only brings about “accumulation of intellectual properties common to all humankind” through acquisition of commonly applicable knowledge regarding the origin of the universe and various phenomena occurring on earth, but also maintains critical national technologies, which serve as a basis of sustainnable development of the country, through developpment of technologies necessary for space developpment and utilization, thereby contributing to national security in a broad sense. It is extremely important because the expanded use of space contributes to the “expansion of the socioeconomic infrastructure” through communications and broadcasting, weather forecasting, and global environment and disaster monitoring, and to “pioneering advanced technologies” that might result in the creation of new technologies in various fields and of new industries with high added value.

Since the successful launch of Japan’s first “Ohsumi” satellite in 1970, Japan has launched 105 satellites as of the end of March 2005. Table 3-2-14 shows the major satellites planned for future launch by Japan and their objectives.

The Council for Science and Technology Policy decided in September 2004 the “Basic Strategies for Space Development and Utilization in Japan”, which indicates action plans of Japan’s space development and utilization.

The Ministry of Education, Culture, Sports, Science and Technology is promoting research and development in a strategic and concentrated way at the Japan Aerospace Exploration Agency (JAXA), in accordance with the Long-Term Program of Space Activities determined by the resolution of the Space Activities Commission in September 2003. In response to such accidents as the failure of the

H-IIA launch vehicle No. 6, JAXA conducted a complete inspection of all satellites and rockets to promote efforts to increase reliability of space technology in terms of both technology and the system. As a consequence, JAXA succeeded in launching H-IIA launch vehicle No. 7 mounting Multifunctional Transport Satellite No. 1 (Himawari No. 6) in February 2005.

The Space Activities Commission conducted an investigation into the causes of failure of H-IIA launch vehicle NO. 6, Midori-II, Nozomi, etc., from technological aspects, conducted a survey and deliberation on future methods, a survey and deliberation on the review of the manufacturing system and responsibility for rockets among JAXA and manufacturers, and a survey and deliberation on the complete inspection of all satellites and rockets.

Table 3-2-14 Satellites and payloads planned to be launched

Satellite/payload	Weight (kg)	Orbital altitude (km) / location	Launchvehicle	Launch date (fiscal year)	Major objectives
ALOS Advanced Land Observing Satellite	Approx. 4,000	Approx. 690	H-IIA	2005	· To contribute to cartography, regional monitoring, disaster situation monitoring, resource exploration, etc.
ASTRO-E II 23rd scientific satellite	Approx. 1,700	Approx. 550	M-V	2005	To observe X-rays from active galactic cores and galactic clusters, to elucidate the structure and evolution of space, etc.
ETS-VIII Engineering Test Satellite-VIII	Approx. 2,800	-	H-IIA	2006	· To develop, test, and demonstrate large satellite bus and mobile satellite communications technologies, etc.
OICETS Optical Inter-orbit Communications Engineering Test Satellite	Approx. 570	Approx. 600	Dnepr (Russia /Ukraine)	2005	· To conduct orbital tests of effective optical communications technologies in inter-satellite communications, and specifically of element technologies focusing on capture pursuit tracking
JEM Japanese Experiment Module	Approx. 26,800	Approx. 400	U.S. Space Shuttle	2007	· Expansion of Japan's space activities, promotion of leading science and technology development, and contribution to the advancement of international cooperation
WINDS Wideband InterNetworking engineering test and Demonstration Satellite	Approx. 2,700	-	H-IIA	2007	· Development, etc., of ultra-fast high-capacity satellite communications technologies and other world-leading technologies
SELENE SELenological and Engineering Explorer	Approx. 2,900	Approx. 100	H-IIA	2006	· To research the origin and evolution of the Moon, collect data for a Moon-use feasibility survey, etc.
SOLAR-B 22nd scientific satellite	Approx. 900	Approx. 600	M-V	2006	· Detailed observation of the structure and motion of micromagnetic fields on the solar surface, to elucidate the components of solar magnetism and the source of solar activity
GOSAT Greenhouse gas Observing Satellite	Approx. 1,500	Approx. 650	H-IIA	2007	· Continuous observation of physical Earth quantities, to contribute to the elucidation and forecast of global warming, climate change, changes in the ozone layer, etc.
GPM/DPR Global Precipitation Measurement/Dual-frequency Precipitation Radar	Approx. 3,000	Approx. 400	H-IIA	2009	· To develop the Dual-frequency Precipitation Radar (DPR) for monitoring precipitation, as part of international cooperation in the Global Precipitation Measurement Program (GPM)
HTV H-II Transfer Vehicle	Maximum supply weight: Approx. 7,000	Approx. 350-460	H-IIA	2008	· To use a Japanese transport system that can contribute a fair share of material supplies to the Space Station
PLANET-C 24th scientific satellite	Approx. 480	Approx. 300-79,000	M-V	2008	· To explore Venus' atmosphere, and solve riddles in the basic principles of planetary weather and the evolution of atmospheres
ASTRO-F 21st scientific satellite	Approx. 960	Approx. 750	M-V	2005	· To use infrared observations toward the elucidation of the formation and evolution of the Milky Way galaxy, stars, and planets
LUNAR-A 17th scientific satellite	Approx. 540	Approx. 200	M-V	To be determined	· Elucidation of crustal structure and thermal structure of the moon
Bepi-Colombo Mercury Exploration Project	Approx. 200 (MMO)	Approx. 400-12,000 (MMO)	Soyuz Fregat 2B	2012	· To observe the magnetic field, magnetosphere, the inside and surface of Mercury from many directions through international cooperation with the ESA (European Space Agency). Japan is in charge of the Mercury Magnetospheric Orbiter (MMO)

