

# **OECD Biotechnology Statistics 2009**

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## FOREWORD

The *OECD Biotechnology Statistics – 2009* edition brings together the latest available economic and activity data on biotechnology and innovation, collected by OECD member and non-member countries. The report builds on the extensive work of the OECD and national experts to improve the comparability of biotechnology statistics. The results should provide a valuable source of information on biotechnology for policy makers, academics and business managers.

The 2009 edition contains government survey data for 22 OECD countries and additional data for four non-member countries. The survey data provide results on the number of biotechnology firms, business expenditures on R&D, biotechnology employment, and sales of biotechnology goods and services. Unfortunately, very few or no survey results are available in this edition for four OECD countries that are leaders in biotechnology: Denmark, Japan, the Netherlands, and the United Kingdom. However, some data are available for these countries from non-survey data sources for biotechnology patents, venture capital, alliances, GM crops, biofuels, and biopharmaceuticals. Results for biofuels and biopharmaceuticals are provided for the first time in this edition.<sup>1</sup>

This is the fourth collection of OECD biotechnology indicators. The previous version, published in 2006,<sup>2</sup> provided data for 23 OECD and 3 non-member countries. The results for OECD member states were obtained from government survey data for 16 OECD countries and from a private consulting firm for six OECD countries.

Developing internationally comparable biotechnology statistics has been a challenge for many years, largely due to different survey definitions of biotechnology and of a biotechnology firm. Unlike ICT or other technologies, there is no single biotechnology 'sector' that can be quickly identified and surveyed. The 2009 edition of OECD biotechnology indicators has benefited from the on-going efforts of the OECD and of national experts to develop and use a harmonized definition of biotechnology and guidelines for the collection of biotechnology statistics.<sup>3</sup> However, a few countries continue to use slightly different definitions of biotechnology.

For 2009, comparability in the definition of a biotechnology firm and classification boundaries for firm size and biotechnology applications have also improved. However, there are still a few challenges for developing full comparability. The main issue is national differences in the method of surveying biotechnology firms. Fourteen countries collected data on biotechnology firms through an official R&D survey, while 12 countries used a dedicated survey of firms that are known to be active in biotechnology. The results are not fully comparable because an R&D survey will not capture firms that are active in biotechnology but do not perform R&D, while dedicated surveys could miss the biotechnology R&D of large diversified firms where biotechnology is only a small part of their business. Ideally, countries would use both survey methods.

### Acknowledgements

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**Disclaimer:** While the authors have made every effort to ensure the accuracy and completeness of the information in this report, mistakes may occur. If there has been an error or omission, we will make every effort to correct it.

<sup>1</sup> Separate data for Denmark, the Netherlands and the United Kingdom are not provided for GM field trials and for biotechnology alliances due to small numbers. Instead, data for these three countries are combined with the results for all other European countries.

<sup>2</sup> van Beuzekom, B. and Arundel, A. (2006), *OECD Biotechnology Statistics 2006*, OECD, Paris.

<sup>3</sup> OECD (2005), *A Framework for Biotechnology Statistics*, <http://www.oecd.org/dataoecd/5/48/34935605.pdf>, OECD, Paris.

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## 1. Methodology

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This report provides statistics on biotechnology activities for 22 OECD countries and four non-member countries. The main methodological challenges concern the production of comparable statistics across countries that have used different survey designs. Table 1.1. summarises the main methodological characteristics of the studies of biotechnology in each country.

This methodological section applies to the data presented in Chapters two through six. The indicators and analyses presented in these Chapters are based on biotechnology data collected by the OECD from national representatives. The chapter on biotechnology patents is based on OECD patent data. The other data presented in the report, including biotechnology in agriculture, biotechnology in health, biotechnology alliances and biotechnology venture capital, are based on external data sources.

In an effort to harmonise data collection and improve international comparability, the OECD developed a data collection questionnaire in 2008 that each national producer of biotechnology statistics could complete and return to the OECD.<sup>4</sup> The data compiled through the OECD biotechnology questionnaire was used in this report. The use of this questionnaire helped to obtain consistent results, providing a major improvement over the data collection for the 2006 edition of *OECD Biotechnology Statistics*, which relied on national reports.

Twenty-one OECD countries and two non-member countries returned the completed questionnaire. Most of these countries provided data for the latest available year; however, 11 countries provided data covering several years. Only Japan, Brazil and South Africa were not able to complete the OECD biotechnology questionnaire. Data for these countries was extracted from national reports.<sup>5</sup>

The OECD biotechnology questionnaire focused on biotechnology activities in the business enterprise sector (firms). This reflects the focus of the OECD *Framework for Biotechnology Statistics*, published in 2005, which proposes definitions, standards and a conceptual framework for collecting internationally comparable data on biotechnology. However, the questionnaire also included one question on biotechnology R&D by sector of performance, in order to capture the public sector. This is part of the OECD's ongoing effort to establish guidelines for the collection of public sector data.

Most of the data presented in this report are for firms active in biotechnology. Data availability depends on how each country collects biotechnology statistics. Biotechnology activities can be measured in three ways:

- *Dedicated surveys* of firms active in biotechnology;
- Adding questions on biotechnology to the national *R&D survey* of firms;
- Constructing *databases* with information on biotechnology firms from diverse secondary sources, and/or data linking exercises.

Several countries conduct more than one collection exercise.

Fourteen countries collect data on biotechnology firm activity via their R&D firm surveys. As a result, these data may underestimate the number of biotechnology firms, as firms that use biotechnology but do not perform biotechnology R&D are excluded. Twelve countries run dedicated biotechnology surveys. Four countries constructed databases: Austria, Belgium, the Netherlands and Sweden. Austria and Belgium obtained information on the biotechnology activities of firms by linking data from secondary sources with the results of existing surveys.

The diverse types of biotechnologies and the range of possible applications create two main challenges for developing comparable biotechnology statistics: how to define biotechnology and how to define a biotechnology firm.

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<sup>4</sup> Not all countries collect biotechnology data on a regular basis, therefore 2004 was established as the data cut-off point for this report. For data before 2004, see *OECD Biotechnology Statistics 2006*.

<sup>5</sup> In some cases, the data in this report may not be comparable with the data presented in the *OECD Biotechnology Statistics 2006* report. In Germany, for example, the survey is now conducted by BIOCOM on behalf of the German government. Previously the survey was conducted by the German Federal Statistical office.



### Definition of biotechnology

In 2002, the OECD developed both a single definition of biotechnology and a list-based definition (see Box below) of different types of biotechnology techniques. The list-based definition of biotechnology was revised in 2005. The OECD recommends that statistical agencies provide both of these definitions to survey respondents when collecting data on biotechnology activities.

The single definition defines biotechnology as:

*“the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services.”*

The single definition covers all modern biotechnology but also many traditional or borderline activities. For this reason, the OECD recommends that the single definition always be accompanied by the list-based definition, which operationalises the definition for measurement purposes.

The list of biotechnology techniques functions as an interpretative guideline to the single definition. The list is indicative rather than exhaustive and is expected to change over time as data collection and biotechnology activities evolve. In 2008, OECD member countries decided to begin work on revising and updating the list-based definition.

#### OECD list-based definition of biotechnology techniques

**DNA/RNA:** Genomics, pharmacogenomics, gene probes, genetic engineering, DNA/RNA sequencing/synthesis/amplification, gene expression profiling, and use of antisense technology.

**Proteins and other molecules:** Sequencing/synthesis/engineering of proteins and peptides (including large molecule hormones); improved delivery methods for large molecule drugs; proteomics, protein isolation and purification, signaling, identification of cell receptors.

**Cell and tissue culture and engineering:** Cell/tissue culture, tissue engineering (including tissue scaffolds and biomedical engineering), cellular fusion, vaccine/immune stimulants, embryo manipulation.

**Process biotechnology techniques:** Fermentation using bioreactors, bioprocessing, bioleaching, biopulping, biobleaching, biodesulphurisation, bioremediation, biofiltration and phytoremediation.

**Gene and RNA vectors:** Gene therapy, viral vectors.

**Bioinformatics:** Construction of databases on genomes, protein sequences; modelling complex biological processes, including systems biology.

**Nanobiotechnology:** Applies the tools and processes of nano/microfabrication to build devices for studying biosystems and applications in drug delivery, diagnostics etc.

Source: OECD (2005), *A Framework for Biotechnology Statistics*, OECD, Paris.

Eighteen OECD countries and two non-member countries used the OECD definitions in their surveys. Korea limits biotechnology to ‘modern’ or third-generation biotechnologies that are similar to the OECD list-based definition. Austria is a particular case, in that the biotechnology data were not directly collected by means of a survey but rather by data linking. Japan and Brazil used biotechnology definitions that include traditional biotechnologies. Portugal and Slovenia did not include a definition of biotechnology in their surveys (see Table 1.1).

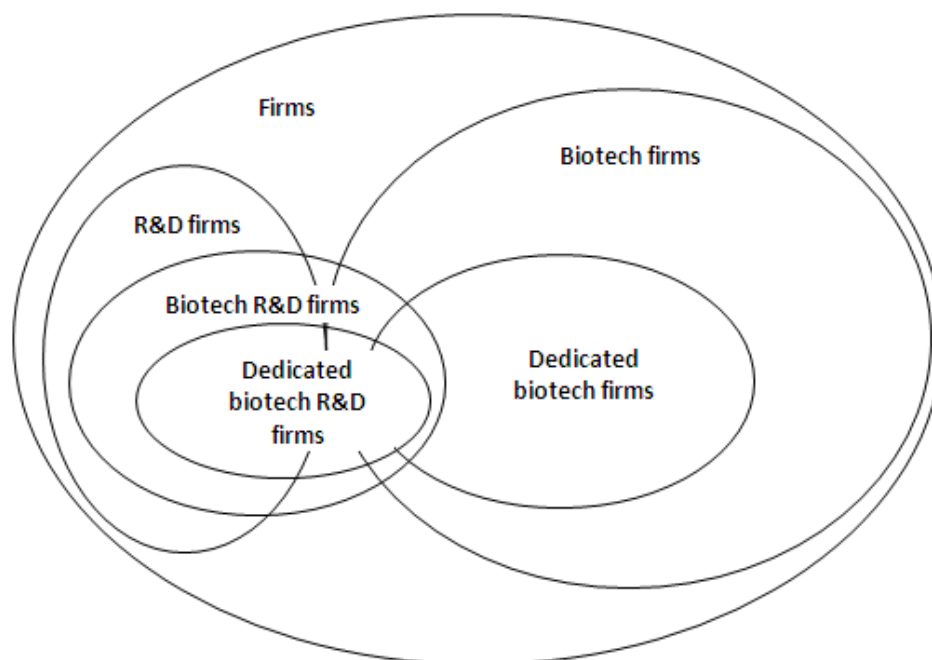
### Definition of a biotechnology firm

A biotechnology firm can be defined as a firm that is engaged in biotechnology by using at least one biotechnology technique (as defined in the OECD list-based definition of biotechnology techniques) to produce goods or services and/or to perform biotechnology R&D. Some of these firms may be large, with only a small share of total economic activity attributable to biotechnology.<sup>6</sup>

There are two subgroups of biotechnology firms.

1. Dedicated biotechnology firm: defined as a biotechnology firm whose predominant activity involves the application of biotechnology techniques to produce goods or services and/or to perform biotechnology R&D.
2. Biotechnology R&D firm: defined as a firm that performs biotechnology R&D. Dedicated biotechnology R&D firms, a subset of this group, are defined as firms that devote 75% or more of their total R&D to biotechnology R&D. All of these firms are captured by R&D surveys.

The data available on firm type depends on how each country collects biotechnology data. Not all countries will have data for all types of biotechnology firms.



### Sampling frame

Two main methods are used for identifying biotechnology firms. Fifteen surveys use the national R&D sampling frame. Fourteen surveys use secondary sources to identify biotechnology firms. These include industry association membership lists, participants in government programmes to support biotechnology, stock market listings, patent records, information provided by venture capital firms, and any other relevant source. Some countries used several sampling frames as they conducted several surveys (see Table 1.1).

<sup>6</sup> Biotechnology firms in this report are equivalent to the group of 'biotechnology active firms' in the 2006 *OECD Biotechnology Statistics*.

### ***Accuracy of the results***

All data, with the exception of data for Brazil and the Philippines, are from official government sources. Twenty-nine of the 31 surveys were conducted by government agencies or by organisations acting at the request of a government agency. The principal advantage of government surveys is that information on the survey methodology is available. The Brazilian survey was undertaken by Biominas, a private foundation. The Philippines survey was undertaken by the Biotechnology Coalition of the Philippines, a non-profit organisation. Note, the Philippines survey methodology was based on the recommendations put forth in the OECD *Framework for Biotechnology Statistics*.

There are three other characteristics that can influence the accuracy of biotechnology statistics: the response rate (RR); whether or not results were imputed to account for non-respondents or extrapolated to the total population (Extrapolation); and whether or not the survey was mandatory (see Table 1.1).

Data accuracy is strongly dependent on a high response rate, which will reduce possible biases due to differences in the types of biotechnology firms that choose or do not choose to respond to a survey. Low response rates could result in underestimates of the number of biotechnology firms or biotechnology activities such as R&D.

The average response rate for the 21 surveys carried out by OECD countries is 76%. Thirteen surveys had above average response rates, of which 12 countries had response rates above 80%. Only three countries had response rates below 50%.

For non-member countries, the average response rate is 63%. This lower figure is due to the response rate for the Philippines (33%) – a first-time survey – and a lack of information for Brazil. The response rate was 75% for Slovenia and 81% for South Africa.

The combination of response rates and no extrapolation may have led three countries to underestimate biotechnology activity by firms: Italy, Poland and the Philippines. Data for Australia may also have been underestimated.

Countries that collect biotechnology statistics through their R&D surveys may also underestimate biotechnology activity by firms, as firms that use biotechnology but do not perform biotechnology R&D are excluded.

### ***Measuring public biotechnology R&D***

The OECD biotechnology questionnaire also included one question on biotechnology R&D by sector of performance, in order to capture the public sector. This is part of the OECD's ongoing effort to establish guidelines for the collection of public sector data.

Six OECD countries and one non-member country collected data on public biotechnology R&D expenditure. Table 1.2. summarises the main methodological characteristics of these surveys.

### ***Conclusions***

Although every effort has been made to maximise comparability across countries, caution must be used in comparing biotechnology activities among countries when the data are obtained from studies with very different methodologies. Factors, such as differences in the definition of biotechnology, whether or not all firms innovate, low response rates, whether or not results were imputed to account for non-respondents or extrapolated to the total population, will also reduce comparability.

In general, the results in this report for the number of biotechnology firms, employment, R&D and sales are more likely to underestimate the true values than to overestimate them. This is primarily caused by the reliance in several countries on studies limited to dedicated biotechnology firms and below average response rates in several studies.

Table 1.1. Characteristics of biotechnology data sources

	Year	Biotech definition	Biotech firms	Only Innovative firms	Sample frame used	Mandatory	Conducted survey	RR	Extra-polation	Type of survey
Australia	2006	OECD	All	Yes	Secondary	No	GOV	27%	Yes	Dedicated
Austria (1)	2006	NR	All	No	Secondary	NR	GOV	NR	No	Database
	2006	NR	NR	Yes	R&D	Yes	GOV	97%	No	R&D survey
Belgium (1)	2006	OECD	All	NR	NR	NR	Federal govt., Regions & Communities	44%	Partial	R&D survey
	2006	OECD	All	No	Secondary	No	GOV	54%	Yes	Database
	2006	OECD	All	No	Secondary	No	GOV	16%	Yes	Dedicated
	March 2008 version	OECD	All	NR	Census	NR	BvDEP: BEL-FIRST database	NR	Partial	NR
Belgium (Flanders)	2007	OECD	All	No	Secondary	Yes	Technopolis-GOV	80%	No	Dedicated
Canada	1999	OECD	R&D	Yes	Secondary	Yes	GOV	80%	Yes	Dedicated
	2001	OECD	R&D	Yes	Secondary	Yes	GOV	84%	Yes	
	2003	OECD	R&D	Yes	Secondary	Yes	GOV	80%	Yes	
	2005	OECD	R&D	Yes	Secondary	Yes	GOV	70%	Yes	
Czech Republic	2007	OECD	R&D	Yes	R&D	Yes	GOV	87%	Partial	R&D survey
Finland	2007	OECD	R&D	Yes	R&D	Yes	GOV	81%	Yes	R&D survey
France	2003	OECD	R&D	Yes	R&D	Yes	GOV	72%	Yes	R&D survey
	2004	OECD	R&D	Yes	R&D	Yes	GOV	75%	Yes	R&D survey
	2005	OECD	R&D	Yes	R&D	Yes	GOV	73%	Yes	R&D survey
	2006	OECD	R&D	Yes	R&D	Yes	GOV	73%	Yes	R&D survey
Germany	2005	OECD	Dedicated	Yes	Secondary	No	BIOCOM-GOV	91%	Partial	Dedicated
	2006	OECD	Dedicated	Yes	Secondary	No	BIOCOM-GOV	89%	Partial	
	2007	OECD	Dedicated	Yes	Secondary	No	BIOCOM-GOV	88%	Partial	
Ireland	2005	OECD	R&D	Yes	R&D	No	GOV	56%	Yes	R&D survey
Italy	2002	OECD	R&D	Yes	R&D	Yes	GOV	58%	No	R&D survey
	2003	OECD	R&D	Yes	R&D	Yes	GOV	50%	No	
	2004	OECD	R&D	Yes	R&D	Yes	GOV	43%	No	
	2005	OECD	R&D	Yes	R&D	Yes	GOV	36%	No	
	2006	OECD	R&D	Yes	R&D	Yes	GOV	42%	No	
Japan	2005	All	All	No	Secondary	No	GOV	55%	No	Dedicated
Korea	2002-2006	Modern	All	Yes	Secondary	No	GOV	100%	No	Dedicated
	2006	All	Yes	Yes	R&D	No	GOV	85%	No	R&D survey
Netherlands	2005	OECD	R&D	Yes	Secondary	No	GOV	NR	Partial	Database
New Zealand	2005	OECD	All	No	Secondary	Yes	GOV	93%	No	Dedicated
	2007	OECD	All	No	Secondary	Yes	GOV	96%	No	
Norway	2005	OECD	R&D	Yes	R&D	Yes	GOV	95%	Yes	R&D survey
Poland	2005-2007	OECD	All	Yes	Secondary	Yes	GOV	62%	No	Dedicated
Portugal	2005	None	R&D	Yes	R&D	Yes	GOV	74%	No	R&D survey
Slovak Republic	2005	OECD	R&D	Yes	R&D	Yes	GOV	87%	No	R&D survey
	2006	OECD	R&D	Yes	R&D	Yes	GOV	88%	No	
Spain	2004	OECD	R&D	Yes	R&D	Yes	GOV	80%	Yes	Dedicated (with Innovation survey)
	2005	OECD	R&D	Yes	R&D	Yes	GOV	86%	Yes	
	2006	OECD	R&D	Yes	R&D	Yes	GOV	86%	Yes	
Sweden	1997-2006	Modern	Dedicated	Yes	Secondary	NR	VINNOVA-GOV	NR	NR	Database
	2007	OECD	R&D	Yes	R&D	Yes	GOV	92%	Yes	R&D survey
Switzerland	2004	OECD	R&D	Yes	R&D	No	GOV	81%	Yes	R&D survey
	2004	OECD	R&D	Yes	R&D	No	GOV	81%	No	
United States	2005	OECD	R&D	Yes	R&D	No	GOV	79%	No	R&D survey
	2006	OECD	R&D	Yes	R&D	No	GOV	77%	No	
Brazil (2)	2007	All	Dedicated	..	Secondary	..	BIOMINAS	..	..	Dedicated
Philippines	2006-2007	OECD	All	Yes	Secondary	No	BPC	33%	No	Dedicated
Slovenia	2006	None	R&D	Yes	R&D	No	GOV	75%	No	R&D survey
South Africa	2006	OECD	All	Yes	Secondary	No	GOV	81%	No	Dedicated

➔ RR = Response rate; NR = Not Relevant; .. = Information not available.

1. Biotechnology data were obtained by matching a database of biotechnology firms / dedicated biotechnology firms with results of existing surveys or databases.
2. The biotechnology definition includes firms that 'commercialise' products or services. Excluded are multinationals that only have a local sales office. Also included are techniques that are not modern biotechnology (e.g. embryo transfer). As a result biotechnology activities may be overestimated.

**Table 1.2. Characteristics of biotechnology data sources for public biotechnology R&D**

	Year	Biotech definition	Sample frame used	Extent of coverage	Mandatory	Who conducted the survey?	RR	Extra-polation
Canada	2005/2006	OECD	Census	Federal Government departments and agencies either performing Science & Technology (S&T) activities or have a budgetary allocation to fund S&T.	Yes	GOV	100%	Yes
Czech Republic	2007	OECD	R&D survey	All	Yes	GOV	88%	Partial
Korea	2006	All	R&D survey	All	No	GOV	85%	No
Norway	2005	OECD	Census	Total HES and the Norwegian Institute sector	No	NIFU STEP	90%	No
Poland	2005	OECD	Secondary sources	Selected for S&T	Yes	GOV	100%	No
Spain	2006	OECD	Census	Only government institutions with Science & Technology (S&T) activities or S&T budgets are included.	Yes	GOV	86%	No
Slovenia	2005	OECD	Secondary sources	Selected for S&T	Yes	GOV	100%	No

➔ RR = Response rate; NR = Not Relevant; .. = Information not available, HES = Higher education sector.

Source: OECD, Biotechnology statistics database, January 2009.

## 2. Biotechnology firms

- Data on the number of firms active in biotechnology are available for 22 OECD countries and four non-member countries.
- Biotechnology firms can be broken down into three types:

1. Biotechnology firm: defined as a firm engaged in biotechnology using at least one biotechnology technique (as defined in the OECD list-based definition of biotechnology techniques) to produce goods or services and/or to perform biotechnology R&D. Some of these firms may be large, with only a small share of total economic activity attributable to biotechnology.

There are two subgroups of biotechnology firms, largely defined by the data collection method.

