NATIONAL SCIENCE FOUNDATION
Directorate for Social, Behavioral, and Economic Sciences

INTERNATIONAL PATENTING TRENDS IN BIOTECHNOLOGY: GENETIC ENGINEERING

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Division of Science Resources Studies

ISSUE BRIEF

June 18, 1999

The United States is widely considered the global leader in the biotechnology field and an examination of U.S. patenting in genetic engineering technologies during 1990-94 supports that perception.

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NSF 99-351

This report is the second in a three-part series that examines America's technological position vis-à-vis that of five other countries—Japan, Germany, France, the United Kingdom, and South Korea—in high-tech areas likely to be important to future economic competitiveness. The areas examined are advanced manufacturing, biotechnology, and advanced materials. The indicator used to determine a country's relative strength and interest in these areas is international patent activity. To facilitate patent search and analysis, the three broad areas are each represented by a narrower subfield. This report examines genetic engineering technologies as a proxy for biotechnology.[1]

International Patenting Activity

Tabulated by priority year, this indicator provides a first measure of the extent and growth of each nation's inventive activity. These patent family counts represent inventions important enough to be patented outside of the country of origin. During the first half of the 1990s, 3,411 international patent families were formed in genetic engineering with priority applications in the six countries examined; the largest increase in number of families was recorded in 1993 (figure 1). Patenting activity in this six-country group accounts for over 85 percent of all families in this technology area.

The United States is widely considered the global leader in the biotechnology field, and these data support that perception. The United States is the priority country (that is, the location of first application) for 63 percent of the international patent families examined here; Japan follows with 13 percent, the United Kingdom with 10 percent, and Germany with 7 percent.

*As used here, **genetic engineering** is defined as recombinant DNA (rDNA) technology. It includes processes for isolation, preparation, or purification of DNA or RNA; DNA or RNA fragments and modified forms thereof; the introduction of foreign genetic material using vectors; vectors; use of hosts; and expression. It excludes monoclonal antibody technology.*

*The analysis is built around the concept of a **patent family,** which consists of all the patent documents published in different countries associated with a single invention. The first application filed anywhere in the world is the **priority application**: it is assumed that the country in which the priority application was filed is the country in which the invention was developed. Similarly, the **priority year** is the year the priority application was filed. The **basic patent** is the first patent or patent application published in any of the roughly 40 countries covered in the database used (the Derwent World Patents Index Database).*

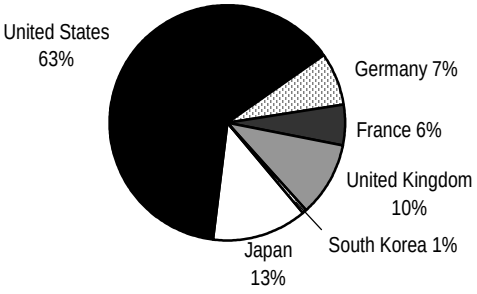
***International patent families** are used to mitigate bias introduced by national systems, such as Japan's, that encourage large numbers of domestic patent applications. An international patent family is created when patent protection is sought in at least one other country besides that in which the earliest priority application was filed.*

*The **three indicators** used in this assessment are overall trends in international inventive activity, highly cited inventions, and the size of international patent families.*

[1]These data were developed under contract for the National Science Foundation by Mogee Research & Analysis Associates and cover the period 1990-94; they were extracted from the Derwent World Patents Index Database published by Derwent Publications, Ltd. The technology areas selected for this study met several criteria:

- Each technology appeared on the lists of "critical" technologies deemed important to future U.S. economic competitiveness or national security (see Mogee 1991; OSTP 1995; and Popper, Wagner, and Larson 1998).
- Each technology could be characterized by the output of patentable products or processes.
- Each technology could be defined sufficiently to permit construction of accurate patent search strategies.
- Each technology yielded a sufficient population for statistical analysis.

Figure 1. Genetic engineering technology: number of international patent families by priority year and country, 1990-94



Priority country	1990	1991	1992	1993	1994	Total
Japan	100	67	94	89	91	441
United States	385	363	409	499	509	2,165
Germany	48	41	35	45	75	244
France	22	36	32	52	54	196
United Kingdom	46	50	58	85	105	344
South Korea	2	4	3	8	4	21
Total	603	561	631	778	838	3,411

SOURCE: Derwent World Patents Index Database (London, Derwent Publications, Ltd.), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

The United States produced 63 percent of the internationally patented genetic engineering families formed during the period examined—nearly five times that produced by Japan and six times that produced by the United Kingdom.

Highly Cited Genetic Engineering Inventions

Interpatent citations are an accepted method of gauging the technological value or significance of different patents. These citations, provided by the patent examiner, indicate the "prior art"—the technology in related fields of invention taken into account in judging the novelty of the present invention. The number of citations a patent receives from later patents can serve as an indicator of its technical importance or value. In fact, Carpenter, Narin, and Woolf (1981) have shown that, on average, technologically important U.S. patents receive twice as many examiner citations as does the average U.S. patent, reinforcing the validity of interpatent citation as an indicator of patent quality.