(Earth Observation and Earth Science)

This is described in 3.2.2.3.

(Space Science and Lunar Exploration)

JAXA plays the core role in the field of space science in Japan, launching scientific satellites with the participation of researchers from universities and colleges nationwide.

The "Hayabusa" Scientific Satellite No.20 MUSES-C was launched in May 2003 for the purpose of performing an engineering test for a later planned mission to take rock samples from the asteroid and return them toEarth. The microwave discharge ion engine mounted on "Hayabusa" marked a total operating time of 20,000 hours in December 2004, and "Hayabusa" is traveling in orbit around the sun toward arriving at the asteroid in the summer of 2005.

Launches scheduled for FY2005 include Scientific Satellite No.23 ASTRO-E II for the observation of X-rays emitted from active galactic cores and galactic clusters to investigate the structure and evolution of the universe, and Scientific Satellite No. 21 ASTRO-F for the elucidation of the process of formation and evolution of galaxies, stars and planets through infrared observation.

Other projects now in development include Scientific Satellite No.22 SOLAR-B for detailed observation with a high degree of accuracy of the structure and motion of magnetic fields on the solar surface to investigate the origins of the solar atomsphere and the causes of solar activity, and the Moon orbiter SELENE to gather data to investigate the origins and evolution of the moon and to clarify feasibility of the utilization of the moon. Incidentally, for Scientific Satellite No. 17 LUNAR-A designnated for the investigation of the lunar internal structure and thermal structure, the plan is under review through consideration of problems in the development of observational equipment to be mounted (penetrator).

(Communications, Broadcasting, and Positioning)

Utilization of satellites for communications, broadcasting, and other purposes offers a broad range of benefits in terms of wide-area use, broadcast simultaneity, durability following disasters, etc. In Japan, the private sector is already deeply involved in satellites for the communications and broadcast sector, such as for satellite broadcasting. To further promote these private-sector efforts, the government is promoting development in advanced and basic technologies where the risks are too great for the private sector, and the development of pioneering technology for the future utilization of space.

(1) Wideband InterNetworking engineering test and Demonstration Satellite (WINDS)

Development is in progress in cooperation with the Ministry of Internal Affairs and Communications on the Wideband InterNetworking engineering test and Demonstration Satellite (WINDS), toward a FY2007 launch. The objectives of this ultra-high speed Internet satellite are to establish a satellite-based communications technology that enables ultra-high speed Internet and large-volume data communications, to test ultra-high speed networking technology using satellite communications, and to implement new utilization tests through cooperation between Industry, academia, and government that will serve to stimulate new demand and to promote the IT revolution in Japan.

(2) Quasi-Zenith Satellite System

The quasi-zenith satellite system would consist of multiple satellites placed in quasi zenith orbits to ensure that more than one satellite is always visible at the zenith in the skies over Japan, to achieve virtually 100% land coverage for high-quality communications, broadcasting, and positioning services, without being affected by narrow mountain valleys or tall buildings. Research into the quasi-zenith satellite system is now being promoted between the government and the private sector toward a FY2008 launch.

(Manned Space Technology)

Japan has obtained various advanced technologies, including highly-advanced manned space technology, through participation in the International Space Station (ISS) Program, and is thereby aiming to accumulate basic technology necessary for Japan in the future. Japan is now carrying out the developpment of the Japanese Experiment Module (JEM; also known as "Kibo") and H-II Transfer Vehicle (HTV).