2. Dedicated biotechnology firm: defined as a biotechnology firm whose predominant activity involves the application of biotechnology techniques to produce goods or services and/or to perform biotechnology R&D.
  3. Biotechnology R&D firm: defined as a firm that performs biotechnology R&D. Dedicated biotechnology R&D firms, a subset of this group, are defined as firms that devote 75% or more of their total R&D to biotechnology R&D.
- The data available on firm type depends on how each country collects biotechnology data. Dedicated biotechnology firms are identified through biotechnology firm surveys, while biotechnology R&D firms are identified through R&D surveys. Only a limited number of countries conduct both types of surveys.
  - Countries that collect biotechnology statistics through their R&D surveys may underestimate the number of biotechnology firms, as firms that use biotechnology but do not perform biotechnology R&D are excluded.
  - The United States has the largest number of biotechnology firms (3 301 firms), followed by Japan (1 007 firms) and France (824 firms). The 15 reporting countries from the European Union have a total of 3 377 firms.

### *Share of dedicated firms out of the total number of biotechnology firms*

- The share of dedicated biotechnology firms out of the total number of all biotechnology firms ranges from 22% in the Slovak Republic to 92% in Austria. The average by country is 60%.

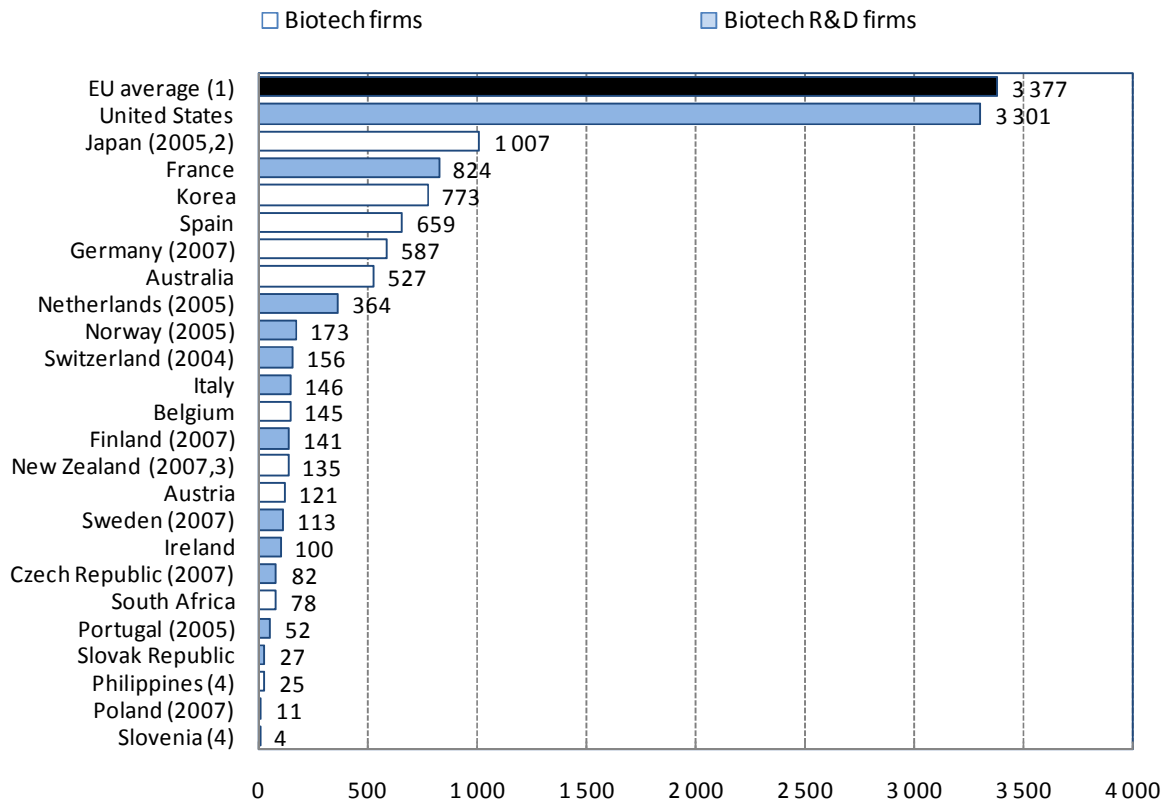
### *Size class data*

- Biotechnology firm size class data, available for ten countries, shows that the majority of firms have less than 50 employees. The share of firms with less than 50 employees ranges from 32% in Japan to 85% in Austria. The average by country is 67%.
- Nine countries provide data on the number of biotechnology firms with over 250 employees. The share of large firms ranges from 4% in New Zealand to 36% in Japan.
- Size class data for biotechnology R&D firms are available for 15 countries. The share of these firms with less than 50 employees ranges from 40% in Sweden to 85% in New Zealand. In the United States, 77% of all biotechnology R&D firms have less than 50 employees (2 528 firms). In France, 67% of biotechnology R&D firms have less than 50 employees (556 firms). The average by country is 63%.
- The share of large firms out of all biotechnology R&D firms ranges from 5% in New Zealand to 44% in the Slovak Republic, with an average share of 15%. Only 9% of biotechnology R&D firms in the United States have over 250 employees.

### *Biotechnology firms over time*

- Ten countries provided biotechnology firm time-series data. In most countries, the number of biotechnology firms increased over time.
- Spain experienced the fastest growth with a compound annual growth rate between 2004 and 2006 of 53% (+379 firms) for biotechnology firms and 30% (+ 189 firms) for biotechnology R&D firms.
- The United States experienced the largest increase in absolute terms with an increase of 719 biotechnology R&D firms between 2004 and 2006, for a compound annual growth rate of 13%.

## 2.1. Number of biotechnology firms, 2006



➔ For those countries where the number of biotechnology firms was unavailable, the number of biotechnology R&D firms was used instead.

➔ Biotechnology firm: a firm that uses biotechnology to produce goods or services and/or to perform biotechnology R&D. These firms are captured by biotechnology firm surveys.

➔ Biotechnology R&D firms: a firm that performs biotechnology R&D. These firms are captured by R&D surveys.

1. Underestimate of the true number. Includes only European countries for which data was available.

2. Overestimate of the true number. Includes firms that are only active in traditional biotechnology. May include firms that are active in biotechnology but which do not develop biotechnology innovations.

3. Probably overestimate of the true number.

4. Probably underestimate of the true number.

Source: OECD, Biotechnology statistics database, January 2009.

### **Dedicated biotechnology firms**

- Data on dedicated biotechnology firms are available for 20 OECD countries and 3 non-member countries.
- As opposed to biotechnology firms, where only a small share of total economic activity may be attributable to biotechnology, the predominant activity of the dedicated biotechnology firm involves the application of biotechnology techniques in the production of goods or services and/or to perform biotechnology R&D.
- The United States has the largest number of dedicated biotechnology R&D firms (2 744 firms), followed by Canada (532 firms), Germany (496 firms) and France (461 firms). The 14 reporting countries from the European Union have a total of 2 075 dedicated biotechnology firms.

#### ***Share of dedicated firms in total biotechnology firms***

- The share of dedicated biotechnology firms out of the total number of biotechnology firms ranges from 22% in the Slovak Republic to 92% in Austria.
- On average, 69% of biotechnology firms are dedicated biotechnology firms. The share of dedicated biotechnology firms out of the total is 83% in the United States, 84% in Germany, and 56% in France.
- The average share of dedicated biotechnology R&D firms out of all biotechnology R&D firms is 58%.

### ***Dedicated biotechnology firms by size***

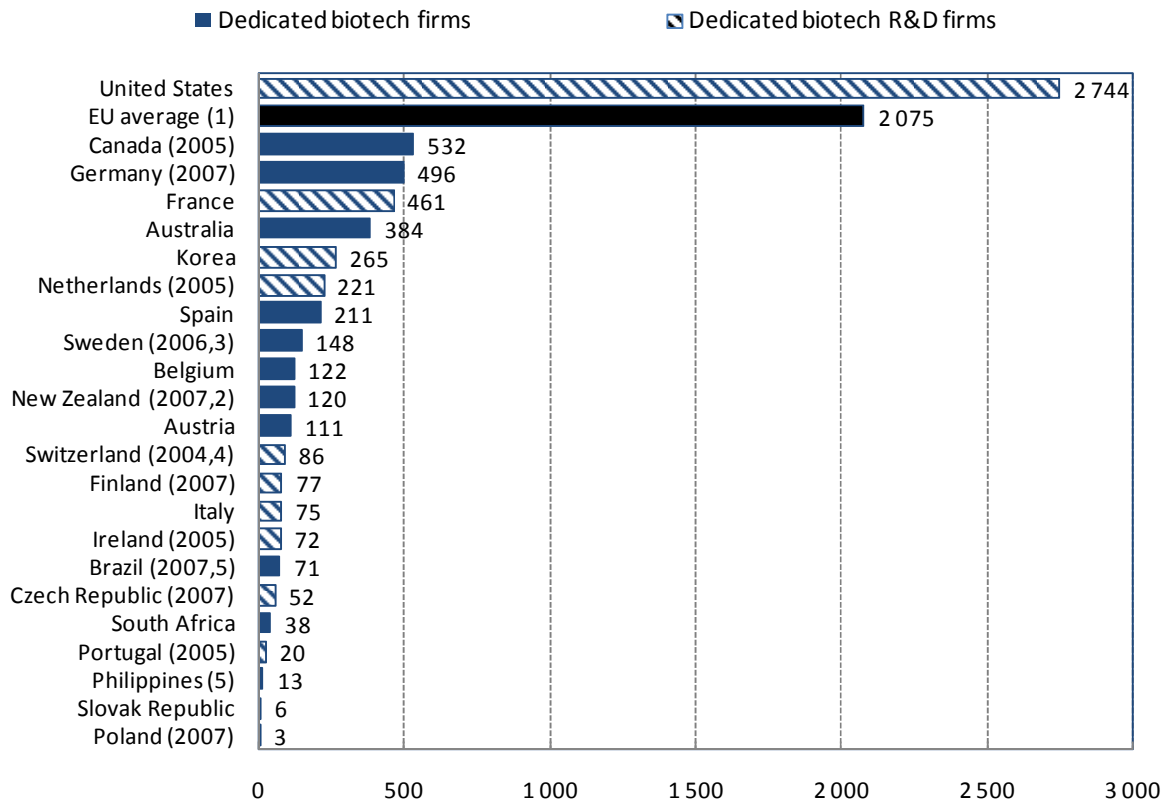
- Size class data for dedicated biotechnology firms, available for ten countries, shows that the majority have less than 50 employees. The share of firms with less than 50 employees ranges from 62% in the Philippines to 100% in Poland, with an average by country of 81%.
- Eight countries provide data on the number of dedicated biotechnology firms with over 250 employees. The share of large firms ranges from 1% in Germany to 9% in Spain.

### ***Dedicated biotechnology firms over time***

- Between 2004 and 2006, Spain experienced the fastest growth in the number of firms with a compound annual growth rate of 59% (+ 128 firms) for dedicated biotechnology firms and 48% (+ 183 firms) for dedicated biotechnology R&D firms.
- In the United States, the number of dedicated biotechnology R&D firms increased by 897 over the 2004 to 2006 period (22% compound annual growth rate).



## 2.2. Number of dedicated biotechnology firms, 2006



➔ For those countries where the number of dedicated biotechnology firms was unavailable, the number of dedicated biotechnology R&D firms was used instead.

➔ Dedicated biotechnology firm: a biotechnology firm whose predominant activity involves the application of biotechnology techniques to produce goods or services and/or to perform biotechnology R&D. These firms are captured by biotechnology firm surveys.

➔ Dedicated biotechnology R&D firms devote 75% or more of their total R&D to biotechnology R&D. These firms are captured by R&D surveys.

1. Underestimate of the true number. Includes only European countries for which data was available.

2. Probably overestimate of the true number.

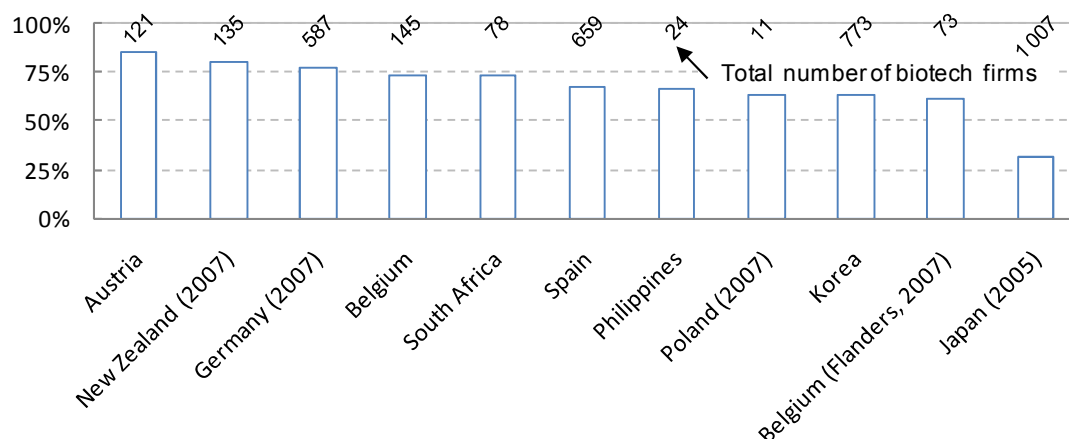
3. Excludes firms that supply biotechnology tools and equipment, biotechnology medical technology, food-related biotechnology and Contract Research Organisations (CROs).

4. For Switzerland, dedicated Biotechnology R&D firms are defined as firms that have dedicated 100% or more of their total R&D to biotechnology R&D.

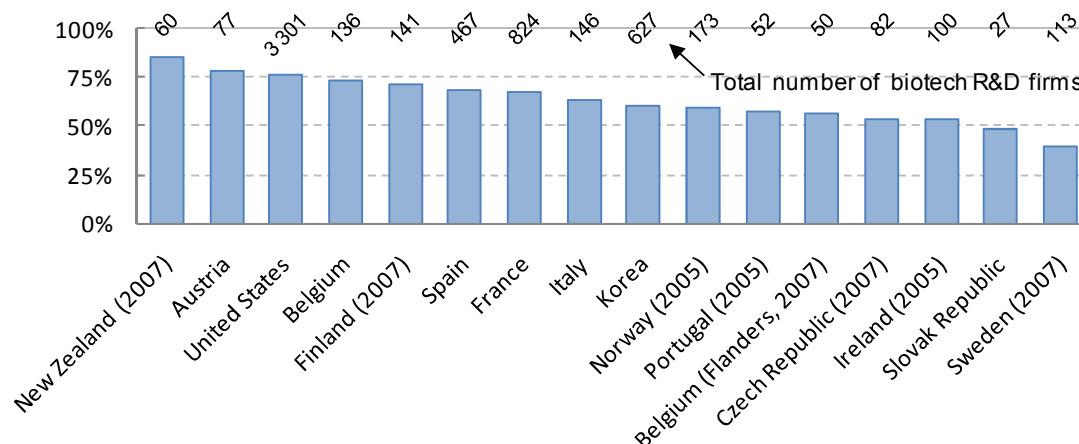
5. Probably underestimate of the true number.

Source: OECD, Biotechnology statistics database, January 2009.

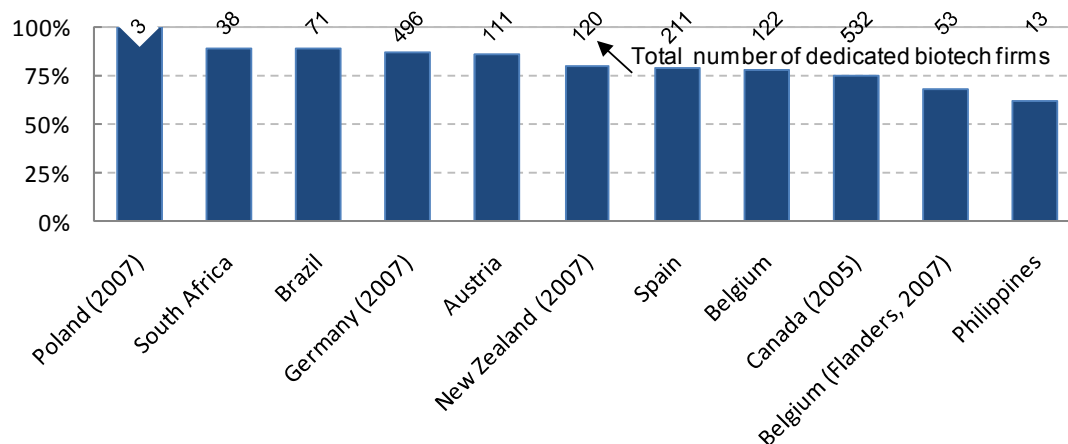
**2.3. Percent of biotechnology firms with less than 50 employees, 2006**



**2.4. Percent of biotechnology R&D firms with less than 50 employees, 2006**



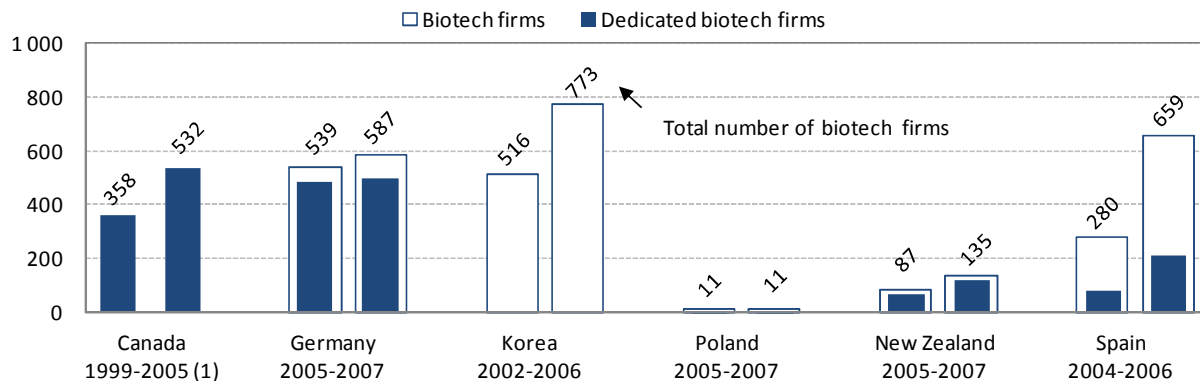
**2.5. Percent of dedicated biotechnology firms with less than 50 employees, 2006**



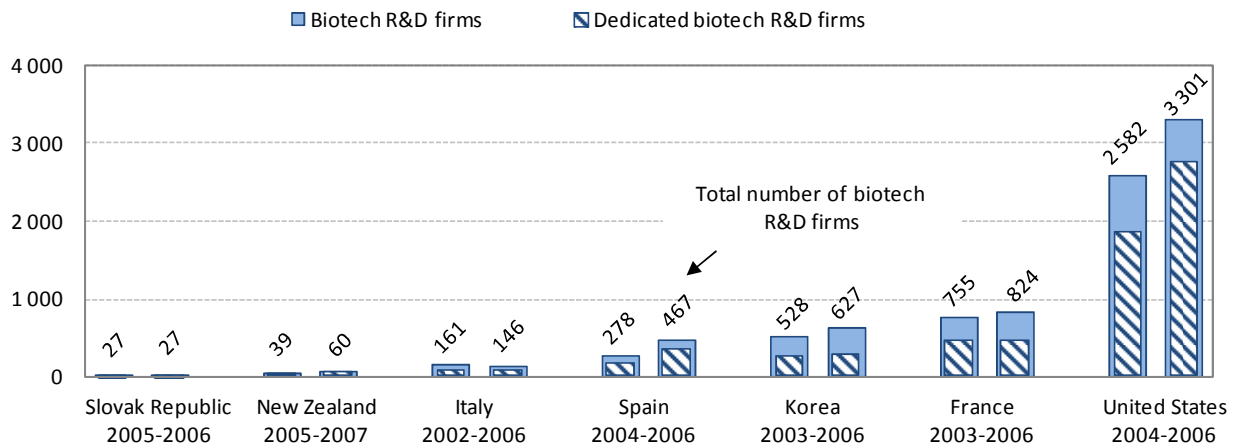
➔ See the tables at the end of the Chapter for additional information.

Source: OECD, Biotechnology statistics database, January 2009.

## 2.6. Biotechnology firms, earliest year and latest year



## 2.7. Biotechnology R&D firms, earliest year and latest year



➔ Biotechnology firm: a firm that uses biotechnology to produce goods or services and/or to perform biotechnology R&D. These firms are captured by biotechnology firm surveys.

➔ Dedicated biotechnology firm: a biotechnology firm whose predominant activity involves the application of biotechnology techniques to produce goods or services and/or to perform biotechnology R&D. These firms are captured by biotechnology firm surveys.

➔ Biotechnology R&D firms: a firm that performs biotechnology R&D. These firms are captured by R&D surveys.

➔ Dedicated biotechnology R&D firms devote 75% or more of their total R&D to biotechnology R&D. These firms are captured by R&D surveys.

1. Dedicated biotechnology firms only.

Source: OECD, Biotechnology statistics database, January 2009.

Table 2.1. Number of biotechnology firms

		Biotech firms	Of which		Biotech R&D firms	Of which	
			Dedicated biotech firms	% of dedicated biotech firms		Dedicated biotech R&D firms	% of dedicated biotech R&D firms
Australia	2006	527	384	73%	405	..	..
Austria	2006	121	111	92%	77	..	..
Belgium	2006	145	122	..	136	104	76%
Belgium (Flanders)	2007	73	53	73%	50	37	74%
Canada	2003	..	490	..	..	..	..
	2005	..	532	..	..	..	..
Czech Republic	2007	..	..	..	82	52	63%
Finland	2007	..	..	..	141	77	55%
France	2003	..	..	..	755	459	61%
	2004	..	..	..	796	476	60%
	2005	..	..	..	720	450	63%
	2006	..	..	..	824	461	56%
Germany	2005	539	480	89%	..	..	..
	2006	551	495	90%	..	..	..
	2007	587	496	84%	..	..	..
Ireland	2005	..	..	..	100	72	72%
Italy	2002	..	..	..	161	79	49%
	2003	..	..	..	175	89	51%
	2004	..	..	..	155	76	49%
	2005	..	..	..	124	61	49%
	2006	..	..	..	146	75	51%
Japan	2005	1 007	..	..	..	..	..
Korea	2002	516	..	..	510	503	99%
	2003	572	..	..	528	250	47%
	2004	620	..	..	596	279	47%
	2005	685	..	..	638	312	49%
	2006	773	..	..	627	265	42%
Norway	2005	..	..	..	173	..	..
Netherlands	2005	..	..	..	364	221	61%
New Zealand	2005	87	66	76%	39	18	46%
	2007	135	120	89%	60	45	75%
Poland	2005	11	3	27%	..	..	..
	2006	11	4	36%	..	..	..
	2007	11	3	27%	..	..	..
Portugal	2005	..	..	..	52	20	38%
Slovak Republic	2005	..	..	..	27	13	48%
	2006	..	..	..	27	6	22%
Spain	2004	280	83	30%	278	154	55%
	2005	477	133	28%	375	239	64%
	2006	659	211	32%	467	337	72%
Sweden (1)	2006 / 2007	..	148	..	113	56	50%
Switzerland (2)	2004	..	..	..	156	86	55%
United States	2004	..	..	..	2 582	1 847	72%
	2005	..	..	..	2 749	1 964	71%
	2006	..	..	..	3 301	2 744	83%
Brazil	2007	..	71	..	..	..	..
Philippines	2006	25	13	..	..	..	..
Slovenia	2006	..	..	..	4	..	..
South Africa	2006	78	38	..	..	..	..