Of the 3,411 international patent families in genetic engineering formed by the six countries during the 1990-94 period, 39 were considered highly cited inventions.[2] The United States, which, as noted above, had the majority of the total international patent families recorded during the period, also had the largest proportion of those that were highly cited —59 percent (table 1). Japan had 10 percent of the highly cited international patent families.

Only France exceeded a proportionate share on this indicator. With far fewer patent families overall than the other countries examined, France produced more than three times the number of important, that is highly cited, patents as expected based on its level of activity. The United States, Japan, and Germany produced fewer highly cited patents than might be expected based on their shares of patent families associated with this technology, although the United States and Japan came close. South Korea did not produce any highly cited international patents. The United Kingdom's share of highly cited patents matched its share of total genetic engineering inventions patented internationally (that is, its citation ratio equals 1.0).

Based on this indicator, the United States leads the other countries in terms of the volume of important (highly cited) genetic engineering inventions it produced during the period examined. While it fell slightly short (citation ratio of 0.9) of what might be expected given its share of overall patenting in this technology, the total number of highly cited patents produced by the United States in this important technology area is nonetheless noteworthy.

Average International Patent Family Size

Given the significant costs associated with obtaining patent protection in multiple countries, this indicator attempts to measure the perceived economic potential of an invention by calculating the number of countries in which patent protection is being sought, adjusted for market size.[3]

Based on this measure, patented genetic engineering inventions developed in Japan and Ger-

[2]The data used here include all international patent families with priority application dates from 1990-94 with four or more citations. The citation counts are those placed on European Patent Office (EPO) patents by EPO examiners, as the EPO citations are believed to be a less biased and broader source of citation than those of the U.S. Patent and Trademark Office. See Claus and Higham (1982). To adjust for the advantage countries with large numbers of international families would have on this indicator, a country's share of highly cited patents is divided by its share of total international patent families.

[3]Operationally, this means counting the number of countries in a family in which a patent publication (a published patent application or an issued patent) exists. Patents in each family are weighted by an index based on the gross domestic product (GDP) in purchasing power parities at current U.S. dollars of the patent country. The index runs from 0 to 1.00 and U.S. GDP is set at 1.00.

Table 1. Genetic engineering: International patent families, highly cited patent families, and citation ratios, by selected priority country, 1990-94

Priority country	Number of international families	Number of highly cited international families[1]	Country share of total (Percent)	Country share of highly cited (Percent)	Citation ratio[2]
Total	**3,411**	**39**	**100.0**	**100.0**	**1.0**
United States	2,165	23	63.5	59.0	0.9
France	196	7	5.7	17.9	3.1
United Kingdom	344	4	10.1	10.3	1.0
Japan	441	4	12.9	10.3	0.8
Germany	244	1	7.2	2.6	0.4
South Korea	21	0	0.6	0.0	0.0

[1]An international patent family was considered highly cited if the number of citations it received ranked it within the top 1 percent compared with all other genetic engineering technology patent families. The top 1 percent threshold was used so that those counted as highly cited would certainly represent important inventions. For this technology area, the top 1 percent received four or more citations.

[2]A citation ratio of greater than 1.0 indicates that a country has a higher share of highly cited international patent families than might be expected based on its share of total international families.

SOURCE: Derwent World Patents Index Database (London: Derwent Publications, Ltd.), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

many appear to be the most commercially valuable on average, although the scores for each country are very similar (table 2). On average, Japan has sought patent protection in 11 countries whose combined economies are equivalent to 1.6 times that of the United States (as based on GDP); German-origin inventions average 14.7 countries with a combined GDP equal to 1.5 times that of the United States. Patented genetic engineering inventions originating in the United States rank third in perceived commercial exploitation potential. Inventions originating in France, South Korea, and the United Kingdom all trailed the three leaders based on this measure.

Summary of U.S. Position

Based on this examination of international patenting in genetic engineering technologies during 1990-94, the U.S. science and technology enterprise emerges as the leading producer of inventions in this key technology area. The United States produced 63 percent of the internationally patented genetic engineering inventions created during the period examined—nearly five times that produced by Japan and six times that produced by the United Kingdom. The United States also produced the largest number of highly cited genetic engineering inventions, although it fell slightly short of what might be expected given its share of overall patenting in this technology. Of the six countries studied, however, only France exceeded expectations on this measure. Interestingly, the "indexed" economic value of U.S. genetic engineering inventions trailed those of Japan and Germany, although scores on this indicator were generally close.

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Table 2. Genetic engineering technology: number of international patent families and average international family size, 1990-94

Priority country	Number of international families	Average international family size	Adjusted average international family size[1]
Japan	441	11.3	1.6
Germany	244	14.7	1.5
United States	2,165	12.8	1.4
France	196	14.9	1.3
South Korea	21	10.0	1.3
United Kingdom	344	12.4	1.0

[1]Patent family data are weighted by an index based on gross domestic product measured in purchasing power parities at current U.S. dollars of the patent country. This weighting adjusts family size for the size of the national markets in which protection is being sought in an effort to better reflect the commercial potential of the invention.

NOTE: Patent family size is determined by the number of countries for which patent protection is sought for a single invention.

SOURCE: Derwent World Patents Index Database (London: Derwent Publications, Ltd.), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

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