(1) Kibo

Japanese astronauts who engage in the assembling and operation of "Kibo" continue training in Japan and abroad. Mr. Soichi Noguchi, an astronaut who is conducting training at the National Aeronautics and Space Administration (NASA), will board the first flight after the accident of Space Shuttle Columbia.

(2) HTV

Technology for rendezvous with a manned facility (ISS) requiring high-level safety and reliability and inter-orbit transportation technology can be established through development of an unmanned transfer vehicle HTV that replenishes ISS with supplies.

(Promotion of Space Environment Utilization)

It is expected that research and development that contributes to society is pursued through the promotion of various kinds of research, experiment and observation utilizing unique conditions of the space environment, such as microgravity and a high vacuum.

The Space Activities Commission compiled a report of the Utilization Subcommittee in June 2004 and recommended the review of the utilization plan to achieve the more efficient and effective operation and utilization of "Kibo."

While advancing development of "Kibo," JAXA is publicizing ground-based research projects offering research opportunities to researchers in a broad array of fields involved in preparation for the utilization of the space environment.

Moreover, until the commencement of operation of "Kibo" in orbit, JAXA implemented space experiments at ISS using Soyuz and scientific experiments through international cooperation. JAXA is also continuously conducting "High-quality Crystalization Project on Protein Structure and Function Analyses for Practical Applications" using a Russian Service Module at ISS based on government-private sector cooperation. To ensure that this kind of research is rationally conducted without trouble, JAXA also utilizes a zero-gravity experiment facility operated by the private sector (drop tower) and zero-gravity experiment (suborbital flight) by aircraft.

Efforts to diversify utilization of "Kibo" are also in progress, to extend its use beyond scientific research to include activities in such sectors as industrial use, education, culture and arts, and the humanities. In the industrial use sector, a system to consistently deal with ground-based research, space experiment and commercialization was newly established through coordination between industry, academia and government and a research basis was established. In the education sector, activities were conducted such as the "Kibo Education Utilization Workshop," space education events involving interaction between children and the astronauts on the International Space Station, and a contest for an aircraft-based zero-gravity experiment for university students.

The Ministry of Economy, Trade and Industry (METI) developed a next-generation Unmanned Space Experiment Recovery System (USERS) to promote the utilization of the space environment. It was launched in September 2002 and the part of the space vehicle containing the results of the test experiments was successfully returned to Earth and retrieved on May 30, 2003. Analysis of the samples obtained in a large-scale superconducting materials crystallization growth test using a microgravity space environment is now in progress. In addition, to encourage the broad use of Japan's well-developed industrial technology in commercial satellite production processes, and to rationalize their design, procurement, and manufacture, etc., the Space Environment Reliability Verification Integrated System (SERVIS) satellite program was used to develop guidelines and necessary intellectual infrastructure for the transfer of industrial technologies to space-related devices and the use of databases of private-sector components for space-related devices, and the satellite was launched on October 2003. The private-sector components worked well in the tests, and various data is being obtained in accordance with the plan.

(Fundamental Satellite Technology)

JAXA and research institutes of related ministries and agencies are engaged in research, development and space demonstration of the new technologies and the fundamental technologies required for the support of space development and utilization activities, to ensure autonomy in space activities, and to contribute to technological innovations that spread beyond the space sector to other sectors.

(1) Engineering Test Satellite VIII (ETS-VIII)

JAXA, cooperating with the Ministry of Internal Affairs and communication (MIC) is developing Engineering Test Satellite Ⅷ (ETS-Ⅷ) to develop and demonstrate large-scale satellite bus technologies, large-scale deployable antenna technologies, mobile multimedia satellite broadcast system technologies, and fundamental technologies related to satellite positioning systems utilizing high-accuracy clock standards.

(Space Infrastructure)

For autonomy of national space development in the international community, it is important for Japan to acquire a capability for deploying necessary materials and equipment at specific locations in space when they are needed. For this purpose, Japan is engaged in the research and development of space transport systems. Japan is also developing an advanced inter-satellite communication technology toward the acquisition of space network operations technology. Japan is also developing an advanced inter-satellite communication technology toward the acquisition of space network operations technology.