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

1. For Sweden, excludes firms that supply biotechnology tools and equipment, biotechnology medical technology, food-related biotechnology and Contract Research Organisations (CROs). Data for biotechnology R&D firms are for 2007.

2. For Switzerland, dedicated biotechnology R&D firms are defined as firms where 100% of their R&D is dedicated to biotechnology R&D.

Source: OECD, Biotechnology statistics database, January 2009.

**Table 2.2. Biotechnology firms by size class**

		Less than 50 employees	50 to 249 employees	250+ employees	Total biotech firms	% of firms with less than 50 employees
Austria	2006	103	12	6	121	85%
Belgium	2006	106	29	10	145	73%
Belgium (Flanders)	2007	45	17	11	73	62%
Germany	2005	435	72	32	539	81%
	2006	440	76	35	551	80%
	2007	455	82	50	587	78%
Japan (1)	2005	320	309	364	1007	32%
Korea	2002	290	87	80	457	63%
	2003	369	114	83	566	65%
	2004	402	121	97	620	65%
	2005	437	121	88	646	68%
	2006	487	179	107	773	63%
New Zealand	2005	51	27	9	87	59%
	2007	108	21	6	135	80%
Poland	2005	7	2	2	11	64%
	2006	8	1	2	11	73%
	2007	7	2	2	11	64%
Spain	2004	164	73	43	280	59%
	2005	315	105	57	477	66%
	2006	446	143	70	659	68%
Philippines	2006	16	4	4	24	67%
South Africa	2006	57	..	..	78	73%

**Table 2.3. Dedicated biotechnology firms by size class**

		Less than 50 employees	50 to 249 employees	250+ employees	Total dedicated biotech firms	% of firms with less than 50 employees
Austria	2006	96	10	5	111	86%
Belgium	2006	95	22	5	122	78%
Belgium (Flanders)	2007	36	11	6	53	68%
Canada (2)	1999	259	68	31	358	72%
	2001	267	74	34	375	71%
	2003	352	92	46	490	72%
	2005	397	101	34	532	75%
Germany	2005	426	49	5	480	89%
	2006	430	58	7	495	87%
	2007	433	56	7	496	87%
New Zealand	2005	42	18	6	66	64%
	2007	96	18	6	120	80%
Poland	2005	3	0	0	3	100%
	2006	4	0	0	4	100%
	2007	3	0	0	3	100%
Spain	2004	60	15	8	83	72%
	2005	95	23	15	133	71%
	2006	167	26	18	211	79%
Brazil	2007	63	..	..	71	89%
Philippines	2006	8	4	1	13	62%
South Africa	2006	34	..	..	38	89%

→ Results for Tables 2.2. and 2.3. are from biotechnology firm surveys or from data compilations.

1. For Japan, 50-300 employees instead of 50-249 and 301 and more instead of 250 and more.
2. For Canada, size class is based on the total number of employees, not the biotechnology employees only.

Source: OECD, Biotechnology statistics database, January 2009.

Table 2.4. Biotechnology R&amp;D firms by size class

		Less than 50 employees	50 to 249 employees	250+ employees	Total biotech R&D firms	% of firms with less than 50 employees
Austria	2006	60	11	6	77	78%
Belgium	2006	99	28	9	136	73%
Belgium (Flanders)	2007	28	13	9	50	56%
Czech Republic	2007	44	29	9	82	54%
Finland	2007	100	26	15	141	71%
France	2003	518	145	92	755	69%
	2004	518	173	105	796	65%
	2005	494	136	90	720	69%
	2006	556	160	109	824	67%
Ireland	2005	54	29	17	100	54%
Italy	2002	72	49	40	161	45%
	2003	83	52	40	175	47%
	2004	79	40	36	155	51%
	2005	63	30	31	124	51%
	2006	93	28	25	146	64%
Korea	2002	285	87	80	452	63%
	2003	339	105	78	522	65%
	2004	382	119	95	596	64%
	2005	414	121	87	622	67%
	2006	377	151	99	627	60%
New Zealand	2005	24	9	6	39	62%
	2007	51	6	3	60	85%
Norway	2005	102	48	23	173	59%
Portugal	2005	30	14	8	52	58%
Slovak Republic	2005	8	7	12	27	30%
	2006	13	2	12	27	48%
Spain	2004	164	73	41	278	59%
	2005	248	79	48	375	66%
	2006	321	95	51	467	69%
Sweden	2007	45	36	32	113	40%
United States	2004	1 917	422	243	2 582	74%
	2005	2 054	443	252	2 749	75%
	2006	2 528	491	282	3 301	77%

Table 2.5. Biotechnology firm growth (compound annual growth rates)

	Biotech firms	Dedicated biotech firms	Biotech R&D firms	Dedicated biotech R&D firms
Compound annual growth rates				
Canada (1999-2005)	..	7%	..	..
France (2003-2006)	..	..	3%	0%
Germany (2005-2007)	4%	2%	..	..
Italy (2002-2006)	..	..	-2%	-1%
Korea (2003-2006)	11%	..	6%	2%
New Zealand (2005-2007)	25%	35%	24%	58%
Poland (2005-2007)	0%	0%	..	..
Slovak Republic (2005-2006)	..	..	0%	-54%
Spain (2004-2006)	53%	59%	30%	48%
United States (2004-2006)	..	..	13%	22%

→ The results for Table 2.4. are from R&D surveys.

Source: OECD, Biotechnology statistics database, January 2009.



### 3. Biotechnology R&D

- Biotechnology R&D expenditure data for the business sector, performed within the country, are available for 17 OECD countries and two non-member countries for 2006 or the latest available year. The data come from R&D surveys for 15 countries and from biotechnology surveys for four countries: Canada, Germany, Poland and South Africa. Of note, biotechnology R&D expenditure data are not available for several OECD countries with substantial business sector capabilities in biotechnology, including Denmark, Japan and the United Kingdom.
- Biotechnology R&D firms in the United States spent USD 25 101 million PPP on biotechnology R&D. This accounts for 75% of the total biotechnology R&D expenditures by firms in the 19 countries for which data are available. France comes second at USD 2 353 million PPP (biotechnology R&D firms). Canada is third with USD 1 404 million PPP, (dedicated biotechnology firms) spent on biotechnology R&D, followed by Germany with USD 1 198 million PPP (dedicated biotechnology firms).

#### ***Average biotechnology R&D spent per dedicated biotechnology firm***

- R&D expenditures by dedicated biotechnology firms are available for 17 countries. These results provide a measure of the level of biotechnology R&D by firms whose predominant activity is biotechnology.
- In the United States, dedicated biotechnology R&D firms spent an average of USD 7.92 million PPP on biotechnology R&D, followed by Sweden (USD 4.64 million PPP), France (USD 4.57 million PPP) and Belgium (USD 4.11 million PPP).

#### ***Share of biotechnology R&D out of total business sector R&D***

- The share of total business expenditures on biotechnology R&D out of total business sector R&D expenditure is an indicator of a research focus on biotechnology.
- The average share of biotechnology R&D out of total business sector R&D is 6.14% for the 19 countries.
- Eight countries have an above average focus on biotechnology R&D. Ireland leads with biotechnology R&D accounting for 21.7% of all business sector R&D, followed by Belgium (13.1%), Canada (11.1%) and the United States (10.4%).

#### ***Biotechnology R&D intensity***

- An alternative measure of a research focus on biotechnology is the biotechnology R&D intensity, defined as the share of biotechnology R&D expenditures out of the total value added of the industry sector. The average biotechnology R&D

intensity is 0.12% for the 19 countries for which data are available.

- Seven countries have above average biotechnology R&D intensities. The United States leads with a biotechnology R&D intensity of 0.31%, followed by Switzerland (0.28%), Ireland (0.27%), Belgium (0.26%) and Sweden (0.24%).
- The Flanders region of Belgium has a biotechnology R&D intensity of 0.44%.

#### ***Biotechnology R&D expenditures by size class***

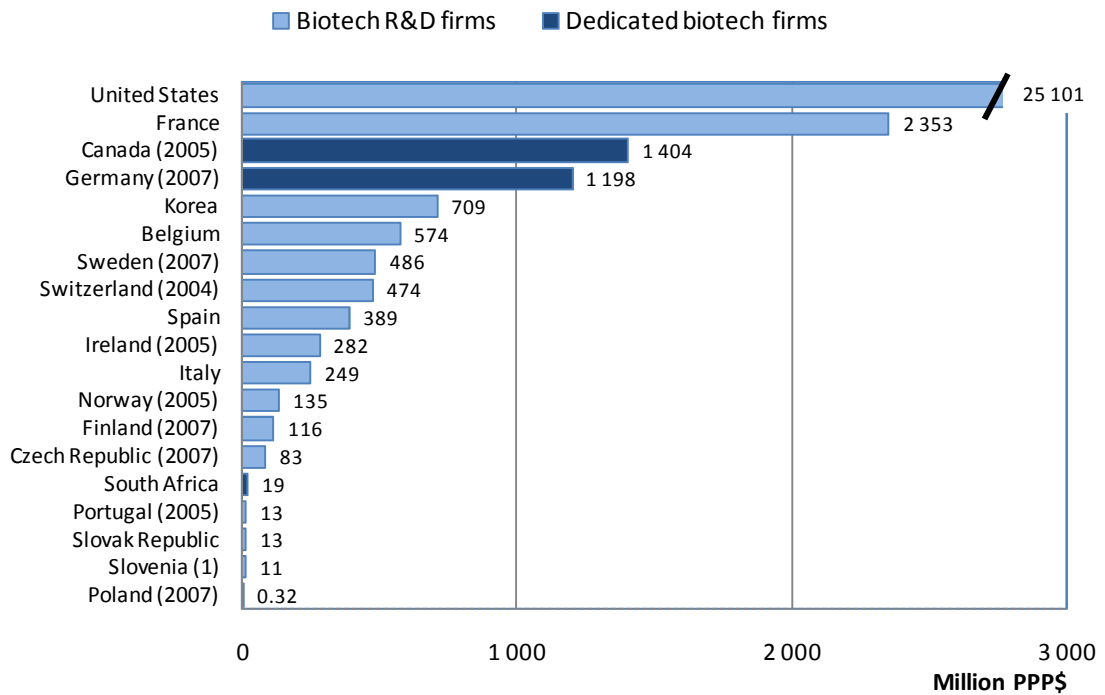
- Biotechnology R&D expenditure by the size of the firm is available for 16 countries. With the exception of Switzerland, the results give the share of total biotechnology R&D expenditures in each of three size classes: firms with less than 50 employees, firms with 50 to 249 employees, and firms with over 250 employees. Only two size classes are available for Switzerland: less than 100 employees and over 100 employees.
- Although the majority of biotechnology firms have less than 50 employees, most biotechnology R&D is performed by large firms with over 250 employees. For the United States and France, the two countries that spent the most on biotechnology R&D, approximately 75% of all biotechnology R&D was performed by large biotechnology R&D firms.
- Only in Portugal and the Slovak Republic is the majority of biotechnology R&D undertaken by biotechnology R&D firms with less than 50 employees.
- For dedicated biotechnology firms in Canada, Germany and Spain, the majority of biotechnology R&D is undertaken by medium-sized firms (50 to 249 employees).

#### ***Biotechnology R&D expenditures over time***

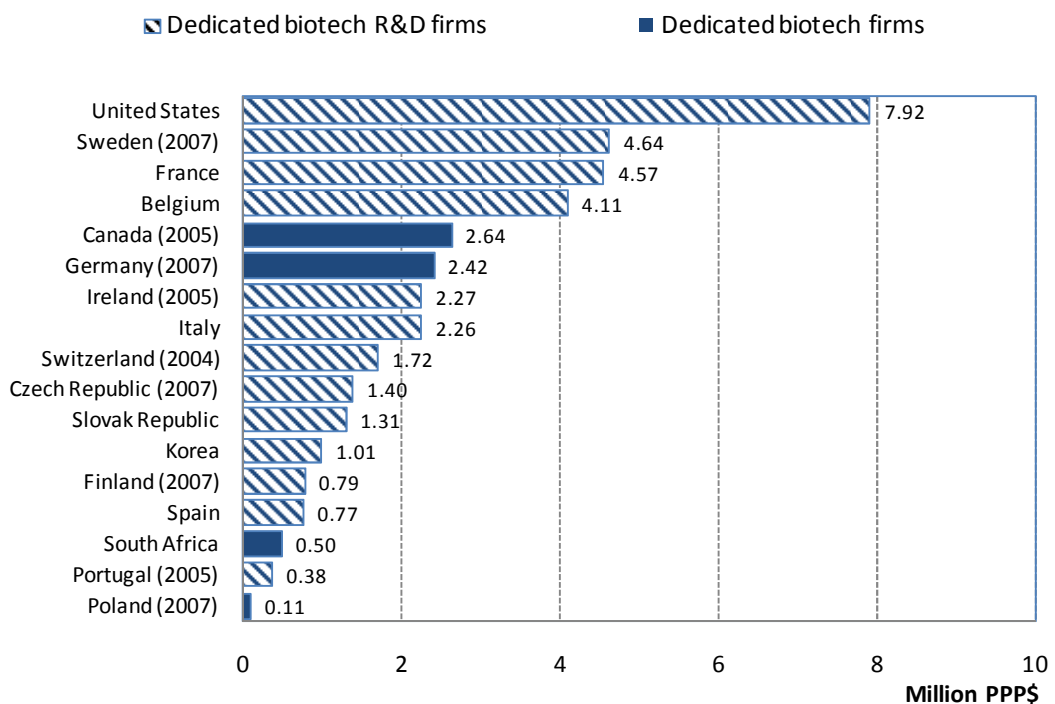
- Time-series data for biotechnology R&D expenditures are available for eight countries. Biotechnology R&D, in constant 2000 prices, increased for all countries.
- Compound annual growth rates for biotechnology R&D expenditures ranged from 1% in Italy (2002-2006) to 52% in Spain (2004-2006). R&D growth mirrors firm growth in Spain.
- For the four countries with the largest business sector expenditures on biotechnology R&D, growth rates ranged from 10% in Canada (1999-2005) to 20% in Germany (2005-2007), with 16% for the United States (2004-2006) and 18% for France (2003-2006).



### 3.1. Total biotechnology R&D expenditures in the business sector, Million PPP\$, 2006



### 3.2. Average biotechnology R&D spent per dedicated biotechnology firm, Million PPP\$, 2006

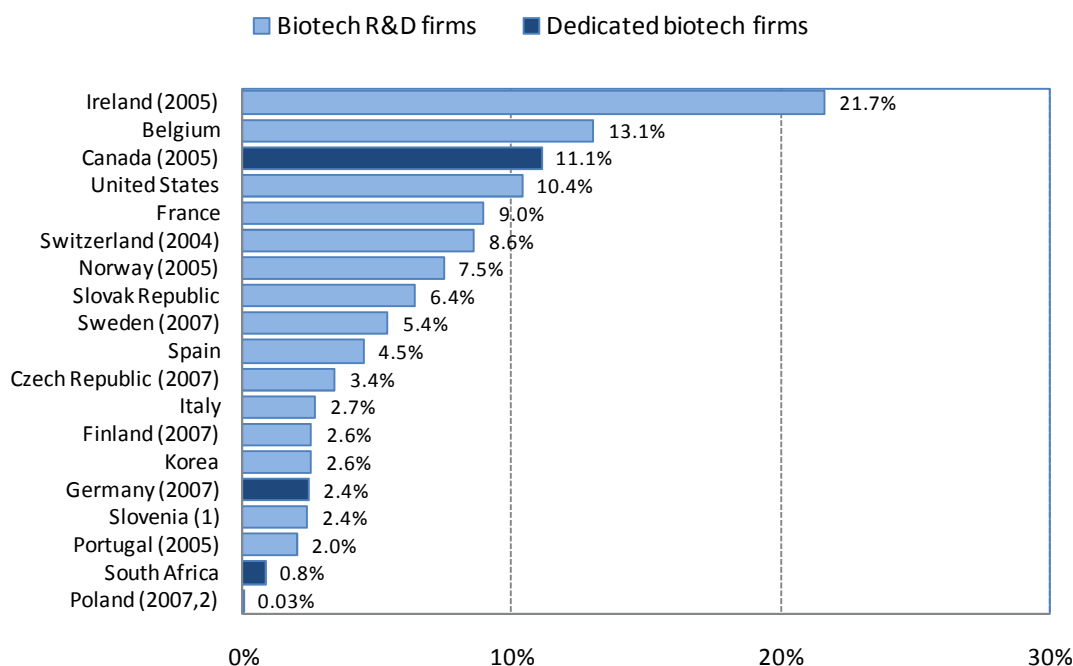


➔ In 2007, Flanders (Belgium) biotechnology R&D firms spent 622.6 Million PPP\$ on biotechnology R&D and the average biotechnology R&D spent per dedicated biotechnology R&D firm was 8.42 Million PPP\$.

1. Data for Slovenia are underestimated.

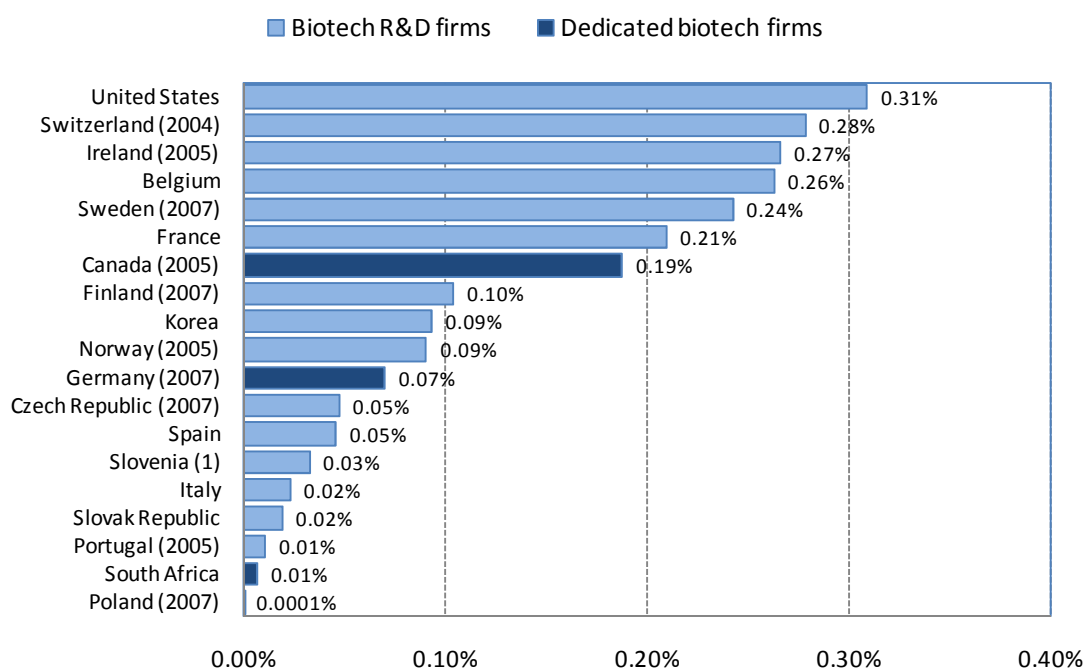
Source: OECD, Biotechnology statistics database, January 2009.

### 3.3. Biotechnology R&D as a percent of total business expenditures on R&D, 2006



### 3.4. Biotechnology R&D intensity, 2006

Biotechnology R&D as a percent of industry value added



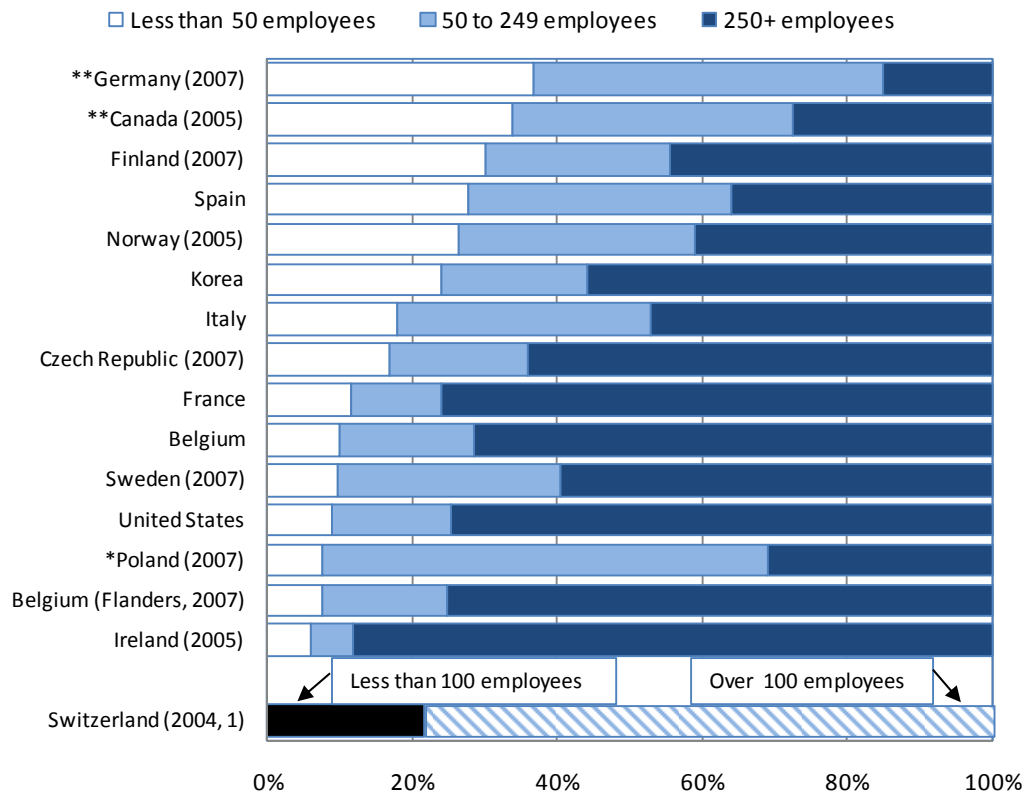
➔ In 2007, Flanders (Belgium) biotechnology R&D as a percent of total business expenditures on R&D was 21%; and the biotechnology R&D intensity was 0.44%.