(1) H-IIA Rockets

For the launching of large-scale satellites, etc., JAXA developed a two-stage rocket that uses liquid oxygen/liquid hydrogen-fueled engines for both the first and second stages (H-IIA) (Table 3-2-15) and uses it to launch large-scale satellites. The launch of the H-IIA launch vehicle No. 1 in August 2001 was followed by four more successful launches that marked the transition to practical operations. However, the launch of the No. 6 vehicle carrying information gathering satellites in November 2003 ended in failure because the solid rocket booster (SRB-A) failed to separate. Thereafter, an investigation into the causes of the accident was conducted and measures were taken from both technical and institutional aspects, while a review that went back to the basics of design was also conducted. Since then, Multifunctional Transport Satellite No. 1 (Himawari No. 6) of the Japan Meteorological Agency and the Ministry of Land, Infrastructure and Transport was launched by H-IIA launch vehicle No. 7 on February 26, 2005 and was successfully placed in the predetermined orbit. In September 2004, the Council for Science and Technology Policy again positioned H-IIA rocket as the Japan’s key rocket and determined to steadily advance tech nology upgrades and increase reliability. Moreover the H-IIA standard type is to be transferred to the private sector to ensure international competitiveness through the unification of manufacturing responsibility for the improvement of product quality. A basic contract for transfer was signed in February 2003 between JAXA and the private-sector entity, Mitsubishi Heavy Industries, and transfer to the private sector is steadily under way.

Table 3-2-15 Main specification of vehicles used to launch satellites

Launch vehicle type	Stages	Overall length (m)	Diameter (m)	Gross weight (tons)	Propellant
M-V	3	Approx.30	2.5	Approx. 139	Solid for all stages
H-IIA (standard)	2	Approx.53	4.0	Approx. 289	1st and 2nd stages, liquid hydrogen/oxygen; SRB-A, solid

(2) M-V Series Rockets

JAXA developed the M-V rocket, which uses solid propellant for all stages, and launches scientific satellites.

(3) GX Rocket

The GX rocket is a rocket designed to launch small and medium-size satellites, which has been developed by private initiative. Public-private sector joint research and development is now progressing toward the first launch in FY2006. JAXA will conduct a flight demonstration of the LNG-fueled natural propulsion system by using a GX rocket.

(4) Optical Inter-orbit Communications Engineering Test Satellite (OICETS)

JAXA is preparing to launch the Optical Inter-orbit Communications Engineering Test Satellite (OICETS), which is to conduct orbital experiments on the elemental technologies needed for optical communications technologies in inter-satellite communication systems, in FY 2005 by a Dnepr rocket of Russia/Ukraine.

(5) Data Relay Test Satellite (DRTS)

For the objective of performing data relay experiments using with earth observing satellites and "Kibo," for the promotion of the development of data relay functions for the Communications and Broadcasting Engineering Test Satellite (COMETS) and to accumulate experience in more advanced inter-satellite communications technology, JAXA launched the "Kodama" Data Relay Test Satellite (DRTS), and is advancing preparation for an inter-satellite communications test with the Advanced Land Observing Satellite (ALOS), which is scheduled to be launched in FY2005.

(Fundamental and Advanced Research on Satellite and Launch Vehicle Technology)

JAXA and research institutes of related ministries and agencies conduct fundamental research on launch vehicle and satellite technology. They also work in a number of advanced research areas, including for an unmanned winged reusable space vehicle and a space plane.

(Promotion of International Cooperation in Space)

With the increasing importance of observations from space by Earth observation satellites as global problems such as earth environmental problems and disasters have become more serious in recent years, and with the increasing internationalization of space activities as the society and the economy have become increasingly globalized, the need for international cooperation in space activities is now greater than ever before. In particular, Japan's contribution in the space sector, including efforts to alleviate disaster using satellites, has become further necessary in response to serious damage to the surrounding area by the Sumatra Earthquake and Indian Ocean tsunami which occurred in December 2004. In February 2005, JAXA acceded to the "International Charter on Space and Major Disasters," a framework for international cooperation aimed at contributing to the understanding of disasters and restoration following disasters, through provision of satellite data without charge at the time of large-scale disasters.

In the area of multilateral cooperation, Japan is actively engaged in the promotion of such cooperation through the activities in the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) which discusses the international order on exploration and utilization of space, and on the promotion of international cooperation, the Asia-Pacific Regional Space Agency Forum (APRSAF) hosted by Japan, a place for exchanging opinions about the international cooperation in space development in the Asia-Pacific region, and the Committee on Earth Observation Satellites (CEOS),where technical coordination and information exchange on earth observation satellite systems is undertaken.

Japan is participating in the International Space Station (ISS) program, the largest international cooperation project in space development, through the provision of "Kibo," HTV and a life science test facility (Centrifuge). This is being carried out in close cooperation with all participating nations in the construction and utilization of ISS.

In the area of bilateral cooperation, cooperative space activities between Japan and the United States are proceeding smoothly in light of the Agreement between the Government of Japan and the Government of the United States of America concerning Cross-Waiver of Liability for Cooperation in the Exploration and Use of Space for Peaceful Purposes. For cooperation with European countries, a close relationship with the European Space Agency (ESA) is maintained through annual administrative Japan-ESA meetings. Moreover, regarding cooperation with Russia, the Japan-Russia Joint Committee on Cooperation in Outer Space is held on a regular basis to promote a cooperative relationship.

(2) Ocean Development

The development and use of the ocean, which contains an abundance of resources, including biological and mineral resources, as well as vast space, is an important issue for a country as physically small and confined by the sea as Japan. Furthermore, because the ocean plays an important role in global environmental changes, and the movements of oceanic crusts are believed to be a major source of earthquakes and volcanic activity, elucidation of their mechanisms is urgent. In light of these conditions, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the Intergovernmental Oceanographic Commission (IOC) called for the implementation in the early 1990s of the Global Ocean Observing System (GOOS), which aims to build a system for the conduct of comprehensive observations and research of ocean phenomena on a worldwide scale. The GOOS project is now being promoted in co-operation with the World Meteorological Organization (WMO).

This plan was also incorporated into the Agenda 21 that was adopted by the United Nations Conference on Environment and Development (UNCED), also called the Earth Summit. Based on these international efforts, it is crucial for Japan to promote ocean research related to global environmental issues, and to promote other research and development into ocean sciences and technologies.

Furthermore, in order to shed some light on ocean phenolmena occurring on a global scale, the relevant ministries and agencies have joined with universities, etc., to actively participate in international ocean research programs such as GOOS. Also, Japan has taken a leading role in cooperation with China, South Korea, and Russia to promote the North East Asian Regional-Global Ocean Observing System (NEAR-GOOS) as a regional pilot project for GOOS.

Japan's ocean development adheres closely to the report of the Council for Science and Technology Subdivision on Ocean Development, and research and development is being promoted with the co-operation of relevant ministries and agencies according to their various situations. In "Basic Concepts and Promotion Measures for Ocean Development from the Long-Term Viewpoint (report)," subdivision responded in August 2002 to an inquiry by the Minister of Education, Culture, Sports, Science and Technology, by noting that "it is important to carefully balance knowing, protecting, and using the ocean for the policies for future ocean developpment when presenting strategic policies and promotion policies toward realization of sustainable utilizetion."

Moreover, the Inter-Ministerial Liaison Committee (this committee was reorganized and expanded into the "Inter-Ministerial Liaison Committee for Survey of the Continental Shelf and Marine Resources" in August 2004) was established to promote surveys for the establishment of the outer limits of the Japanese continental shelf. The liaison committee recognizes the importance to the government as a whole of firmly implementing these surveys, and that maximizing the use of scientific knowledge is important for the performance of appropriate surveys and analyses.

At the Ministry of Internal Affairs and Communication, the National Institute of Information and Communications Technology conducts research into high-resolution three-dimensional microwave radar and shortwave ocean radar to facilitate the establishment of methods for the measurement of marine oil pollution, currents, and waves, etc., and the prediction of changes in the global environment, and implements joint observation in cooperation with universities and other research institutes.

At the Ministry of Education, Culture, Sports, Science, and Technology, research Institutions including the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) are promoting advanced and basic research and development into ocean sciences and technologies. These institutions cooperate with related ministries and agencies, universities, etc., to promote comprehensive projects.

Among these projects, the Japan Agency for Marine-Earth Science and Technology conducted marine observation using Triton buoys and an oceanographic research vessel "MIRAI" with the aim of investigating the interactions between the atomsphere and the ocean, such as El-Nino events, as well as the effects they have on global climate change. In addition, the deep sea research vessel "KAIREI" was used for ocean surveys for research into the dynamics of ocean plates. In addition, the agency conducted geological, biological, and geo- chemical studies during a five-month research voyage "NIRAI-KANAI," primarily extended aro-und the southern-hemisphere Pacific Ocean on bo-ard "YOKOSUKA," the support mother vessel for a manned research submersible "SHINKAI 6500." For the deep-sea Earth drilling project, construction of the "CHIKYU" deep sea drilling vessel continues to progress since its commencement in FY1999.