1. Data for Slovenia are underestimated.

2. As the 2007 Business Expenditures on R&D (BERD) data were not available for Poland, 2006 BERD data were used.

Sources: OECD, Biotechnology statistics database; OECD, MSTI 2008/1, January 2009.

### 3.5. Share of total biotechnology R&D expenditures by firm size class, 2006

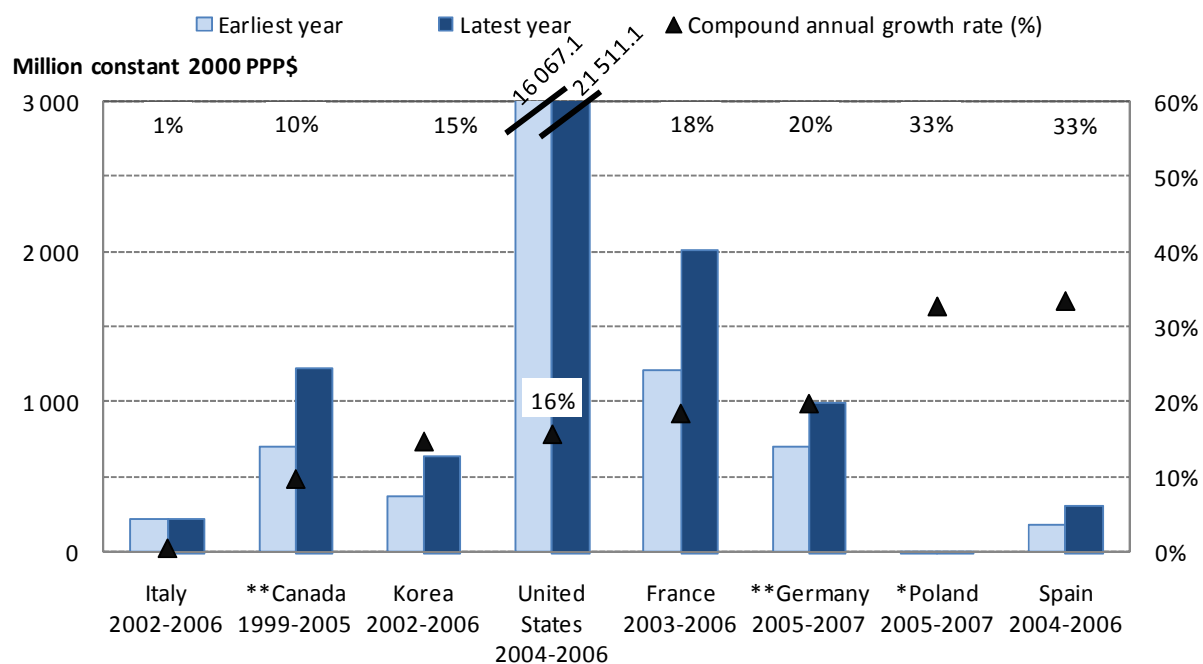


➔ For those countries where biotechnology R&D firm data were unavailable, dedicated biotechnology firm data (\*\*) or biotechnology firm data (\*) are used instead.

1. For Switzerland, firms with less than 100 employees and over 100 employees.

Source: OECD, Biotechnology statistics database, January 2009

### 3.6. Biotechnology R&D in biotechnology firms, Million constant 2000 PPP\$



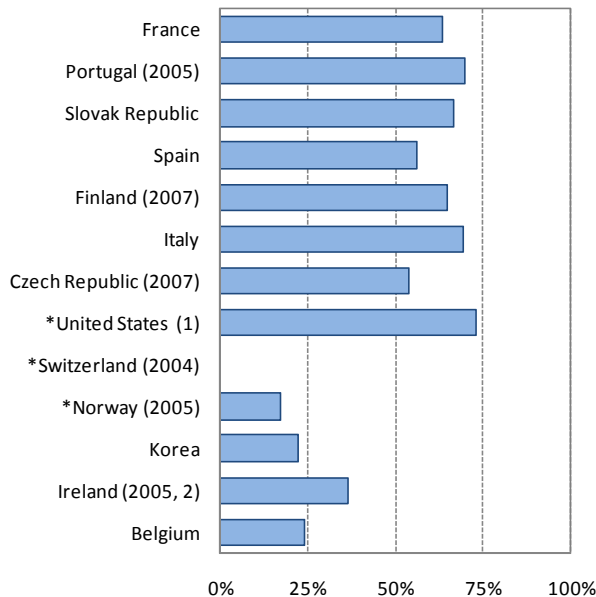
➔ For those countries where biotechnology R&D firm data were unavailable, dedicated biotechnology firm data (\*\*) or biotechnology firm data (\*) are used instead; see the tables at the end of the Chapter for additional information.

Source: OECD, Biotechnology statistics database, January 2009.

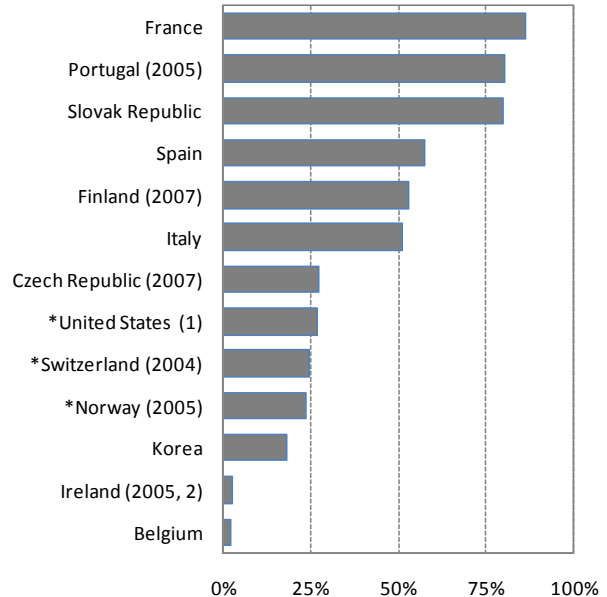
## Biotechnology R&D in the services sector

### 3.7. Role of the services sector in biotechnology R&D, 2006

Service sector share of dedicated biotechnology R&D firms



Share of biotechnology R&D performed in the services sector



➔ For those countries where dedicated biotechnology R&D firm data were unavailable, biotechnology R&D firm data are used instead. These countries are marked with an asterisk (\*).

1. Non-manufacturing. The United States classifies its data into manufacturing and non-manufacturing. Non-manufacturing includes: services, mining, construction and utilities.
2. Data for Ireland are underestimated.

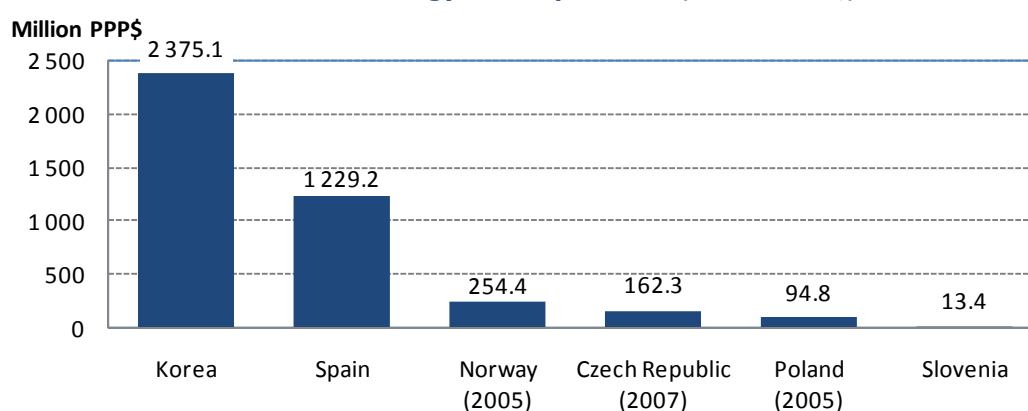
Source: OECD, Biotechnology statistics database, January 2009.

- Biotechnology firms that provide services to other firms or which have no products on the market are assigned to the services sector. These firms either sell services, for instance platform technologies such as genetic sequencing, or primarily conduct R&D with the goal of developing future marketable goods such as new pharmaceuticals or plant varieties.
- The percentage of total biotechnology R&D (in all sectors) that is performed in the services sector is available for 13 countries for biotechnology R&D firms. Data on the number of biotechnology firms active in the services sector are available for 12 countries.
- The share of all biotechnology R&D firms that are active in the services sector ranges from 17% in Norway to 73% in the United States. The average for the 12 reporting countries is 52%.
- The share of all biotechnology R&D that is performed in the services sector ranges from 2% in Belgium to 86% in France, with an average of 41% for the 13 reporting countries.
- In the United States, 73% of all biotechnology R&D firms are in the non-manufacturing sector. However, only 27% of all biotechnology R&D is attributed to the non-manufacturing sector.
- In Switzerland, 75% of all biotechnology R&D is performed outside the services sector.
- For ten countries it is possible to calculate the average biotechnology R&D spent per dedicated biotechnology R&D firm in the services sector. In four countries, average biotechnology R&D expenditure per firm in the services sector is higher than in total industry: France (USD 6.22 million PPP), the Slovak Republic (USD 1.57 million PPP), Spain (USD 0.79 million PPP) and Portugal (USD 0.44 million PPP).

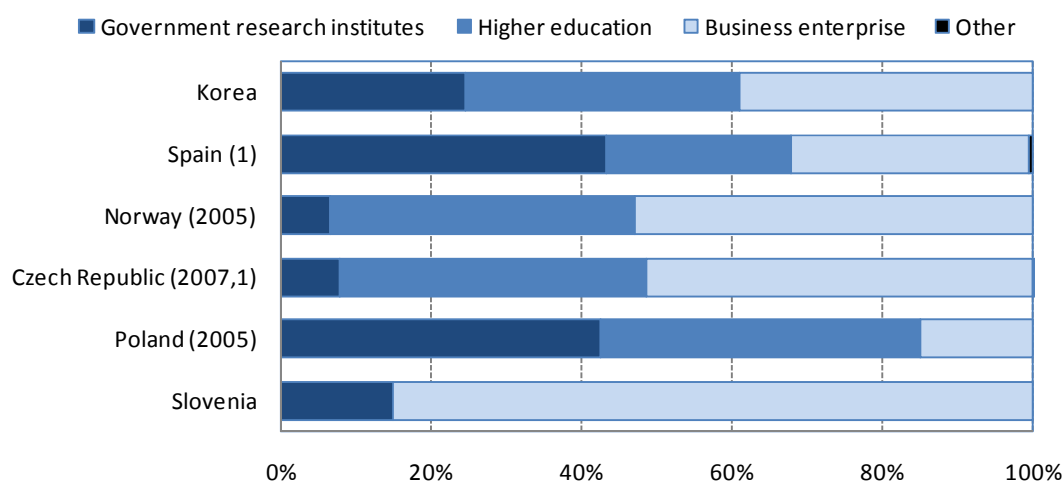
### Biotechnology R&D by sector of performance

- Biotechnology R&D can be performed in the public sector (government research institutes or higher education institutes), by the business sector, and by the private non-profit sector.
- Data on total biotechnology R&D by sector of performance are available for six countries.
- In these six countries, the highest total biotechnology R&D expenditures (all sectors combined) was in Korea (USD 2 375.1 million PPP), followed by Spain (USD 1 229.2 million PPP) and Norway (USD 254.4 million PPP).
- In three countries, the business enterprise sector accounts for over half of total biotechnology R&D: Slovenia (85%), Norway (53%), and the Czech Republic (51%).
- The government sector undertakes the largest share of biotechnology R&D in Spain (43%) and Poland (43%).
- The share of the higher education sector in total biotechnology R&D expenditures ranges from 25% in Spain to 42% in Poland. The average for the six reporting countries is 37%.

### 3.8. Total biotechnology R&D expenditures, Million PPP\$, 2006



### 3.9. Breakdown of total biotechnology R&D expenditures by sector of performance, 2006



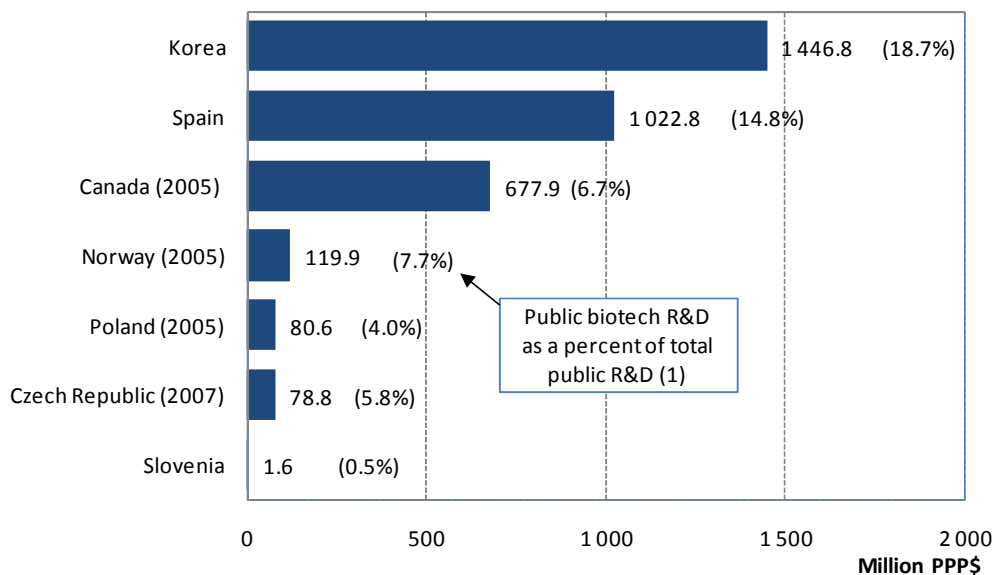
1. Other includes the private non-profit sector.

Source: OECD, Biotechnology statistics database, January 2009.

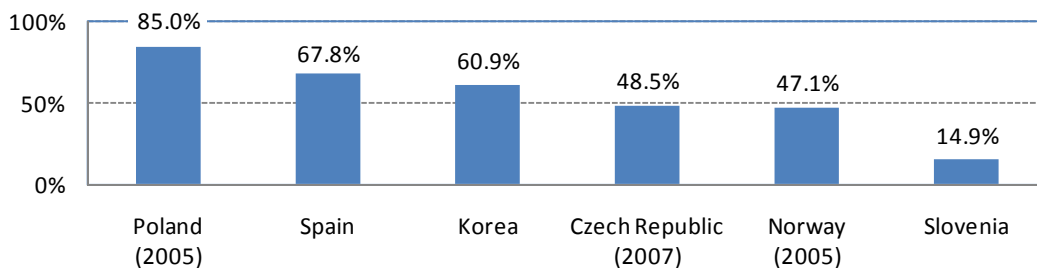
### Biotechnology R&D by sector of performance: Public biotechnology R&D

- Data on public biotechnology R&D expenditures are available for seven countries. Public biotechnology R&D has been defined as the sum of government and higher education biotechnology R&D.
  - Among these seven countries, the highest level of public sector expenditures on biotechnology R&D is found in Korea (USD 1 446.8 million PPP), followed by Spain (USD 1 022.8 million PPP) and Canada (USD 677.9 million PPP).
  - The biotechnology share of all public R&D expenditures is highest in Korea, at 18.7%, followed by Spain (14.8%), Norway (7.7%) and Canada (6.7%).
- Share of public biotechnology R&D in total public R&D expenditures**
- Data on the share of public biotechnology R&D in total biotechnology R&D expenditures are available for six countries. The share of public biotechnology R&D expenditures is highest in Poland, at 85%, followed by Spain (67.8%) and Korea (60.9%).
- Share of public biotechnology R&D in total biotechnology R&D expenditures**
- The share of public biotechnology R&D in total public R&D spending provides an indicator of the importance governments place on biotechnology R&D.

#### 3.10. Public biotechnology R&D expenditures, Million PPP\$, 2006 Government and higher education biotechnology R&D



#### 3.11. Share of public biotechnology R&D in total biotechnology R&D expenditures, 2006



1. Total public R&D includes Government Intramural Expenditure on R&D (GOVERD) plus Higher Education Expenditure on R&D (HERD).

Source: OECD, Biotechnology statistics database, January 2009.

Table 3.1. Biotechnology firms and R&amp;D

Biotech firms			Of which		% of biotech R&D in total R&D	Biotech R&D spent per biotech firm Million PPP\$	Biotech R&D as a percent of total business expenditures on R&D (BERD)	Biotech R&D as a percent of value added
			Total R&D expenditures	Biotech R&D expenditures				
			Million PPP\$					
Austria	2006	121	667.1	..	..	..	..	..
Belgium	2006	145	1 095.6	574.0	52%	3.959	13.07%	0.263%
Belgium (Flanders)	2007	73	1 799.5	622.6	35%	8.529	20.91%	0.443%
Korea	2002	516	..	386.6	..	0.749	2.29%	0.063%
	2003	572	1 594.8	429.7	27%	0.751	2.36%	0.069%
	2004	620	2 376.4	503.7	21%	0.812	2.35%	0.074%
	2005	685	2 714.3	601.6	22%	0.878	2.56%	0.085%
	2006	773	2 596.4	709.3	27%	0.918	2.56%	0.093%
Poland (1)	2005	11	9.2	4.8	52%	0.436	0.51%	0.001%
	2006	11	10.2	5.6	55%	0.510	0.57%	0.001%
	2007	11	13.0	8.8	68%	0.801	0.90%	0.002%
Spain	2004	280	554.6	201.2	36%	0.719	3.14%	0.027%
	2005	477	674.2	262.0	39%	0.549	3.67%	0.033%
	2006	659	889.7	389.2	44%	0.591	4.50%	0.046%

Table 3.2. Dedicated biotechnology firms and R&amp;D

Dedicated biotech firms			Of which		% of biotech R&D in total R&D	Biotech R&D spent per dedicated biotech firm Million PPP\$	Biotech R&D as a percent of total business expenditures on R&D (BERD)	Biotech R&D as a percent of value added
			Total R&D expenditures	Biotech R&D expenditures				
			Million PPP\$					
Austria	2006	111	563.3	..	..	..	..	..
Belgium	2006	122	459.4	426.3	93%	3.494	9.70%	0.195%
Belgium (Flanders)	2007	53	311.5	311.5	100%	5.877	10.46%	0.222%
Canada	1999	358	1 016.1	697.8	69%	1.949	7.99%	0.129%
	2001	375	1 707.2	1 024.8	60%	2.733	8.74%	0.168%
	2003	490	1 870.1	1 210.7	65%	2.471	10.59%	0.185%
	2005	532	2 083.8	1 404.0	67%	2.639	11.10%	0.188%
Germany	2005	480	799.9	799.9	100%	1.667	1.85%	0.050%
	2006	495	1 099.2	1 099.2	100%	2.221	2.36%	0.066%
	2007	496	1 198.2	1 198.2	100%	2.416	2.45%	0.070%
Spain	2004	83	242.9	119.3	49%	1.437	1.86%	0.016%
	2005	133	355.5	172.7	49%	1.299	2.42%	0.022%
	2006	211	469.8	299.0	64%	1.417	3.45%	0.035%
Poland (1)	2005	3	0.2	0.2	100%	0.068	0.02%	0.0001%
	2006	4	0.3	0.3	100%	0.077	0.03%	0.0001%
	2007	3	0.3	0.3	100%	0.108	0.03%	0.0001%
South Africa	2006	38	..	19.0	..	0.499	0.82%	0.007%

→ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

→ Germany classifies all R&D in dedicated biotechnology firms as biotechnology R&D.

1. As the 2007 BERD data were not available for Poland 2006 BERD was used.

Source: OECD, Biotechnology statistics database; OECD, MSTI 2008/1, January 2009.



Table 3.3. Biotechnology R&amp;D firms and R&amp;D expenditures

Biotech R&D firms			Of which		Total R&D expenditures	Of which	
			Dedicated biotech R&D firms	% of dedicated biotech R&D firms		Biotech R&D expenditures	Spent by dedicated biotech R&D firms
					Million PPP\$		
Austria	2006	77	..	..	667.1	..	..
Belgium	2006	136	104	76%	1 084.3	574.0	427.3
Belgium (Flanders)	2007	50	37	74%	1 799.5	622.6	311.5
Czech Republic	2007	82	52	63%	168.8	83.5	72.7
Finland	2007	141	77	55%	364.1	115.6	60.9
France	2003	755	459	61%	2 505.5	1 297.8	1 157.5
	2004	796	476	60%	2 810.0	1 424.0	1 256.4
	2005	720	450	63%	3 341.7	2 052.7	1 862.7
	2006	824	461	56%	3 802.9	2 353.0	2 104.8
Ireland	2005	100	72	72%	..	281.6	162.4
Italy	2002	161	79	49%	686.1	227.6	145.7
	2003	175	89	51%	701.2	200.8	133.7
	2004	155	76	49%	1 364.8	251.1	158.6
	2005	124	61	49%	1 365.8	313.6	232.8
	2006	146	75	51%	1 388.9	248.6	169.8
Korea	2002	510	503	99%	..	386.6	386.5
	2003	528	250	47%	1 582.8	429.7	158.7
	2004	596	279	47%	2 376.0	503.7	210.3
	2005	638	312	49%	2 714.1	601.6	258.5
	2006	627	265	42%	2 596.3	709.3	266.5
Netherlands	2005	364	221	61%	..	..	..
Norway	2005	173	..	..	436.6	134.5	..
Portugal	2005	52	20	38%	34.5	13.1	7.6
Slovak Republic	2005	27	13	48%	72.9	30.1	23.5
	2006	27	6	22%	84.8	12.9	7.9
Spain	2004	278	154	55%	554.0	201.2	141.2
	2005	375	239	64%	636.9	262.0	182.6
	2006	467	337	72%	825.4	389.2	260.4
Sweden	2007	113	56	50%	1 485.2	486.1	259.6
Switzerland	2004	156	86	55%	2 938.6	474.1	147.9
United States	2004	2 582	1 847	72%	29 534.0	17 590.0	14 911.0
	2005	2 749	1 964	71%	36 907.0	23 044.0	19 923.0
	2006	3 301	2 744	83%	42 447.0	25 101.0	21 746.0
Slovenia (1)	2006	4	..	..	108.9	11.4	2.9

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

1. Data for Slovenia are underestimated.

Source: OECD, Biotechnology statistics database, January 2009.