Furthermore, the Project for Research on Marine and Extremobiosphere Biology promoted research for the elucidation of the physiological adaptivity of deep-sea organisms existing in extreme environm-ents.In addition, Ocean Research Institute, Univer-sity of Tokyo, is at the center of continuing oce-an-related scientific research, including basic rese-arch related to GOOS for the purpose of building a comprehensive observation system for the elucid-ation and forecast of changes in the ocean enviro-nment, and for its preservation, participation in joint surveys of the Western Pacific region, and research into ocean flux, which can contribute to the elucidation of physical cycles in the ocean. In addition, national universities are engaged in research into marine biosystems and conducting observations of changes in the atmosphere and oceans.

The Ministry of Agriculture, Forestry and Fis-heries elucidated ocean surface layer ecologies to facilitate the rational utilization and management of organic marine resources, and also elucidated the structure of deep sea ecologies and the relationship between mechanisms of change, and changes in su-rface layer ecologies.

The Ministry of Economy, Trade and Industry continues to implement surveys for reserves of oil and other resources, prediction of effects on the marine environment and surveys of the ocean bottom in cooperation with Japan Oil, Gas and Me-tals National Corporation, the National Institute of Advanced Industrial Science and Technology and other organizations.

The Ministry of Land, Infrastructure and Transp-ort promoted research and development into next-g eneration coasting vessels (the Super Eco-Ship), and expanded the Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS) in cooperation with the Port and Airport Research Institute. The Japan Coast Guard is engaged in research into upgrading water channel measurement and marine condition monitoring technologies, and into the development of seabed monitoring technologies and upgrading of the accuracy of current flow forecasting. The Japan Meteorological Agency continues to conduct inve-stigation and research on the ocean, such as the oceanographic and marine meteorological obser-vations and elucidation of El Nino phenomena, in order to improve the information about monitoring and forecasting of marine phenomena and climate change. Moreover, the National Maritime Research Institute is carrying out research into safety and environmental protection in the field of marine technology. In relation to the NEAR-GOOS pro-ject, the Japan Meteorological Agency and the Japan Coast Guard operate a system for promoting the exchange of oceanic data for sea regions bordering on Japan, in order to better promote oceanographic research. In addition, the Geogr-aphical Survey Institute conducts basic research of coastal sea areas for the purpose of providing the basic information needed for the formulation of comprehensive development, utilization,and prote-ction plans for coastal sea areas.

At the Ministry of the Environment, the Global Environment Research Fund is being used to cond-uct research into the elucidation of the effects of pollution from the Changjiang River on marine ecosystem in the East China Sea, and on global-sc-ale ocean pollution due to toxic substances.

Table 3-2-16 summarizes the main research subjects undertaken in the ocean sciences and technology sector by various ministries and agencies in FY2004.