Table 3.3. Biotechnology R&D firms and R&D expenditures (*cont.*)

		% of biotech R&D in total R&D	Biotech R&D spent per biotech R&D firm	% of biotech R&D spent by dedicated biotech R&D firms	Biotech R&D spent per dedicated biotech R&D firm	Biotech R&D as a percent of total business expenditures on R&D (BERD)	Biotech R&D as a percent of value added
			Million PPP\$		Million PPP\$		
Austria	2006	..	..	..	..	..	..
Belgium	2006	53%	4.221	74%	4.109	13%	0.263%
Belgium (Flanders)	2007	35%	12.453	50%	8.418	21%	0.443%
Czech Republic	2007	49%	1.018	87%	1.399	3%	0.047%
Finland	2007	32%	0.820	53%	0.791	3%	0.104%
France	2003	52%	1.719	89%	2.522	6%	0.130%
	2004	51%	1.789	88%	2.639	6%	0.138%
	2005	61%	2.853	91%	4.139	8%	0.191%
	2006	62%	2.854	89%	4.566	9%	0.209%
Ireland	2005	..	2.813	58%	2.268	22%	0.266%
Italy	2002	33%	1.413	64%	1.844	3%	0.023%
	2003	29%	1.147	67%	1.502	2%	0.020%
	2004	18%	1.620	63%	2.086	3%	0.024%
	2005	23%	2.529	74%	3.816	3%	0.030%
	2006	18%	1.703	68%	2.265	3%	0.023%
Korea	2002	..	0.758	100%	0.768	2%	0.063%
	2003	27%	0.814	37%	0.635	2%	0.069%
	2004	21%	0.845	42%	0.754	2%	0.074%
	2005	22%	0.943	43%	0.829	3%	0.085%
	2006	27%	1.131	38%	1.006	3%	0.093%
Netherlands	2005	..	..	..	..	..	..
Norway	2005	31%	0.777	..	..	7%	0.091%
Portugal	2005	38%	0.253	58%	0.380	2%	0.011%
Slovak Republic	2005	41%	1.114	78%	1.806	14%	0.050%
	2006	15%	0.478	61%	1.313	6%	0.019%
Spain	2004	36%	0.724	70%	0.917	3%	0.027%
	2005	41%	0.699	70%	0.764	4%	0.033%
	2006	47%	0.833	67%	0.773	4%	0.046%
Sweden	2007	33%	4.302	53%	4.635	5%	0.242%
Switzerland	2004	16%	3.039	31%	1.719	9%	0.278%
United States	2004	60%	6.813	85%	8.073	8%	0.246%
	2005	62%	8.383	86%	10.144	10%	0.302%
	2006	59%	7.604	87%	7.925	10%	0.309%
Slovenia (1)	2006	10%	2.849	25%	..	2%	0.033%

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

1. Data for Slovenia are underestimated.

Source: OECD, Biotechnology statistics database; OECD, MSTI 2008/1, January 2009.

**Table 3.4. Biotechnology R&D in biotechnology firms in million constant 2000 PPP\$**

			Biotech firms	Total R&D expenditures	Of which		Biotech R&D per biotech firm
					Biotech R&D expenditures		
					Million constant 2000 PPP\$		
Austria	2006	121	584.9	..	..		
Belgium	2006	145	973.2	509.9	3.516		
Belgium (Flanders)	2007	73	1562.5	540.6	7.406		
Korea	2002	516	..	373.3	0.724		
	2003	572	1549.3	417.5	0.730		
	2004	620	2244.1	475.7	0.767		
	2005	685	2551.3	565.5	0.826		
	2006	773	2368.6	647.1	0.837		
New Zealand	2005	126	..	..	..		
Poland	2005	11	8.3	4.4	0.396		
	2006	11	9.1	5.0	0.455		
	2007	11	11.4	7.7	0.698		
Spain	2004	280	485.8	176.3	0.630		
	2005	477	573.4	222.8	0.467		
	2006	659	717.8	314.0	0.476		
South Africa	2006	78	..	..	..		

**Table 3.5. Biotechnology R&D in dedicated biotechnology firms in million constant 2000 PPP\$**

			Total R&D expenditures	<i>Of which</i>	Biotech R&D per biotech firm
				Biotech R&D expenditures	
Austria	2006	111	493.9	..	..
Belgium	2006	122	408.1	378.6	3.103
Belgium (Flanders)	2007	53	270.5	270.5	5.103
Canada	1999	358	1021.6	701.6	1.960
	2001	375	1667.0	1 000.7	2.669
	2003	490	1764.0	1 142.0	2.331
	2005	532	1820.3	1 226.5	2.305
Germany	2005	480	698.6	698.6	1.455
	2006	495	944.2	944.2	1.908
	2007	496	1002.5	1 002.5	2.021
New Zealand	2005	99	..	..	..
Poland	2005	3	0.2	0.2	0.062
	2006	4	0.3	0.3	0.068
	2007	3	0.3	0.3	0.094
Spain	2004	83	212.8	104.5	1.259
	2005	133	302.3	146.9	1.104
	2006	211	379.1	241.2	1.143
South Africa	2006	38	..	16.2	0.427

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

➔ Germany classifies all R&D in dedicated biotechnology firms as biotechnology R&D.

Source: OECD, Biotechnology statistics database, January 2009.

**Table 3.6. Biotechnology R&D in biotechnology R&D firms in million constant 2000 PPP\$**

Biotech R&D firms			Total R&D expenditures	Of which Biotech R&D expenditures	Biotech R&D per biotech firm
			Million constant 2000 PPP\$		
Austria	2006	77	584.9	..	..
Belgium	2006	136	963.1	509.9	3.749
Belgium (Flanders)	2007	50	1562.5	540.6	10.813
Czech Republic	2007	82	144.5	71.5	0.872
Finland	2007	141	319.7	101.5	0.720
France	2003	755	2347.8	1 216.1	1.611
	2004	796	2596.0	1 315.6	1.653
	2005	720	2973.6	1 826.6	2.539
	2006	824	3268.7	2 022.5	2.453
Ireland	2005	100	..	253.1	2.529
Italy	2002	161	666.8	221.2	1.374
	2003	175	667.0	191.0	1.091
	2004	155	1292.1	237.7	1.533
	2005	124	1271.6	292.0	2.355
	2006	146	1261.3	225.8	1.546
Korea	2002	510	..	373.3	0.732
	2003	528	1537.7	417.5	0.791
	2004	596	2243.8	475.7	0.798
	2005	638	2551.1	565.5	0.886
	2006	627	2368.5	647.1	1.032
New Zealand	2005	48	..	..	..
Norway	2005	173	375.9	115.8	0.669
Portugal	2005	52	29.9	11.4	0.219
Slovak Republic	2005	27	63.3	26.1	0.967
	2006	27	72.0	10.9	0.405
Spain	2004	278	485.3	176.3	0.634
	2005	375	541.7	222.8	0.594
	2006	467	665.9	314.0	0.672
Sweden	2007	113	1327.9	434.6	3.846
Switzerland	2004	156	2699.2	435.5	2.792
United States	2004	2 582	26977.0	16 067.1	6.223
	2005	2 749	32646.2	20 383.6	7.415
	2006	3 301	36376.3	21 511.1	6.517
Slovenia	2006	4	95.4	10.0	2.495

**Table 3.7. Biotechnology R&D expenditures growth (compound annual growth rates)**

	Biotech firms	Dedicated biotech firms	Biotech R&D firms
Compound annual growth rates			
Canada (1999-2005)	..	10%	..
France (2003-2006)	..	..	18%
Germany (2005-2007)	..	20%	..
Italy (2002-2006)	..	..	1%
Korea (2002-2006)	15%	..	15%
Poland (2005-2007)	33%	23%	..
Spain (2004-2006)	33%	52%	33%
United States (2004-2006)	..	..	16%

→ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

Source: OECD, Biotechnology statistics database, January 2009.

**Table 3.8. Biotechnology R&D in biotechnology firms by size class**

		Less than 50 employees	50 to 249 employees	250+ employees	Total biotech R&D	% biotech R&D performed by small firms
		Million PPP\$				
Austria (1)	2006	58.1	130.2	478.8	667.1	9%
Belgium	2006	58.0	106.5	409.6	574.0	10%
Belgium (Flanders)	2007	47.0	107.4	468.2	622.6	8%
Korea	2002	106.8	55.5	196.2	358.4	30%
	2003	129.4	82.1	206.4	418.0	31%
	2004	132.4	85.6	285.8	503.7	26%
	2005	176.8	106.8	315.2	598.8	30%
	2006	170.9	142.0	396.4	709.3	24%
Poland	2005	1.6	3.0	0.2	4.8	34%
	2006	0.4	2.5	2.7	5.6	7%
	2007	0.7	5.4	2.7	8.8	8%
Spain	2004	56.6	88.6	56.0	201.2	28%
	2005	79.1	92.7	90.2	262.0	30%
	2006	107.8	141.7	139.7	389.2	28%

**Table 3.9. Biotechnology R&D in dedicated biotechnology firms by size class**

		Less than 50 employees	50 to 249 employees	250+ employees	Total biotech R&D	% biotech R&D performed by small firms
		Million PPP\$				
Austria (1)	2006	54.7	123.8	384.8	563.3	10%
Belgium	2006	55.0	75.1	296.2	426.3	13%
Belgium (Flanders)	2007	46.5	98.4	166.5	311.5	15%
Canada	1999	217.5	160.4	320.0	697.8	31%
	2001	282.5	532.9	209.4	1 024.8	28%
	2003	403.0	641.6	166.1	1 210.7	33%
	2005	475.4	542.2	386.4	1 404.0	34%
Germany	2005	401.1	329.3	69.6	799.9	50%
	2006	417.0	377.8	304.5	1 099.2	38%
	2007	439.5	578.6	180.0	1 198.2	37%
Poland	2005	0.2	0.0	0.0	0.2	100%
	2006	0.3	0.0	0.0	0.3	100%
	2007	0.3	0.0	0.0	0.3	100%
Spain	2004	33.4	57.8	28.1	119.3	28%
	2005	53.0	69.2	50.6	172.7	31%
	2006	82.8	111.2	105.0	299.0	28%

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

1. Not limited to biotechnology R&D, total R&D undertaken by biotechnology firms.

Source: OECD, Biotechnology statistics database, January 2009.

**Table 3.10. Biotechnology R&D in biotechnology R&D firms by size class**

		Less than 50 employees	50 to 249 employees	250+ employees	Total biotech R&D	% biotech R&D performed by small firms
		Million PPP\$				
Belgium	2006	58.0	106.5	409.6	574.0	10%
Belgium (Flanders)	2007	47.0	107.4	468.2	622.6	8%
Czech Republic	2007	14.1	15.9	53.5	83.5	17%
Finland	2007	34.9	29.4	51.4	115.6	30%
France	2003	234.3	260.0	803.6	1 297.8	18%
	2004	243.9	373.0	807.1	1 424.0	17%
	2005	259.3	278.0	1 515.4	2 052.7	13%
	2006	275.5	293.5	1 783.9	2 353.0	12%
Ireland	2005	16.9	16.4	248.2	281.6	6%
Italy	2002	41.2	75.5	110.9	227.6	18%
	2003	43.6	95.9	61.3	200.8	22%
	2004	68.3	75.0	107.8	251.1	27%
	2005	62.0	81.8	169.9	313.6	20%
	2006	44.9	86.9	116.8	248.6	18%
Korea	2002	106.8	55.5	196.2	358.4	30%
	2003	129.4	82.1	206.4	418.0	31%
	2004	132.4	85.6	285.8	503.7	26%
	2005	176.8	106.8	315.2	598.8	30%
	2006	170.9	142.0	396.4	709.3	24%
Norway	2005	35.7	43.7	55.1	134.5	27%
Portugal	2005	7.1	2.9	3.2	13.1	54%
Slovak Republic	2005	5.7	10.4	14.0	30.1	19%
	2006	7.0	2.1	3.8	12.9	54%
Spain	2004	56.6	88.6	56.0	201.2	28%
	2005	79.1	92.7	90.2	262.0	30%
	2006	107.8	141.7	139.7	389.2	28%
Sweden	2007	47.8	148.5	289.8	486.1	10%
Switzerland (1)	2004	102.4	371.7	N/A	474.1	22%
United States	2004	2 333.0	3 441.0	11 816.0	17 590.0	13%
	2005	1 996.0	3 567.0	17 481.0	23 044.0	9%
	2006	2 236.0	4 140.0	18 725.0	25 101.0	9%

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

1. For Switzerland, firms with less than 100 employees and over 100 employees.

Source: OECD, Biotechnology statistics database, January 2009.

**Table 3.11. Business sector biotechnology R&D undertaken in the services sector, 2006****Biotechnology R&D firms and R&D expenditures**

				% services in total industries	Total Industries		Total Services		% services in total industries
					Biotech R&D active firms (units)		Biotech R&D Expenditures		
							Million PPP\$		
Belgium	2006	136	30	22%	574.2	9.1	2%		
Czech Republic	2007	82	46	56%	83.5	28.9	35%		
Finland	2007	141	85	60%	115.6	44.4	38%		
France	2006	824	464	56%	2 353.0	1 934.4	82%		
Ireland (1)	2005	77	23	30%	275.5	6.1	2%		
Italy	2006	146	85	58%	248.6	128.9	52%		
Korea	2006	626	87	14%	708.5	66.5	9%		
Norway	2005	173	30	17%	134.5	31.7	24%		
Portugal	2005	52	29	56%	13.1	9.2	70%		
Slovak Republic	2006	27	24	89%	12.9	11.3	88%		
Spain	2006	467	241	52%	389.2	193.4	50%		
Switzerland	2004	156	..	..	474.1	116.9	25%		
United States (2)	2006	3 301	2 418	73%	25 101.0	6 801.0	27%		

**Dedicated biotechnology R&D firms and R&D expenditures**

				% services in total industries	Total Industries	Total Services	% services in total industries
					Biotech R&D Expenditures		
Dedicated biotech R&D active firms (units)						Million PPP\$	
Belgium	2006	104	25	24%	427.3	8.9	2%
Czech Republic	2007	52	28	54%	72.7	20.0	28%
Finland	2007	77	50	65%	60.9	32.4	53%
France	2006	461	293	64%	2 104.8	1 820.0	86%
Ireland (1)	2005	55	20	37%	158.7	4.1	3%
Italy	2006	75	52	69%	169.8	86.8	51%
Korea	2006	265	59	22%	266.5	48.5	18%
Portugal	2005	20	14	70%	7.6	6.1	80%
Slovak Republic	2006	6	4	67%	7.9	6.3	80%
Spain	2006	337	190	56%	260.4	149.3	57%

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

1. Data for Ireland are underestimated.

2. Non-manufacturing. The United States classifies its data into manufacturing and non-manufacturing. Non-manufacturing includes: services, mining, construction and utilities.

Source: OECD, Biotechnology statistics database, January 2009.

**Table 3.12. Biotechnology R&D, Million PPP\$, 2006**

		Total public biotech R&D expenditures	Total biotech R&D expenditures	% public biotech R&D in total biotech R&D	Government Intramural Expenditure on R&D+Higher Education Expenditure	% public biotech R&D in total public expenditures on R&D (GOVERD+HERD)
Canada	2005	677.9	..	..	10 078.7	6.7%
Czech Republic	2007	78.8	162.3	48.5%	1 361.6	5.8%
Korea	2006	1 446.8	2 375.1	60.9%	7 720.3	18.7%
Norway	2005	119.9	254.4	47.1%	1 551.7	7.7%
Poland	2005	80.6	94.8	85.0%	1 994.9	4.0%
Spain	2006	832.8	1 229.2	67.8%	6 912.1	12.0%
Slovenia	2006	2.0	13.4	14.9%	310.5	0.6%

**Table 3.13. Biotechnology R&D by sector of performance, Million PPP\$, 2006**

		Government research institutes	Higher education	Business enterprise	Other	Total
Million PPP\$						
Czech Republic (1)	2007	12.6	66.1	83.5	0.1	162.3
Korea	2006	583.5	863.3	928.3	0.0	2 375.1
Norway	2005	16.5	103.4	134.5	0.0	254.4
Poland	2005	40.3	40.3	14.2	0.0	94.8
Spain (1)	2006	531.7	301.2	389.2	7.2	1 229.2
Slovenia	2006	2.0	0.0	11.4	0.0	13.4

➔ Total public R&D includes Government Intramural Expenditure on R&D (GOVERD) plus Higher Education Expenditure on R&D (HERD).

1. Other includes the private non-profit sector.

Source: OECD, Biotechnology statistics database; OECD, MSTI 2008/1, January 2009.





#### 4. Biotechnology employment

- There are four measures of employment in firms that are active in biotechnology:
  1. Total employment.
  2. Total R&D employment.
  3. Biotechnology employment: all employees with biotechnology-related activities.
  4. Biotechnology R&D employment: scientists and technical staff involved in biotechnology R&D.
- Employment data are available for 18 OECD countries and three non-member countries.
- The most commonly available employment statistic is for total employment in biotechnology firms.

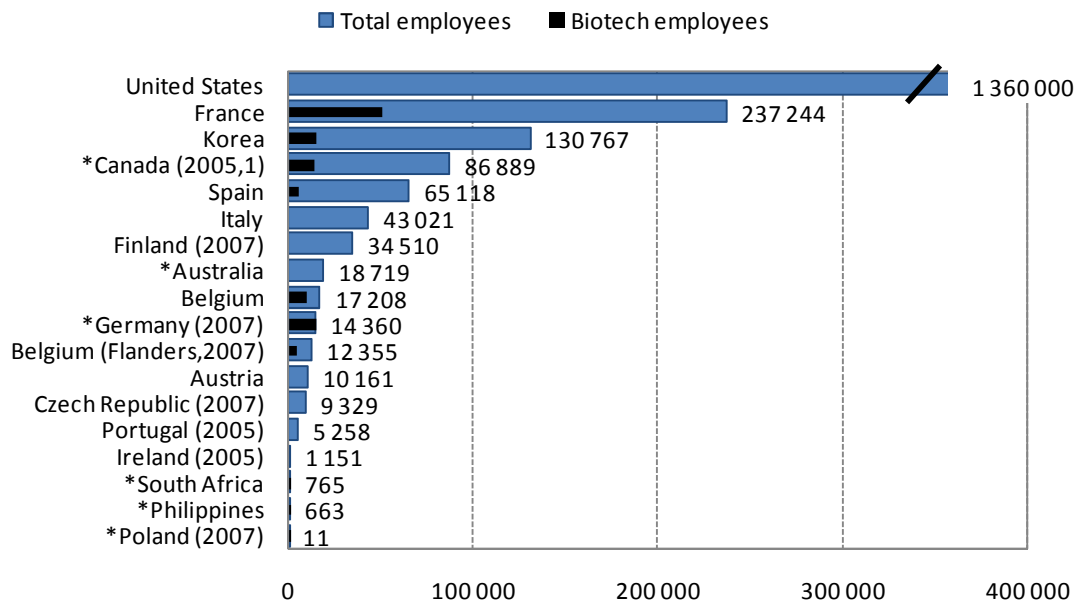
##### **Total employment in biotechnology R&D firms**

- The charts show only employment data for biotechnology R&D firms and dedicated biotechnology firms. Employment data for biotechnology firms is not shown, as the results are more susceptible to bias by large firms with only a small share of total economic activity attributable to biotechnology. This bias can also occur for biotechnology R&D firms.
- For example, for the six countries where both total employment and biotechnology employment data are available, the average share of biotechnology employment out of total employment is 12% for biotechnology firms. For biotechnology R&D firms, the average share is 18% (complete data were only available for four countries).
- Note: Germany classifies all employees (total employment) in dedicated biotechnology firms as biotechnology employees, and all R&D employees as biotechnology R&D employees.
- In terms of total employment, the United States leads with an estimated 1 360 000 employees in biotechnology R&D firms, followed by France (237 444 employees) and Korea (130 767 employees). Canada is fourth with 86 889 employees in dedicated biotechnology firms.
- For total R&D employment, the United States also leads with 150 000 R&D employees in biotechnology R&D firms. Of note, not all of these R&D employees will be involved in biotechnology R&D. France has a total of 25 946 R&D employees in biotechnology R&D firms, Switzerland has 12 970 R&D employees, and Italy 8 168 R&D employees.

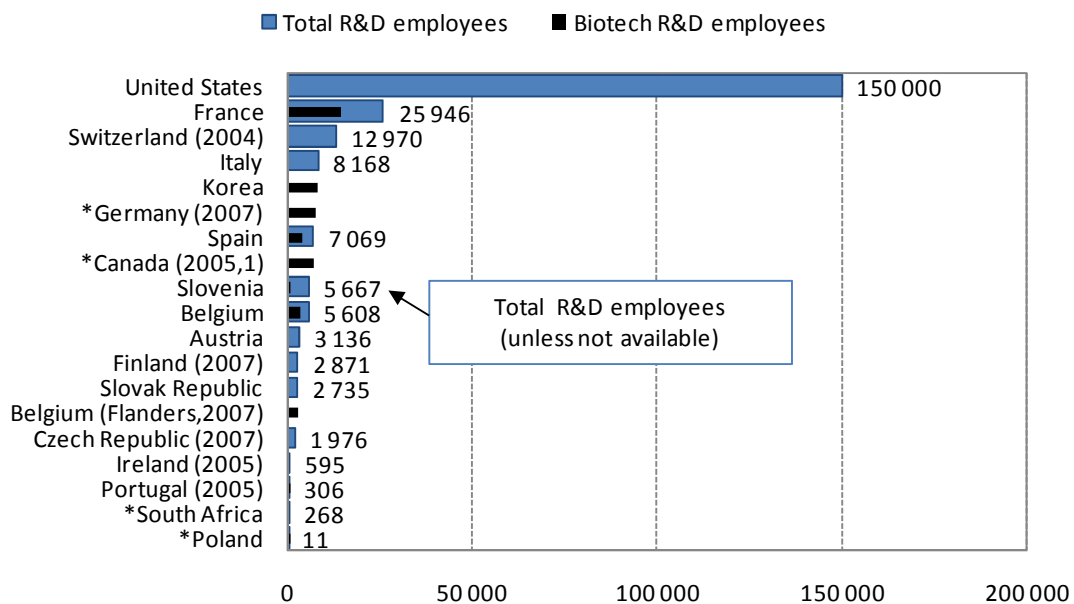
##### **Biotechnology employment in biotechnology R&D firms**

- Results on the number of employees actively involved in biotechnology-related activities or biotechnology R&D are available for 11 countries.
- For total biotechnology employment in these 11 countries, France leads with 50 098 biotechnology employees, followed by Korea (15 132), Germany (14 360), and Canada (13 433).
- France also leads with the number of biotechnology R&D employees (14 362), followed by Korea (7 725), Germany (7 240) and Canada (7 065).
- The average number of biotechnology employees per firm ranges from 4 in Poland (dedicated biotechnology firms) to 89 in Belgium, Flanders (dedicated biotechnology R&D firms).
- The average number of biotechnology R&D employees per biotechnology R&D firm ranges from 1 in Portugal to 125 in Slovenia.

## 4.1. Employment in biotechnology R&amp;D firms, 2006



## 4.2. R&amp;D Employment in biotechnology R&amp;D firms, 2006



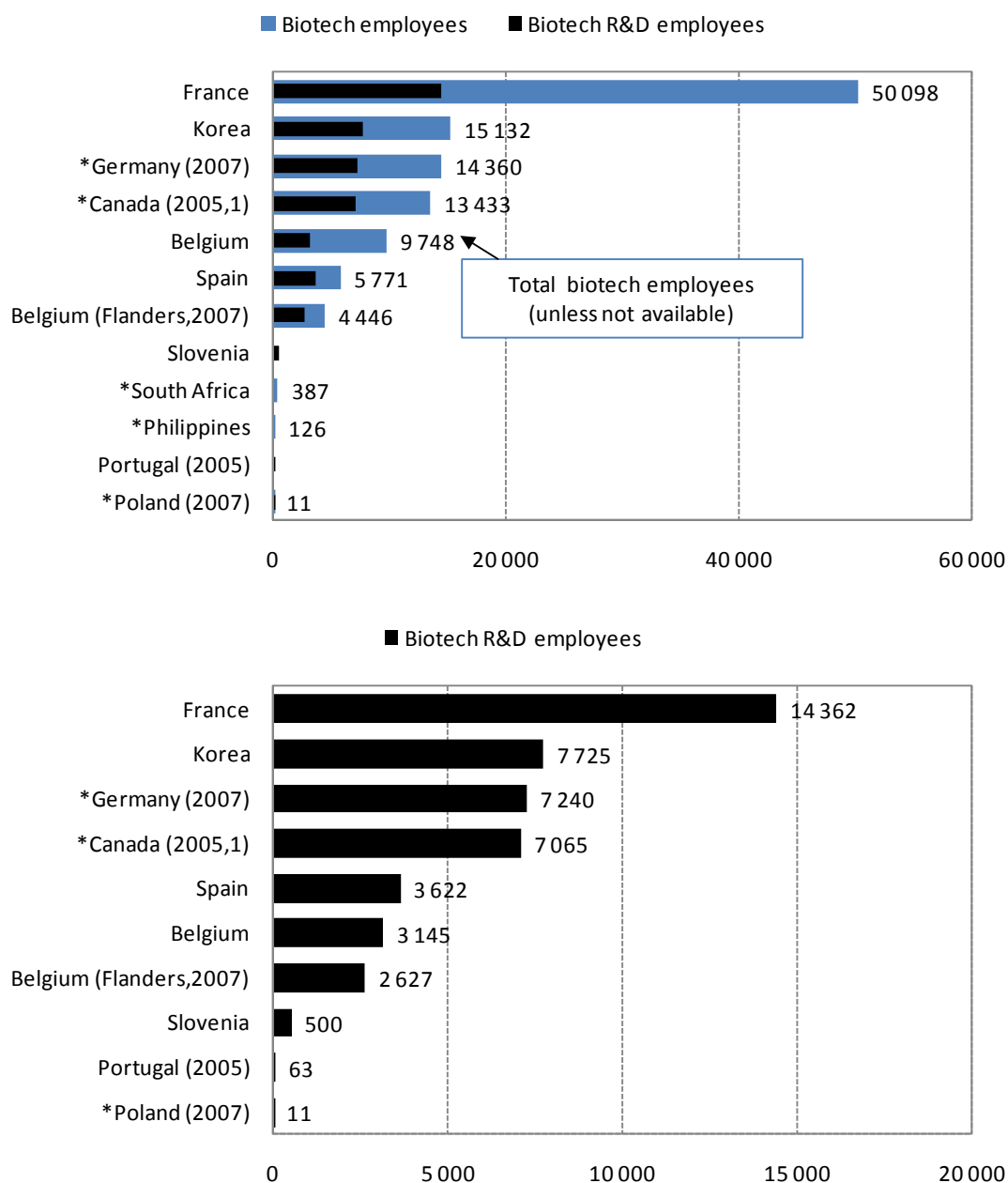
➔ For those countries where biotechnology R&D firm data were unavailable, dedicated biotechnology firm data are used instead. These countries are marked with an asterisk (\*). Data refer to Full-time equivalents (FTE) or to headcounts; see the tables at the end of the Chapter for additional information.

➔ Germany classifies all employees (total employment) in dedicated biotechnology firms as biotechnology employees, and all R&D employees as biotechnology R&D employees.

1. In Canada, most biotechnology employees are full-time employees (in 2005 12,623 were full-time and 810 were part-time).

Source: OECD, Biotechnology statistics database, January 2009.

## 4.3. Close-up on biotechnology employment in biotechnology R&amp;D firms, 2006



→ Figure 4.3. provides a close-up of the results for employees involved in biotechnology activities. The upper figure gives count data for all employees with biotechnology related activities. The lower figure gives the count data for all scientists and technical staff involved in biotechnology R&D.

→ For those countries where biotechnology R&D firm data were unavailable, dedicated biotechnology firm data are used instead. These countries are marked with an asterisk (\*). Data refer to Full-time equivalents (FTE) or to headcounts; see the tables at the end of the Chapter for additional information.

→ Germany classifies all employees (total employment) in dedicated biotechnology firms as biotechnology employees, and all R&D employees as biotechnology R&D employees.

1. In Canada, most biotechnology employees are full-time employees (in 2005 12,623 were full-time and 810 were part-time).

Source: OECD, Biotechnology statistics database, January 2009.

Table 4.1. Biotechnology employment in biotechnology firms

			Total employees	Of which		% biotech in total	Total R&D employees	Of which		% biotech in total R&D
Biotech firms				Biotech employees				Biotech R&D employees		
Australia	2006	527	28 573	..	HC	..	..	..	..	..
Austria	2006	121	10 462	..	HC	..	3 136	..	FTE	..
Belgium	2006	145	17 777	10 053	FTE	57%	5 664	3 142	FTE	55%
Belgium (Flanders)	2007	73	13 309	5 059	FTE	38%	..	2 975	FTE	..
Germany	2005	539	..	23 877	HC	..	..	..	..	..
	2006	551	..	28 950	HC	..	..	..	..	..
	2007	587	..	29 570	HC	..	..	..	..	..
Korea	2002	516	..	8 604	HC	..	..	5 030	HC	..
	2003	572	..	10 485	HC	..	..	5 773	HC	..
	2004	620	138 250	12 107	HC	9%	..	6 592	HC	..
	2005	685	..	13 818	HC	..	..	7 399	HC	..
	2006	773	141 924	17 066	HC	12%	..	8 629	HC	..
Poland	2005	11	1 315	568	HC	43%	1 093	568	HC	52%
	2006	11	1 101	550	HC	50%	930	550	HC	59%
	2007	11	1 214	541	HC	45%	970	541	HC	56%
Spain	2004	280	67 284	..	HC	..	4 940	2 387	FTE	48%
	2005	477	79 396	..	HC	..	6 046	2 564	FTE	42%
	2006	659	88 124	7 861	HC	9%	7 755	3 622	FTE	47%
Philippines	2006	25	3 391	196	HC	6%	..	..	..	..
South Africa	2006	78	72 844	2 051	..	3%	..	1 153	..	..

Table 4.2. Biotechnology employment in dedicated biotechnology firms

			Total employees	Of which		% biotech in total	Total R&D employees	Of which		% biotech in total R&D
Dedicated biotech firms				Biotech employees				Biotech R&D employees		
Australia	2006	384	18 719	..	..	..	..	..	..	..
Austria	2006	111	9 543	..	HC	..	2 400	..	FTE	..
Belgium	2006	122	9 274	8 693	FTE	94%	2 856	2 529	FTE	89%
Belgium (Flanders)	2007	53	3 585	3 585	FTE	100%	2 073	2 073	FTE	100%
Canada (1)	1999	358	62 613	7 749	HC	12%	..	2 342	HC	..
	2001	375	62 242	11 897	HC	19%	..	5 852	HC	..
	2003	490	75 448	11 863	HC	16%	..	6 441	HC	..
	2005	532	86 889	13 433	HC	15%	..	7 065	HC	..
Germany	2005	480	13 021	13 021	HC	100%	6 134	6 134	HC	100%
	2006	495	14 150	14 150	HC	100%	6 463	6 463	HC	100%
	2007	496	14 360	14 360	HC	100%	7 240	7 240	HC	100%
Poland	2005	3	18	14	HC	78%	18	14	HC	78%
	2006	4	21	17	HC	81%	21	17	HC	81%
	2007	3	11	11	HC	100%	11	11	HC	100%
Spain	2004	83	8 231	..	HC	..	2 178	1 344	FTE	62%
	2005	133	14 622	..	HC	..	3 030	1 662	FTE	55%
	2006	211	17 760	5 055	HC	28%	3 762	2 641	FTE	70%
Sweden	2006	148	..	5 240	FTE	..	..	..	..	..
Philippines	2006	13	663	126	HC	19%	..	..	..	..
South Africa	2006	38	765	387	..	51%	268	..	..	..

→ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

→ FTE: Full-time equivalents; HC: headcounts.

→ Germany classifies all employees (total employment) in dedicated biotechnology firms as biotechnology employees, and all R&D employees as biotechnology R&D employees.

1. In Canada, most biotechnology employees are full-time employees (in 2005 12,623 were full-time and 810 were part-time).

Source: OECD, Biotechnology statistics database, January 2009.

Table 4.3. Biotechnology employment in biotechnology R&amp;D firms

			Total employees	Of which		% biotech in total	Total R&D employees	Of which		% biotech in total R&D
Biotech R&D firms				Biotech employees				Biotech R&D employees		
Austria	2006	77	10 161	..	HC	..	3 136	..	FTE	..
Belgium	2006	136	17 208	9 748	FTE	57%	5 608	3 145	FTE	56%
Belgium (Flanders)	2007	50	12 355	4 446	FTE	36%	..	2 627	FTE	..
Czech Republic	2007	82	9 329	..	..	..	1 976	..	HC	..
Finland	2007	141	34 510	..	HC	..	2 871	..	FTE	..
France	2003	755	195 167	46 571	HC	24%	18 916	8 983	HC	47%
	2004	796	223 333	40 777	HC	18%	21 055	9 169	HC	44%
	2005	720	194 098	38 800	HC	20%	23 814	12 836	HC	54%
	2006	824	237 244	50 098	HC	21%	25 946	14 362	HC	55%
Ireland	2005	100	1 151	..	HC	..	595	..	HC	..
Italy	2002	161	37 600	..	FTE	..	5 300	..	FTE	..
	2003	175	54 508	..	FTE	..	5 322	..	FTE	..
	2004	155	52 481	..	FTE	..	8 545	..	FTE	..
	2005	124	38 306	..	FTE	..	8 266	..	FTE	..
	2006	146	43 021	..	FTE	..	8 168	..	FTE	..
Korea	2002	510	..	8 541	HC	..	..	4 980	HC	..
	2003	528	..	10 095	HC	..	..	5 662	HC	..
	2004	596	136 835	11 948	HC	9%	..	6 544	HC	..
	2005	638	..	13 583	HC	..	..	7 294	HC	..
	2006	627	130 767	15 132	HC	12%	..	7 725	HC	..
Portugal	2005	52	5 258	..	HC	..	306	63	FTE	21%
Slovak Republic	2005	27	..	..	..	..	2 075	..	FTE	..
	2006	27	..	..	..	..	2 735	..	FTE	..
Spain	2004	278	65 008	..	HC	..	4 927	2 387	FTE	48%
	2005	375	70 455	..	HC	..	5 434	2 564	FTE	47%
	2006	467	65 118	5 771	HC	9%	7 069	3 622	FTE	51%
Switzerland (2)	2004	156	..	..	..	..	12 970	5 691	HC	44%
United States	2004	2 582	985 000	..	HC	..	112 000	..	FTE	..
	2005	2 749	1 107 000	..	HC	..	121 000	..	FTE	..
	2006	3 301	1 360 000	..	HC	..	150 000	..	FTE	..
Slovenia	2006	4	..	..	..	..	5 667	500	FTE	9%

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

➔ FTE: Full-time equivalents; HC: headcounts.

2. In Switzerland, biotechnology R&D employees includes all researchers, and not exclusively those working on biotechnology.

Source: OECD, Biotechnology statistics database, January 2009.



## 5. Biotechnology sales

- Data on the total sales of biotechnology firms are available for eight OECD countries and one non-member country. Six countries also provided data for the sales of biotechnology goods and services only.

### Average sales per dedicated biotechnology firm

- Average total sales per dedicated biotechnology firm is highest in Canada with USD 83 million PPP, followed by Belgium with USD 33 million PPP and Austria with USD 26 million PPP.
- Average total sales per biotechnology R&D firm is highest in the United States, with USD 168 million PPP, followed by Portugal with USD 106 million PPP.
- Belgium has the highest average biotechnology-specific sales per dedicated biotechnology firm (USD 31 million PPP), followed by Korea, with USD 7 million PPP biotechnology sales per biotechnology R&D firm.

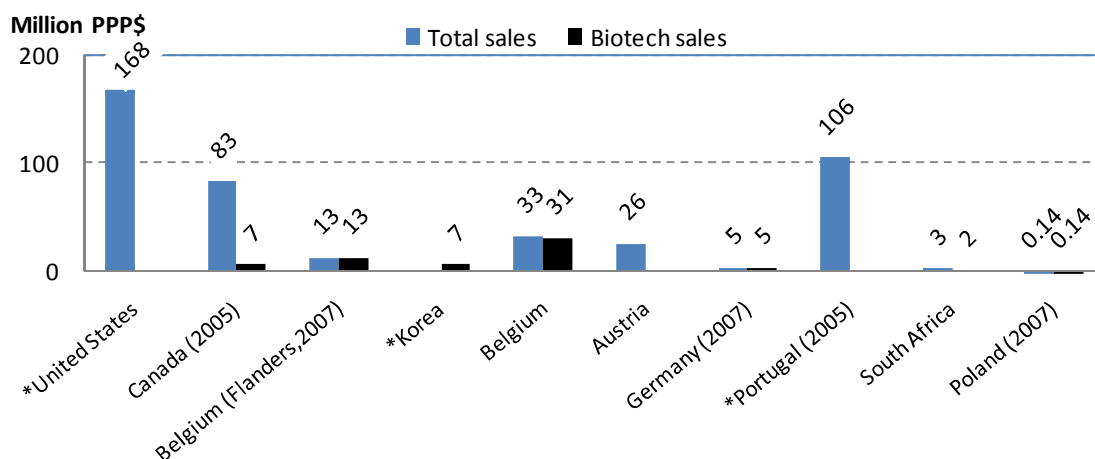
### Biotechnology sales as a share of total sales in dedicated biotechnology firms

- Five countries provided sales data for total sales as well as for sales of biotechnology goods and services only. The share of biotechnology sales out of total sales ranges from 8% in Canada, even though the results are for dedicated biotechnology firms to 100% in Poland. Germany classifies all sales in dedicated biotechnology firms as biotechnology sales. The share is 64% in South Africa and 96% in Belgium for dedicated biotechnology firms.

### Biotechnology sales over time

- Four countries provided biotechnology sales time-series data. Biotechnology sales, in constant 2000 prices, increased for all countries (compound annual growth rates).
- The annual growth rate for biotechnology sales was highest for Poland at 34%, followed by Germany (13%), Korea (12%) and Canada (11%).

5.1. Average sales per dedicated biotechnology firm, Million PPP\$, 2006



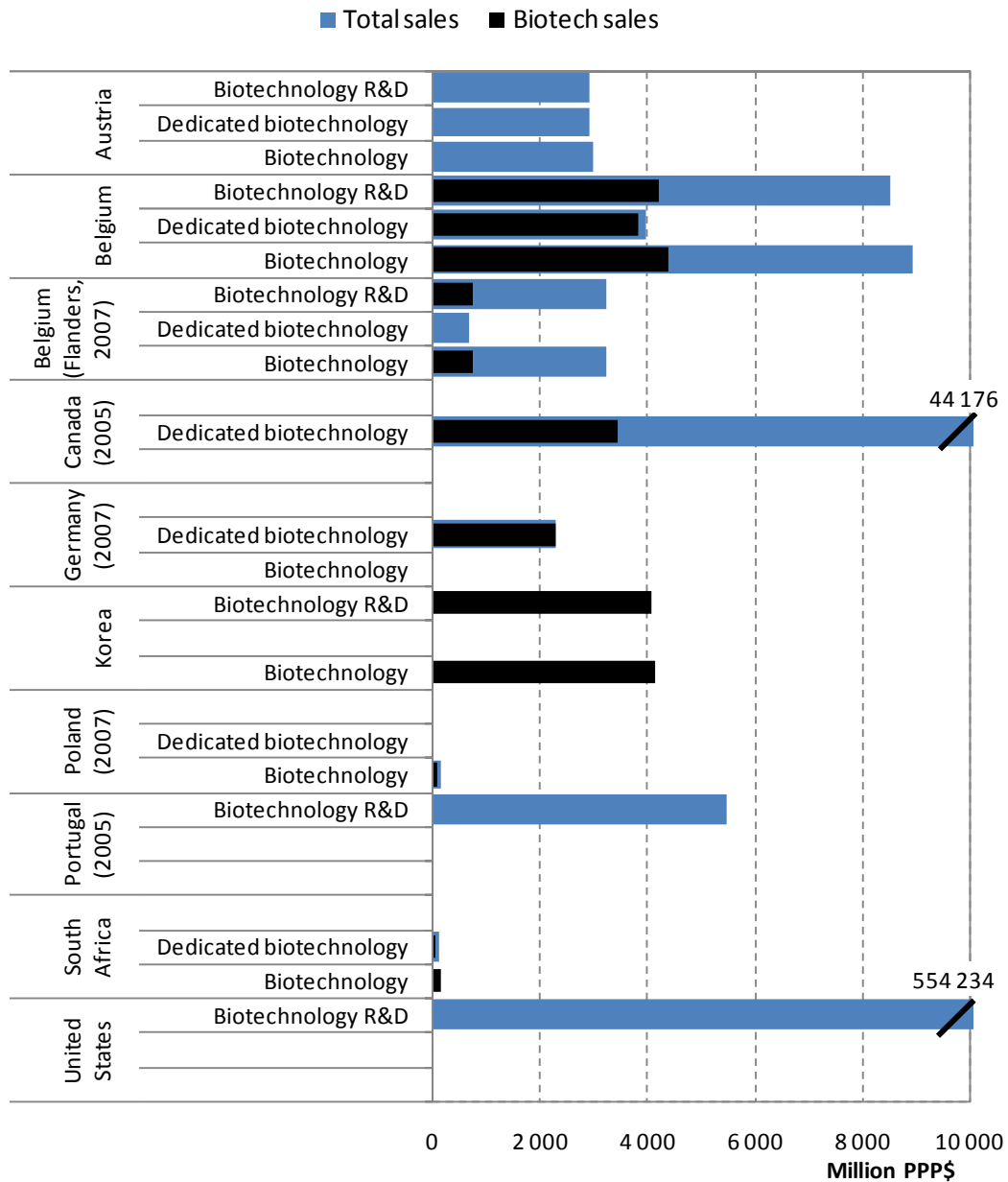
→ \* For those countries where dedicated biotechnology firm data were unavailable, biotechnology R&D firm data are used instead. These countries are marked with an asterisk (\*).

→ Germany classifies all sales in dedicated biotechnology firms as biotechnology sales.

Source: OECD, Biotechnology statistics database, January 2009.