Table 3-2-16 Major research subjects in marine science and technology (FY2004)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	· Research into global environment measurement and forecasting technology, using 3-D high-resolution imaging radar · Research and development of ocean radar
Ministry of Education, Culture, Sports, Science and Technology	Japan Agency for Marine-Earth Science and Technology	· Development of marine research technology · Research and development of deep-sea research · Promotion of ocean drilling in the 21st Century · Frontier research · Research and development of ocean utilization and marine ecosystems · Research and development of ocean observation
	National universities and other institutions	· Integrated Ocean Drilling Program (IODP) · Cooperative study of the Western Pacific (WESTPAC) · Global Ocean Observing System (GOOS)
Ministry of Agriculture, Forestry and Fisheries	Fisheries Research Agency	· R&D into fisheries resources · Development of techniques for stock enhancement · Development of techniques for advanced use of fishing grounds · Research into the improvement and development of fishing grounds · Observations of oceanographic environments related to fisheries · Technological development of fishing gear and methods · Measures for marine environmental conservation · Research of marine space use · Technological development of marine resources use
	Marino Forum 21	· Development of artificial fishing ground technology, using deep ocean water · Development and practical application of new technologies for protecting against red tide
Ministry of Economy, Trade and Industry	Japan Oil, Gas and Metals National Corporation	· Research and development of deep-sea mineral resources
	National Institute of Advanced Industrial Science and Technology	· Prediction of Earth and ocean environments based on geochemical and palaeontological research of modern and past environments
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	· IOC Sub-Commission for the Western Pacific Region (WESTPAC)
	Japan Meteorological Agency, Meteorological Research Institute	· Observational research on variability of carbon cycle in the ocean
	Geographical Survey Institute	· Basic research of coastal sea areas
	National Maritime Research Institute	· Research into technology for upgrading megafloats, and international standardization · Research and development into next-generation domestic route shipping (Super Ecoship)
	Private Sector	· R&D into very large floating structures
	Port and Airport Research Institute	· Research into the physical environment of sand beaches · Elucidation of the mechanisms for wave liquefaction and deformation of the ground, and research into countermeasure and utilization technologies · Research into coastal seawater flows, and seabed environments
Ministry of the Environment	Research Funding to the National Research Institute engaged in Environmental Pollution Research	· Research into application of mitigation technologies to the Seto Inland Sea for creating an appropriate environment
	Water Environment Department	· Research into red tide
	National Institute for Environment Studies	· Research into coastal environment management · Research into a mechanism of maintaining high-level nutrient salt concentration in the Ariake Sea: For appropriate shallow water management
	Global Environment Research Fund	· Research into the elucidation of the ocean's absorption of carbon dioxide from human sources in the Pacific region · Iron fertilization feasibility as an option for CO2 mitigation, and its effects on marine ecosystems · Research on the biogeochemical cycle in the East China Sea responding to the change in the environmental loading from land · Study on the marine environmental deterioration due to N and P loadings, and silica deficiency in the global aquatic system
	Global Environment Research Coodination System	· Research into material databases related to carbon dioxide in the ocean, for the elucidation of oceanic carbon dioxide absorption volumes · Study on the increase of sea-surface temperature in Asian monsoon regions based on coral skeletal climatology · Evaluation of the effects of the oceanic segregation of carbon dioxide on the oceanic material cycling process

3.2.2.9 Promotion of Science and Technology for Safety, Security, and Spiritual Enrichment

Toward realization of the goal of "a nation securing safety and quality of life," offered in the Basic Plan as a stance that Japan should be aiming for, the Ministry of Education, Culture, Sports, Science and Technology in April 2003 established the "Study Group on Science and Technology Policy for Building a Safe and Secure Society," consisting of representatives from industry, academia, and government, to conduct studies into scientific and technological policies toward the realization of a society that can ensure safety and security. The study group compiled the final report in April 2004. In addition, the "2nd Japan-U.S. Workshop on Science and Technology for a Secure and Safe Society" was convened in March 2005 to discuss how Japan and the United States can cooperate in the fields of science and technology in response to the various risks and threats that confront society, and is continuing a wide range of studies toward building a safe and secure society.

In addition, research and development utilizing competitive funding, such as the Special Coordination Funds for Promoting Science and Technology, the Project for Promotion of Strategic Creative Research (Japan Science and Technology Agency) and the Research Program on Development of Innovative Technology (Japan Science and Technology Agency), is conducted in order to promote scientific and technological activities that contribute to the creation of new culture.

3.3 Reform of Japan's Science and Technology System

3.3.1 Reform of Japan's Research and Development System

3.3.1.1 Construction of Research and Development Systems for Producing Outstanding Results

(1) Maintenance of a Competitive Research and Development Environment

In terms of competitive funding to form a competitive research and development environment, the system reform to maximize its effectiveness was promoted, while the funding was expanded based on the goals set in the Basic Plan.

The competitive funding for each ministry is shown in Table 3-3-1.