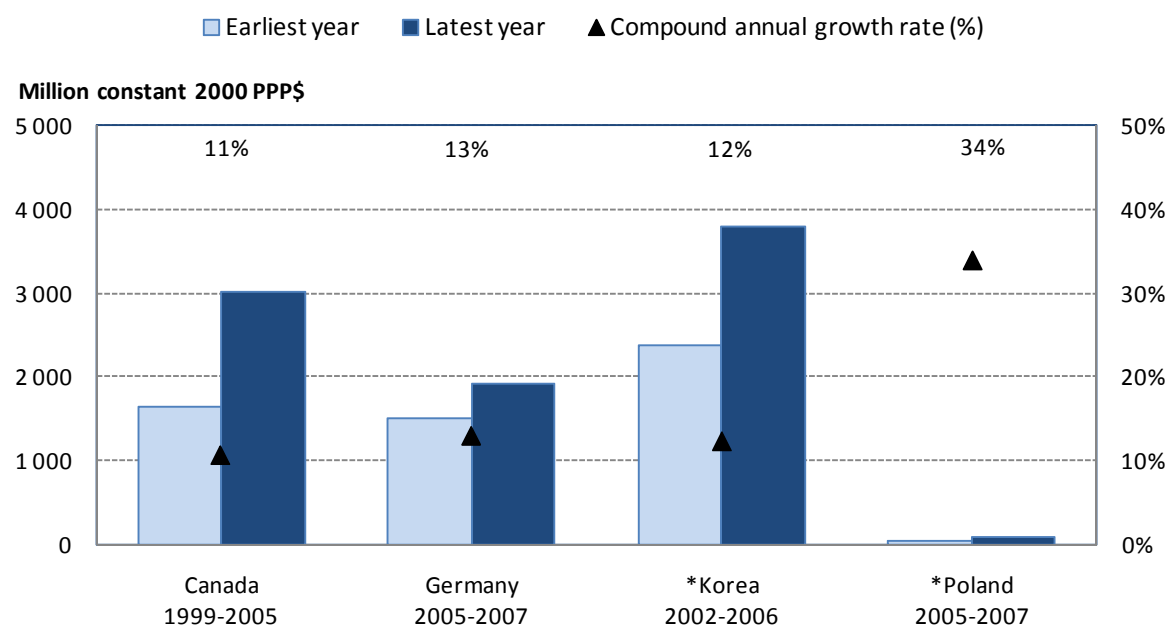
## 5.2. Total sales and biotechnology sales by type of biotechnology firm, Million PPP\$, 2006



→ Germany classifies all sales in dedicated biotechnology firms as biotechnology sales.

Source: OECD, Biotechnology statistics database, January 2009.

### 5.3. Biotechnology sales by dedicated biotechnology firms in million constant 2000 PPP\$



➔ \* For those countries where dedicated biotechnology firm data were unavailable, biotechnology firm data are used instead. These countries are marked with an asterisk (\*).

Source: OECD, Biotechnology statistics database, January 2009.

**Table 5.1. Sales by biotechnology firms**

Biotech firms			Total sales	Of which	% of biotech sales in total sales	Average sales per firm	Average biotech sales per firm
				Biotech sales (from biotech goods & services)			
						Million PPP\$	
Austria	2006	121	2 993	..	..	24.7	..
Belgium	2006	145	8 960	4 392	49%	61.8	30.3
Belgium (Flanders)	2007	73	3 266	763	..	44.7	..
Korea	2002	516	..	2 460	..	..	4.8
Korea	2003	572	..	2 613	..	..	4.6
Korea	2004	620	..	3 047	..	..	4.9
Korea	2005	685	..	3 513	..	..	5.1
Korea	2006	773	..	4 146	..	..	5.4
Poland	2005	11	170	52	30%	15.5	4.7
Poland	2006	11	127	86	68%	11.6	7.8
Poland	2007	11	161	97	60%	14.6	8.8
South Africa	2006	78	..	191	..	..	2.5

**Table 5.2. Sales by dedicated biotechnology firms**

Dedicated biotech firms			Total sales	Of which	% of biotech sales in total sales	Average sales per firm	Average biotech sales per firm
				Biotech sales (from biotech goods & services)			
			Million PPP\$		Million PPP\$		
Austria	2006	111	2 927	..	..	26.4	..
Belgium	2006	122	3 998	3 839	96%	32.8	31.5
Belgium (Flanders)	2007	53	692	692	100%	13.1	13.1
Canada	1999	358	15 729	1 636	10%	43.9	4.6
Canada	2001	375	21 962	2 742	12%	58.6	7.3
Canada	2003	490	25 118	3 128	12%	51.3	6.4
Canada	2005	532	44 176	3 461	8%	83.0	6.5
Germany	2005	480	1 723	1 723	100%	3.6	3.6
Germany	2006	495	1 994	1 994	100%	4.0	4.0
Germany	2007	496	2 297	2 297	100%	4.6	4.6
Poland	2005	3	1.981	0.437	22%	0.660	0.146
Poland	2006	4	1.129	1.103	98%	0.282	0.276
Poland	2007	3	0.424	0.424	100%	0.141	0.141
South Africa	2006	38	130	84	64%	3.4	2.2

→ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

→ Germany classifies all sales in dedicated biotechnology firms as biotechnology sales.

Source: OECD, Biotechnology statistics database, January 2009.

Table 5.3. Sales by biotechnology R&amp;D firms

Biotech R&D firms			Total sales	Of which	% of biotech sales in total sales	Average sales per firm	Average biotech sales per firm
				Biotech sales (from biotech goods & services)			
			Million PPP\$			Million PPP\$	
Austria	2006	77	2 930	..	..	38.0	..
Belgium	2006	136	8 552	4 235	50%	62.9	31.1
Belgium (Flanders)	2007	50	3 250	761	23%	65.0	15.2
Korea	2002	510	..	2 459	..	..	4.8
Korea	2003	528	..	2 579	..	..	4.9
Korea	2004	596	..	3 026	..	..	5.1
Korea	2005	638	..	3 489	..	..	5.5
Korea	2006	627	..	4 106	..	..	6.5
Portugal	2005	52	5 487	..	..	105.5	..
United States	2004	2 582	318 188	..	..	123.2	..
United States	2005	2 749	383 239	..	..	139.4	..
United States	2006	3 301	554 234	..	..	167.9	..

➔ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

Source: OECD, Biotechnology statistics database, January 2009.

**Table 5.4. Sales by biotechnology firms in million constant 2000 PPP\$**

Biotech firms			Of which		Biotech R&D per biotech firm	Biotech sales per biotech firm	% total R&D in total sales	% biotech R&D in biotech sales
			Total sales	Biotech sales				
			Million constant 2000 PPP\$		Million constant 2000 PPP\$			
Austria	2006	121	2 624.0	..	..	..	22%	..
Belgium	2006	145	7 958.7	3 900.6	3.864	26.901	13%	14%
Belgium (Flanders)	2007	73	2 835.9	662.5	7.406	9.076	55%	82%
Korea	2002	516	..	2 374.9	0.724	4.603	..	16%
	2003	572	..	2 538.8	0.730	4.439	..	16%
	2004	620	..	2 877.6	0.767	4.641	..	17%
	2005	685	..	3 302.0	0.826	4.820	..	17%
	2006	773	..	3 782.5	0.837	4.893	..	17%
Poland	2005	11	154.5	46.9	0.396	4.268	5%	9%
	2006	11	113.5	77.0	0.455	7.000	8%	7%
	2007	11	140.1	84.3	0.698	7.661	8%	9%
Spain	2004	280	..	..	0.630	..	..	..
	2005	477	..	..	0.467	..	..	..
	2006	659	..	..	0.476	..	..	..
South Africa	2006	78	..	163.7	..	2.099	..	..

**Table 5.5. Sales by dedicated biotechnology firms in million constant 2000 PPP\$**

Dedicated biotech firms			Of which		Biotech R&D per biotech firm	Biotech sales per biotech firm	% total R&D in total sales	% biotech R&D in biotech sales
			Total sales	Biotech sales				
			Million constant 2000 PPP\$		Million constant 2000 PPP\$			
Austria	2006	111	2 566.6	..	..	..	19%	..
Belgium	2006	122	3 550.7	3 409.7	3.103	27.948	11%	11%
Belgium (Flanders)	2007	53	600.9	600.9	5.103	11.337	45%	45%
Canada	1999	358	15 814.3	1 644.8	1.960	4.594	6%	43%
	2001	375	21 445.5	2 677.4	2.669	7.140	8%	37%
	2003	490	23 693.2	2 950.5	2.331	6.021	7%	39%
	2005	532	38 589.1	3 023.7	2.305	5.684	5%	41%
Germany	2005	480	1 504.9	1 504.9	1.455	3.135	46%	46%
	2006	495	1 713.3	1 713.3	1.908	3.461	55%	55%
	2007	496	1 921.8	1 921.8	2.021	3.875	52%	52%
Poland	2005	3	1.8	0.4	0.062	0.132	10%	47%
	2006	4	1.0	1.0	0.068	0.246	27%	28%
	2007	3	0.4	0.4	0.094	0.123	77%	77%
Spain	2004	83	..	..	1.259	..	..	..
	2005	133	..	..	1.104	..	..	..
	2006	211	..	..	1.143	..	..	..
South Africa	2006	38	110.9	71.5	0.427	1.881	..	23%

- The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.
- Germany classifies all sales in dedicated biotechnology firms as biotechnology sales.

Source: OECD, Biotechnology statistics database, January 2009.

Table 5.6. Sales by biotechnology R&amp;D firms in million constant 2000 PPP\$

		Biotech R&D active firms	Total sales	Of which Biotech sales	Biotech R&D per biotech firm	Biotech sales per biotech firm	% total R&D in total sales	% biotech R&D in biotech sales
			Million constant 2000 PPP\$		Million constant 2000 PPP\$			
Austria	2006	77	2 568.6	..	..	..	23%	..
Belgium	2006	136	7 595.9	3 761.9	3.750	27.661	13%	14%
Belgium (Flanders)	2007	50	2 822.4	660.5	10.813	13.211	55%	82%
Czech Republic	2007	82	..	..	0.872	..	..	..
Finland	2007	141	..	..	0.720	..	..	..
France	2003	755	..	..	1.611	..	..	..
	2004	796	..	..	1.653	..	..	..
	2005	720	..	..	2.539	..	..	..
	2006	824	..	..	2.453	..	..	..
Ireland	2005	100	..	..	2.529	..	..	..
Italy	2002	161	..	..	1.374	..	..	..
	2003	175	..	..	1.091	..	..	..
	2004	155	..	..	1.533	..	..	..
	2005	124	..	..	2.355	..	..	..
	2006	146	..	..	1.546	..	..	..
Korea	2002	510	..	2 374.6	0.732	4.656	..	16%
	2003	528	..	2 505.4	0.791	4.745	..	17%
	2004	596	..	2 857.9	0.798	4.795	..	17%
	2005	638	..	3 279.7	0.886	5.141	..	17%
	2006	627	..	3 745.9	1.032	5.974	..	17%
Norway	2005	173	..	..	0.669	..	..	..
Portugal	2005	52	4 745.1	..	0.219	..	1%	..
Slovak Republic	2005	27	..	..	0.967	..	..	..
	2006	27	..	..	0.405	..	..	..
Spain	2004	278	..	..	0.634	..	..	..
	2005	375	..	..	0.594	..	..	..
	2006	467	..	..	0.672	..	..	..
Sweden	2007	113	..	..	3.846	..	..	..
Switzerland	2004	156	..	..	2.792	..	..	..
United States	2004	2 582	290 639.4	..	6.223	..	9%	..
	2005	2 749	338 995.2	..	7.415	..	10%	..
	2006	3 301	474 968.4	..	6.517	..	8%	..
Slovenia	2006	4	..	..	2.495	..	..	..

Table 5.7. Biotechnology sales growth (compound annual growth rates)

	Biotech firms	Dedicated biotech firms
	Compound annual growth rates	
Canada (1999-2005)	..	11%
Germany (2005-2007)	..	13%
Korea (2002-2006)	12%	..
Poland (2005-2007)	34%	..

→ The data for 'biotech firms' are from biotechnology firm surveys while the data for 'biotech R&D firms' are from R&D surveys.

Source: OECD, Biotechnology statistics database, January 2009.

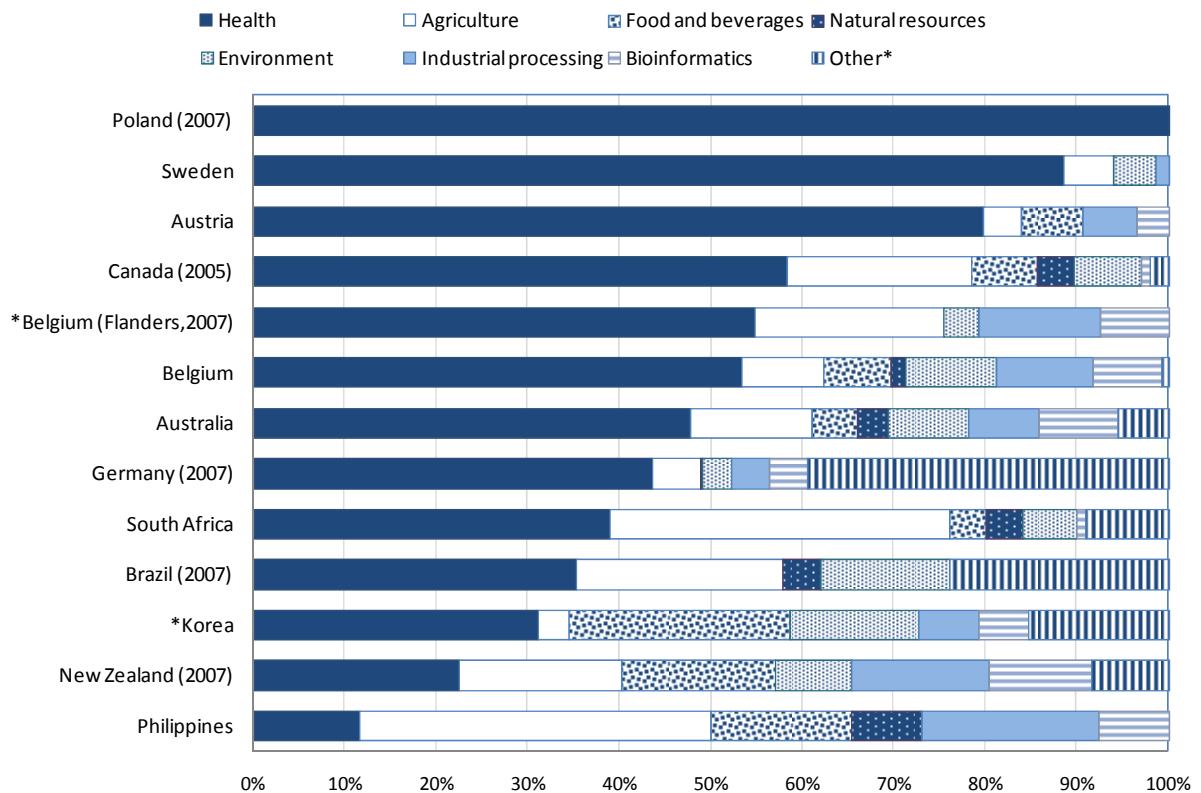


## 6. Biotechnology applications

- Biotechnology has applications in many fields, including health (human and animal), agriculture, food and beverages processing, natural resources, environment, industrial processing, and bioinformatics. In addition, an “other” category mostly covers platform biotechnologies and minor applications that are not included in the seven main categories.
  - Data are available by application field for the number of firms, R&D investments, employment and sales.
  - The charts show only application data for dedicated biotechnology firms as their predominant activity involves the application of biotechnology techniques to produce goods or services and/or to perform biotechnology R&D.
  - Of note, application data are not available for several OECD countries with substantial business sector capabilities in biotechnology, including Denmark, Japan and the United Kingdom.
  - Several countries provided biotechnology data by industrial sector. These results are captured by the R&D surveys. However, these data are not compatible with application data and are therefore not included below. A major problem is that it is impossible to determine the application field for biotechnology firms assigned to the services sector.
- Number of firms by application**
- Data on the number of dedicated biotechnology firms active in each application are available for 11 countries plus Flanders (Belgium). As dedicated biotechnology firm data were unavailable for Korea, biotechnology firm data were used instead.
  - Firms can be active in more than one application field. For eight countries and one region each firm was assigned to a primary application, while in four countries firms could report activity in more than one field. For the latter, the results are the percentage of the total number of ‘reports’ in each application field. The data tables at the end of the Chapter provide the actual counts.
  - For all countries combined, 45% of firms are active in health, followed by 11% of firms active in agriculture, 10% active in food and beverages processing, 8% in environment, 6% in industrial processing, 5% in bioinformatics, 2% in natural resources, and 13% in the “other” category.
  - For five countries, firms in health applications made up over 50% of all biotechnology firms: Poland (100%), Sweden (89%), Austria (80%), Canada (58%) and Belgium (53%).
  - In Germany, 39.5% of firms are in the “other” category, which includes platform technologies and services. Many of these firms could be active in health applications.
  - The Philippines, South Africa and Brazil lead all other countries in the share of biotechnology firms active in agriculture, at 38%, 37%, and 23% respectively. The share for agricultural applications is less than 10% in Belgium (9%), Germany (5%), Sweden (5%) and Austria (4%).
  - The share of biotechnology firms in food and beverages processing is highest in New Zealand (17%), followed by the Philippines (15%). Four countries had no dedicated biotechnology firms in food and beverages processing: Brazil, Germany, Poland and Sweden. The share of Korean biotechnology firms active in food and beverages processing is 24%, but this includes all biotechnology firms and not just dedicated biotechnology firms, as for other countries.



### 6.1. Share of dedicated biotechnology firms by application, 2006



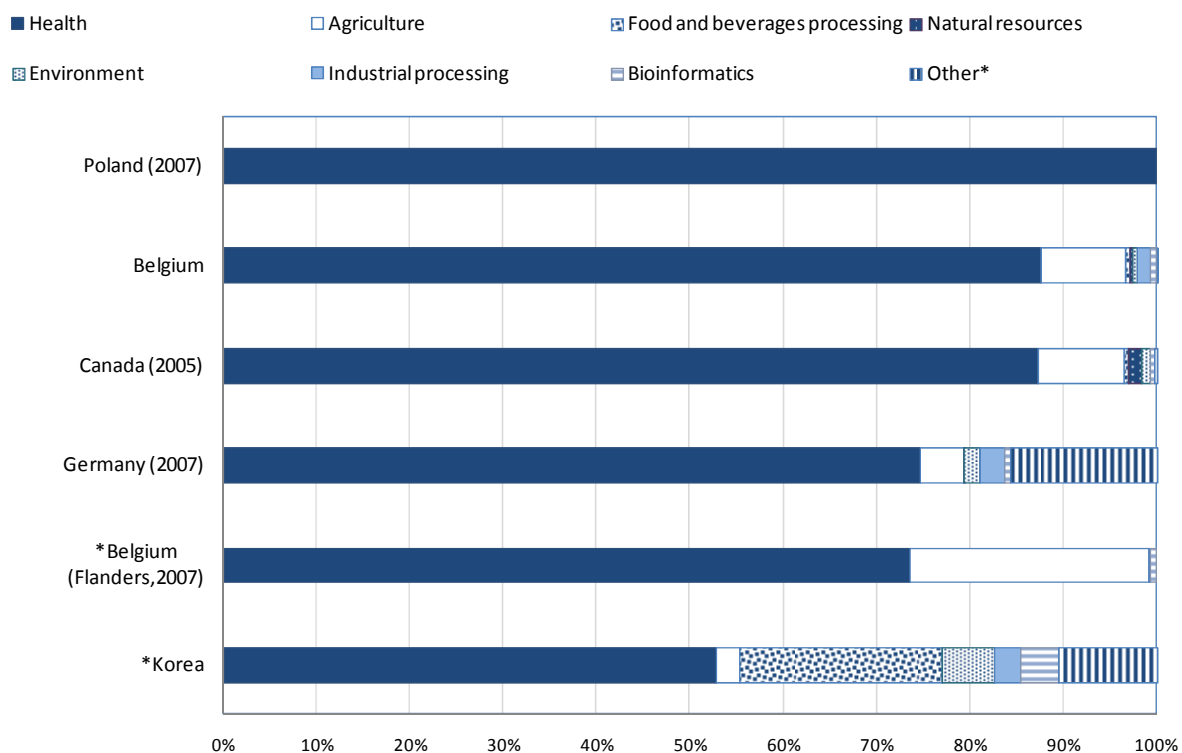
- ➔ Results limited to dedicated biotechnology firms, except for biotechnology firms for Korea.
- ➔ \* For Belgium (Flanders), "Agriculture" includes "Food and beverages processing".
- ➔ \* For Korea, "Agriculture" includes "Natural resources".
- ➔ For a list of applications included in "Other", see Table 6.1.

Source: OECD, Biotechnology statistics database, January 2009.

**Biotechnology R&D by application**

- Data on R&D expenditures by application field by dedicated biotechnology firms are available for four countries plus Flanders (Belgium). As dedicated biotechnology firm data was unavailable for Korea, biotechnology firm data was used instead.
- Total biotechnology R&D for the five countries combined is USD 3 738 million PPP. Of note, this represents only 11% of the total biotechnology R&D expenditures by firms in the 19 countries for which data are available (see Chapter 3. on Biotechnology R&D).
- Health applications dominate biotechnology R&D. Approximately 77% of all estimated biotechnology R&D expenditures in the five countries are for health applications, 6% for agriculture, 4% for food and beverages processing, 2% in environment, 1.5% in industrial processing, 1.2% in bioinformatics, 0.6% in natural resources and 7% for "other" applications.
- In Poland, all of biotechnology R&D was attributed to health applications (100%). Almost 90% of biotechnology R&D is for health applications in Belgium (87.7%) and in Canada (87.3%). In Germany 75% of biotechnology R&D was attributed to health applications. The lowest share is in Korea (53%), but this may be because the data are classified according to the Korean Bio-industry Classification, a classification which is not totally compatible with the OECD application field classification.
- Belgium and Canada have the highest share of biotechnology R&D investment on agricultural applications (9%), followed by Germany (5%).
- Natural resources applications get the smallest share of all biotechnology R&D investments in most countries. In Korea, R&D on natural resources cannot be identified separately as it is combined with agriculture.
- Biotechnology R&D investments in the "other" category are quite significant in Germany (16%) and Korea (10%). The "other" category covers application fields not included in the seven main categories. In Germany, the "other" category includes non-specific services, i.e. firms that provide platform tools or services using modern biotechnology to other firms without a specific product development in any of the defined fields (such as health, agriculture etc.). In Korea, the "other" category includes biochemicals and bioelectronics.
- Average biotechnology R&D invested per dedicated biotechnology firm was highest for the health sector in every country. The average biotechnology R&D per dedicated biotechnology firm in the health sector is highest in Flanders (Belgium) with USD 7.9 million PPP, followed by Germany with USD 4.1 million PPP, and Canada with USD 4.0 million PPP. In Korea, the average is USD 1.6 million PPP per firm; however these results are for all biotechnology firms.