Table 3-3-1 Comprehensive table of competitive funding

Name of ministry/agency	Sponsoring institution	Name of program	FY2003		FY2004	
			Budget (million yen)	Indirect expenses introduced (million yen)	Budget (million yen)	Indirect expenses introduced (million yen)
Ministry of Internal Affairs and Communications	Ministry	Promotion Programme Strategic Information and Communications R&D	2,250	479	3,033	687
	Institute of Information and Communications Technology	Program for Promotion of Basic Research in the Information and Communications Sectors	630	91	304	34
	Institute of Information and Communications Technology	R&D Program for Utilization of Gigabit Network	112	11	–	–
	Institute of Information and Communications Technology	Advanced technology development for pioneering new communications and broadcasting areas (Telecom incubation)	475	0	748	0
	Institute of Information and Communications Technology	Program for Promotion of Private-Sector Basic Technology Research	10,500	2,245	10,400	2,400
	Fire and Diaster Management Agency	Program for Promotion of Science and Technology Research for Fire Safety and Disaster Prevention	199	28	300	68
Subtotal			14,166	2,855	14,785	3,189 (Upper limit)
Ministry of Education, Culture, Sports, Science, and Technology	Japan Society for the Promotion of Science	Grants-in-Aid for Academic Research	176,500	12,531	183,000	13,553
	Japan Science and Technology Agency	Basic Research Programs	44,689	2,848	46,329	2,958
	Ministry	Special Coordination Funds for Promoting Science and Technology (Chosei-hi)	37,700	3,254	38,600	3,623
	Japan Science and Technology Agency	Development of Systems and Technology for Advanced Measurement and Analysis	–	–	3,300	690
	Ministry	Public Proposal System for Ingenious Technology Development Research	3,562	248	2,366	0
	Japan Science and Technology Agency	Research Program on Development of Innovative Technology	–	–	950	170
	Ministry	Support System for Creation of University-Derived Venture Companies	1,786	369	1,634	337
	Japan Science and Technology Agency	Support System for Creation of University-Derived Venture Companies (In FY2003: Project to Create University-based Start-ups)	502	104	2,697	177
	Ministry	Grants for future pioneering science research	6,646	0	3,576	0
Subtotal			271,386	19,354	282,453	21,508
Ministry of Health, Labour, and Welfare	Ministry	Health and Labour Sciences Research Grants	38,011	1,561	37,930	1,324
	Pharmaceuticals and Medical Devices Agency	Program for Promotion of Basic Research in the Health Care Sector	6,562	255	2,224	444 (Upper limit)
Subtotal			44,573	1,816	40,154	1,768 (Upper limit)

Name of ministry/agency	Sponsoring institution	Name of program	FY2003		FY2004	
			Budget (million yen)	Indirect expenses introduced (million yen)	Budget (million yen)	Indirect expenses introduced (million yen)
Ministry of Agriculture, Forestry, and Fisheries	Bio-oriented Technology Research Advancement Institution	Program for promotion of basic research for creation of new technologies and new sectors	3,983	401	4,030	614
		R&D program for creation of new enterprises	1,213	0	735	0
	Bio-oriented Technology Research Advancement Institution	Program for the Promotion of Research on the Integration of Different Fields for the Creation of Bio-oriented Industries	339	3	1,760	329
	Ministry	Technology Development Project for the Creation of Collective Private Agribusiness	560	0	560	0
	Ministry	Research project for utilizing advanced technologies in agriculture, forestry and fisheries	1,973	441	3,000	675
Subtotal			8,067	845	10,084	1,618
Ministry of Economy, Trade, and Industry	New Energy and Industrial Technology Development Organization	New Energy and Industrial Technology Development Organization	5,280	1,062	5,821	1,274 (Upper limit)
Subtotal			5,280	1,062	5,821	1,274 (Upper limit)
Ministry of Land, Infrastructure, and Transport	Japan Railway Construction, Transport and Technology Agency	Program for Promoting Fundamental Transport Technology Research	389	47	445	35
	Ministry	R&D fund support program for the development of construction technology	250	53	250	53
Subtotal			639	100	695	88
Ministry of the Environment	Ministry	Global Environmental Research Fund	2,965	249	3,015	266
	Ministry	Environmental Research and Technology Development Fund	765	117	815	143
	Ministry	Ministry of the Environment Waste Management Research Grants	1,150	54	1,150	138
	Ministry	Project for Development of Technology for Global Warming Countermeasures	—	—	1,634	377 (Upper limit)
Subtotal			4,880	420	6,614	924 (Upper limit)
Total			348,991	26,452	360,606	30,370

Notes: 1. The initial budget amount, which served as the basis for doubling competitive funding during the period of the Second Science and Technology Basic Plan.
2. Figures in each column and in the totals columns are rounded up to the nearest whole number, and may not add up.
3. The "indirect expenses introduced" figures are estimated as of FY2001.

Based on the "Reform of the Competitive Funding System (opinion)" prepared by the Council for Science and Technology Policy on April 21, 2003, progress was made on the following reforms during FY2004: further expansion of indirect expenses; posting of program officers with research backgrounds to each funding agency to improve the implementation structure for managing the array of businesses of the competitive funding system consistently, etc.

(Competitive Funding of Each Ministry)

(1) Ministry of Internal Affairs and Communications

The Ministry of Internal Affairs and Communications is implementing the "Strategic Information and Communications R&D Promotion Programme." This project aims to actively promote unique and innovative research and development that is in keeping with priority strategic targets in order to create world-leading intellectual assets, increase the level of researchers by creating competitive research environments, and improve research and development capabilities in information and communications technologies.