## 6.2. Share of biotechnology R&amp;D by application, 2006



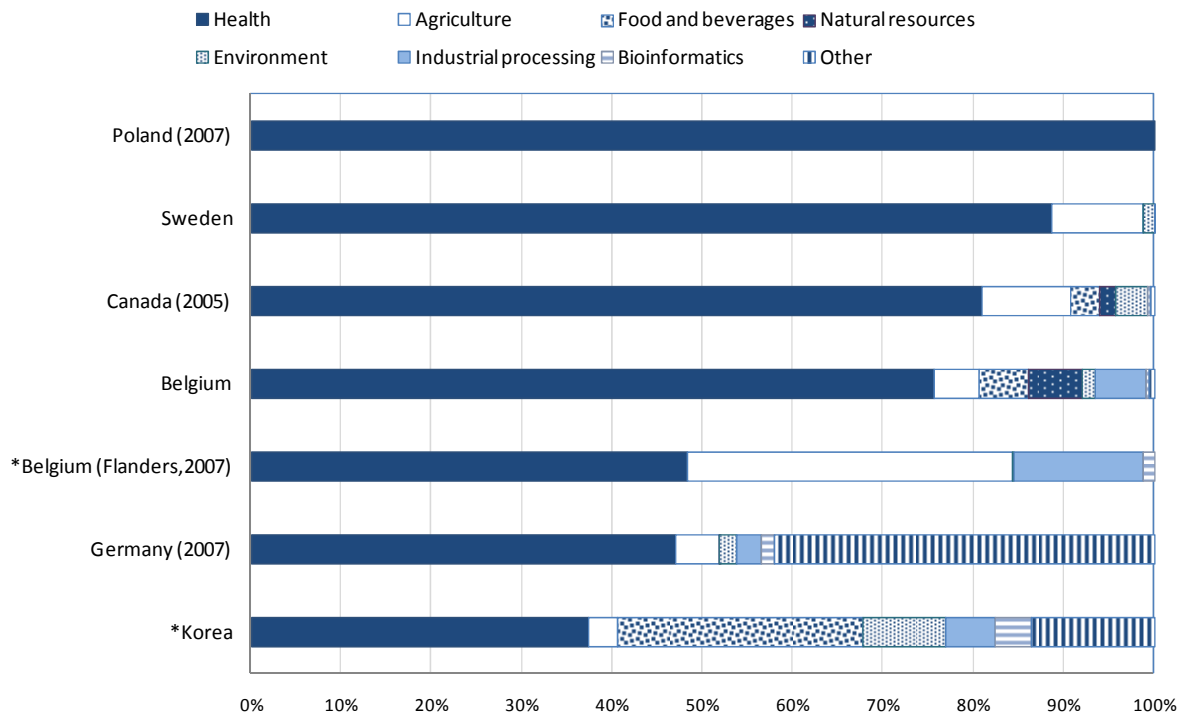
- ➔ Results limited to dedicated biotechnology firms, except for biotechnology firms for Korea.
- ➔ \* For Belgium (Flanders), "Agriculture" includes "Food and beverages processing".
- ➔ \* For Korea, "Agriculture" includes "Natural resources".
- ➔ For a list of applications included in "Other", see Table 6.1.

Source: OECD, Biotechnology statistics database, January 2009.

***Biotechnology employment by application***

- Data on biotechnology employment by application field in dedicated biotechnology firms are available for five countries plus Flanders (Belgium). The results refer to personnel actively involved in biotechnology tasks. As dedicated biotechnology firm data were unavailable for Korea, biotechnology firm data are used instead.
- Biotechnology employment data are headcount data for Canada, Germany, Korea and Poland and full-time equivalents (FTE) data for Belgium and Sweden.
- Total biotechnology employment for the six countries, for all employment categories combined is 58 803. Approximately 48% of these are biotechnology R&D employees, based on data for the five countries for which complete data are available (excluding Sweden).
- For the six countries combined, 60% of employment is in health applications, 9% in food and beverages processing, 6% in agriculture, 4% in environment, 3% in industrial processing, 2% in bioinformatics, 1% in natural resources, and 14% in "other" applications.
- The share of biotechnology employment in health applications is 75% or greater in Belgium (76%), Canada (81%), Sweden (89%) and Poland (100%).
- In Canada, Sweden and Flanders (Belgium), agriculture had the second largest share of biotechnology employees: 10% for Canada and Sweden and 36% for Flanders.
- In Belgium, four application fields had very similar employment shares: natural resources (6%), Industrial processing (5.6%), food and beverages (5.5%) and agriculture (5.0%).
- Biotechnology employment in the "other" category is quite significant in Germany (42%) and Korea (14%). The "other" category in Germany includes non-specific services, i.e. firms that provide platform tools or services using modern biotechnology to other firms without a specific product development in any of the defined fields (such as health, agriculture etc.). In Korea, the "other" category includes biochemicals and bioelectronics.

### 6.3. Share of biotechnology employees by application, 2006



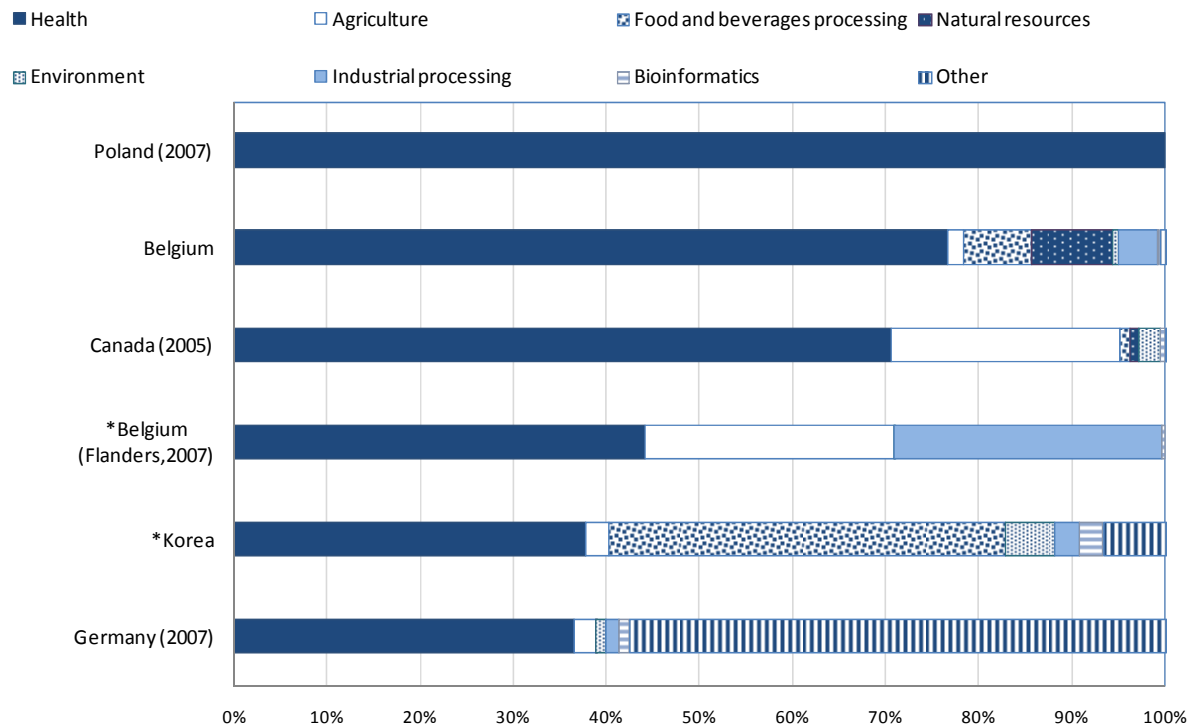
- ➔ Results limited to dedicated biotechnology firms, except for biotechnology firms for Korea.
- ➔ \* For Belgium (Flanders), "Agriculture" includes "Food and beverages processing".
- ➔ \* For Korea, "Agriculture" includes "Natural resources".
- ➔ For a list of applications included in "Other", see Table 6.1.

Source: OECD, Biotechnology statistics database, January 2009.

***Biotechnology sales by application***

- Data on sales of biotechnology goods and services by application field in dedicated biotechnology firms are available for four countries plus Flanders (Belgium). As dedicated biotechnology firm data were unavailable for Korea, biotechnology firm data are used instead.
- Total biotechnology sales for the five countries combined is USD 13 744 million PPP.
- As with the other results by application, health applications account for the largest share of biotechnology sales with 57%, followed by food and beverages at 15% and agriculture at 8%.
- The share of sales from health applications of biotechnology is above 50% in three countries: Poland (100%), Belgium (77%) and Canada (71%).
- The share of sales from food and beverages processing ranges from 43% in Korea (biotechnology firms) to 1% in Canada, with 0% for both Poland and Germany.
- The agricultural sales share is highest in Canada with 25% of total biotechnology sales. In Belgium, Germany and Korea agricultural sales constitute approximately 2% of total biotechnology sales.
- In Germany, the "other" category constitutes the largest sales category with 57% of all biotechnology sales.
- Average sales per dedicated biotechnology firm in the health sector was highest in Belgium with USD 45 million PPP, followed by Canada with USD 8 million PPP, Korea (per biotechnology firm) with USD 7 million PPP and Germany with USD 4 million PPP.

## 6.4. Share of biotechnology sales by application, 2006



- ➔ Results limited to dedicated biotechnology firms, except for biotechnology firms for Korea.
- ➔ \* For Belgium (Flanders), "Agriculture" includes "Food and beverages processing".
- ➔ \* For Korea, "Agriculture" includes "Natural resources".
- ➔ For a list of applications included in "Other", see Table 6.1.

Source: OECD, Biotechnology statistics database, January 2009.

Table 6.1. Biotechnology firms by application

		Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total biotech firms
Australia*	2006	353	185	0	22	85	90	84	48	527
Austria	2006	101	7	9	1	2	12	5	0	121
Belgium	2006	75	15	14	3	15	14	9	0	145
Belgium (Flanders)	2007	33	14	x	0	6	15	5	0	73
Germany	2005	252	38	0	1	21	25	15	187	539
Germany	2006	247	42	0	1	21	25	18	197	551
Germany	2007	258	59	0	1	18	30	20	201	587
Korea	2002	154	48	112	x	63	29	33	77	516
Korea	2003	178	16	146	x	74	47	30	81	572
Korea	2004	179	21	157	x	87	49	33	94	620
Korea	2005	220	23	151	x	96	47	42	106	685
Korea	2006	241	25	187	x	109	51	42	118	773
New Zealand*	2005	48	45	45	NA	18	27	15	15	87
New Zealand*	2007	72	63	66	NA	33	48	39	27	135
Poland	2005	9	1	0	0	0	0	0	1	11
Poland	2006	7	2	0	0	1	0	0	1	11
Poland	2007	8	1	0	0	1	0	1	0	11
Philippines*	2006	4	19	6	6	1	9	2	0	25
South Africa	2006	76	0	0.08	1	0.16	0	0.08	0	78

Table 6.2. Dedicated biotechnology firms by application

		Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total dedicated biotech firms
Australia*	2006	287	80	30	20	53	46	52	33	384
Austria*	2006	94	5	8	0	0	7	4	0	111
Belgium	2006	65	11	9	2	12	13	9	1	122
Belgium (Flanders)	2007	29	11	x	0	2	7	4	0	53
Canada	1999	150	90	28	18	35	0	18	19	358
Canada	2001	197	65	48	10	33	0	11	11	375
Canada	2003	262	86	52	21	38	0	16	15	490
Canada	2005	310	107	39	21	39	0	5	11	532
Germany	2005	222	24	0	1	19	16	15	183	480
Germany	2006	218	28	0	1	19	17	18	194	495
Germany	2007	216	26	0	1	16	21	20	196	496
New Zealand*	2005	39	42	36	NA	12	21	15	12	66
New Zealand*	2007	72	57	54	NA	27	48	36	27	120
Poland	2005	3	0	0	0	0	0	0	0	3
Poland	2006	3	0	0	0	0	0	0	1	4
Poland	2007	3	0	0	0	0	0	0	0	3
Sweden	2006	131	8	0	0	7	2	0	0	148
Brazil	2007	25	16	0	3	10	0	0	17	71
Philippines*	2006	3	10	4	2	0	5	2	0	13
South Africa	2006	15	14	2	2	2	0	0	3	38

➔ \* Multiple selection: Firms can be active in more than one application field.

➔ X For Belgium (Flanders): "Agriculture" includes "Food and beverages processing" and for Korea: "Agriculture" includes "Natural resources". NA = Not available.

➔ Other: Australia, Other: Self-identified as "other"; Canada, Other: includes aquaculture and "other"; Germany, Other: includes non-specific services, i.e. firms that provide tools or services using modern biotechnology for other (biotech, pharma, etc...) firms without a specific product development in any of the defined fields (such as health, agriculture etc.); New Zealand, Other: includes Biodiscovery; Chemical genetics; Plant transgenics; Invitro drug assays; Epigenetics / epigenomics; Microarrays; Spectra analysis of blood; Medical devices; Protein purification; Antibodies; Microparticles; Virus screening; Breath VOC measurement; Biodegradable resins; Manufacturing process; Enzyme induced chemical reactions; Envirogenomics; Antifouling; Formulation; Insulin infusion protocols; Bioactives; Computer modelling and imaging; Synthesis of glycotherapeutics; Formulation; Surgical measurement equipment; Protein chromatography; Microbial detection; Micro encapsulation; Forensic science DNA profile; Poland, Other: includes reagents based on biotechnological principles in research; Brazil, Other: includes reagents and "other"; South Africa, Other: includes non-food and "other".

Source: OECD, Biotechnology statistics database, January 2009.



Table 6.3. Biotechnology R&amp;D in biotechnology firms by application

Total biotech firms			Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total biotech R&D expenditures
			Million PPP\$								Million PPP\$
Belgium	2006	148	516.1	39.1	6.8	1.5	1.7	6.0	2.8	0.2	574.2
Belgium (Flanders)	2007	73	517.1	80.2	x	0.0	0.5	23.0	2.0	0.0	622.6
Korea	2002	516	192.3	23.1	79.5	x	14.8	7.1	21.0	48.9	386.6
Korea	2003	572	215.2	15.8	81.0	x	16.7	15.6	20.2	65.2	429.7
Korea	2004	620	250.8	11.8	104.6	x	23.2	13.2	20.5	79.5	503.7
Korea	2005	685	307.3	16.1	123.4	x	32.6	16.0	24.9	81.3	601.6
Korea	2006	773	374.7	18.2	153.7	x	39.1	20.4	28.9	74.1	709.3
Poland	2005	11	2.1	2.7	0.0	0.0	0.0	0.0	0.0	0.1	4.8
Poland	2006	11	3.0	2.5	0.0	0.0	0.1	0.0	0.0	0.1	5.6
Poland	2007	11	6.0	2.6	0.0	0.0	0.1	0.0	0.1	0.0	8.8

Table 6.4. Biotechnology R&amp;D in dedicated biotechnology firms by application

Total dedicated biotech firms			Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total biotech R&D expenditures
			Million PPP\$								Million PPP\$
Belgium	2006	122	373.7	38.3	2.3	1.5	1.5	6.0	2.8	0.1	426.3
Belgium (Flanders)	2007	53	229.3	79.5	x	0.0	0.0	0.7	2.0	0.0	311.5
Canada	1999	358	590.4	55.4	5.9	23.5	2.5	0.0	16.8	3.4	697.8
Canada	2001	375	886.0	54.2	39.4	10.7	14.0	0.0	17.2	3.3	1 024.8
Canada	2003	490	1 071.4	53.7	18.7	10.6	30.1	0.0	21.2	4.9	1 210.7
Canada	2005	532	1 226.1	128.5	8.2	19.8	11.5	0.0	7.4	2.5	1 404.0
Germany	2005	480	659.2	31.7	0.0	0.1	3.0	4.6	12.6	88.7	799.9
Germany	2006	495	858.7	40.0	0.0	0.1	7.3	10.5	14.6	168.1	1 099.2
Germany	2007	496	894.9	56.2	0.0	0.1	21.2	30.7	7.1	188.0	1 198.2
Poland	2005	3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Poland	2006	4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
Poland	2007	3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3

→ x For Belgium (Flanders): "Agriculture" includes "Food and beverages processing" and for Korea: "Agriculture" includes "Natural resources".

Table 6.5. Biotechnology employment in biotechnology firms by application

		Total biotech firms	Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total Biotech Employees	Total Biotech R&D Employees
Belgium	2006	145	7 673	533	663	520	147	488	29	0	10 053	3 142 FTE
Belgium (Flanders)	2007	73	2 742	1 403	x	0	73	794	47	0	5 059	2 975 FTE
Germany	2005	539	16 138	1 357	0	6	232	1 126	297	4 721	23 877	.. HC
Germany	2006	551	19 657	1 909	0	6	356	1 160	263	5 600	28 950	.. HC
Germany	2007	587	19 594	2 001	0	5	313	1 340	193	6 124	29 570	.. HC
Korea	2002	516	3 342	678	2 084	x	561	374	477	1 088	8 604	5 030 HC
Korea	2003	572	4 248	294	2 624	x	719	633	502	1 465	10 485	5 773 HC
Korea	2004	620	4 338	407	3 471	x	983	644	531	1 733	12 107	6 592 HC
Korea	2005	685	5 238	457	3 550	x	1 189	675	711	1 998	13 818	7 399 HC
Korea	2006	773	6 379	556	4 633	x	1 567	933	684	2 314	17 066	8 629 HC
Poland	2005	11	465	96	0	0	0	0	0	7	568	568 HC
Poland	2006	11	429	109	0	0	11	0	0	2	550	550 HC
Poland	2007	11	435	93	0	0	7	0	6	0	541	541 HC

Table 6.6. Biotechnology employment in dedicated biotechnology firms by application

		Total dedicated biotech firms	Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total Biotech Employees	Total Biotech R&D Employees
Belgium	2006	122	6 568	436	478	520	131	488	29	42	8 693	2 529 FTE
Belgium (Flanders)	2007	53	1 732.0	1 291.0	x	0.0	4.0	515.3	43.0	0.0	3 585.3	2 073 FTE
Canada	1999	358	5 487	985	338	149	323	0	227	240	7 749	2 342 HC
Canada	2001	375	8 699	1 249	973	C	727	0	C	C	11 897	5 852 HC
Canada	2003	490	9 255	1 085	747	120	246	0	244	166	11 863	6 441 HC
Canada	2005	532	10 866	1 317	438	240	479	0	38	55	13 433	7 065 HC
Germany	2005	480	7 018	615	0	6	197	252	297	4 636	13 021	6 134 HC
Germany	2006	495	7 124	664	0	6	319	250	263	5 525	14 150	6 463 HC
Germany	2007	496	6 749	691	0	5	273	405	193	6 044	14 360	7 240 HC
Poland	2005	3	14	0	0	0	0	0	0	0	14	14 HC
Poland	2006	4	14	0	0	0	0	0	0	3	17	17 HC
Poland	2007	3	11	0	0	0	0	0	0	0	11	11 HC
Sweden	2006	148	4 644	529	0	0	60	7	0	0	5 240	.. FTE

→ FTE: Full-time equivalents, HC: headcount.

→ \* For Belgium (Flanders): "Agriculture" includes "Food and beverages processing" and for Korea: "Agriculture" includes "Natural resources".

**Table 6.7. Biotechnology sales in biotechnology firms by application**

Total biotech firms			Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total Biotech Sales	Total Sales
			Million PPP\$								Million PPP\$	
Belgium (Flanders)	2007	73	305.7	191.8	x	0.0	18.8	245.1	1.7	0.0	763.0	3 266.0
Korea	2002	516	752.9	57.7	1 229.4	x	112.4	72.5	96.4	138.2	2 459.5	..
Korea	2003	572	1 013.7	33.7	968.5	x	109.0	62.5	54.2	371.7	2 613.4	..
Korea	2004	620	1 078.6	57.0	1 413.2	x	143.3	101.9	64.7	188.5	3 047.2	..
Korea	2005	685	1 295.0	73.9	1 512.3	x	186.6	115.8	87.9	241.5	3 512.9	..
Korea	2006	773	1 571.6	100.5	1 770.7	x	216.2	111.5	103.5	272.3	4 146.2	..
Poland	2005	11	47.1	3.3	0.0	0.0	0.0	0.0	0.0	1.3	51.7	170.3
Poland	2006	11	81.0	3.4	0.0	0.0	1.7	0.0	0.0	0.2	86.3	127.2
Poland	2007	11	89.0	3.9	0.0	0.0	2.1	0.0	1.6	0.0	96.7	160.7

**Table 6.8. Biotechnology sales in dedicated biotechnology firms by application**

Total dedicated biotech firms			Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other	Total Biotech Sales	Total Sales
			Million PPP\$								Million PPP\$	
Belgium	2006	122	2 947.6	64.8	277.9	335.6	27.0	160.5	3.5	22.0	3 838.8	3 997.5
Belgium (Flanders)	2007	53	305.7	185.3	x	0.0	0.1	199.2	1.7	0.0	692.0	692.0
Canada	1999	358	870.0	440.0	155.4	94.9	37.8	0.0	16.8	21.0	1 635.9	15 728.8
Canada	2001	375	1 835.3	162.6	514.1	C	219.3	0.0	C	C	2 741.9	21 962.3
Canada	2003	490	1 627.5	382.7	1 029.1	38.3	29.3	0.0	9.8	11.4	3 128.0	25 118.4
Canada	2005	532	2 445.0	852.0	40.4	33.0	75.8	0.0	12.4	3.3	3 461.8	44 176.1
Germany	2005	480	918.2	39.2	0.0	0.4	11.6	14.8	36.0	703.0	1 723.1	1 723.1
Germany	2006	495	845.3	50.1	0.0	0.3	13.0	16.6	38.5	1 030.7	1 994.5	1 994.5
Germany	2007	496	841.0	55.1	0.0	0.3	23.9	33.3	22.5	1 320.8	2 297.0	2 297.0
Poland	2005	3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.0
Poland	2006	4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.1	1.1
Poland	2007	3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4

→ X For Belgium (Flanders): "Agriculture" includes "Food and beverages processing" and for Korea: "Agriculture" includes "Natural resources".

Source: OECD, Biotechnology statistics database, January 2009.

**Table 6.9. Average biotechnology R&D investment per firm by application, 2006**

Total dedicated biotech firms			Health	Agriculture	Food and beverages processing	Natural resources	Environment	Industrial processing	Bioinformatics	Other
			Million PPP\$							
Belgium	2006	122	5.7	3.5	0.3	0.8	0.1	0.5	0.3	0.1
Belgium (Flanders)	2007	53	7.9	7.2	x		0.0	0.1	0.5	
Canada	2005	532	4.0	1.2	0.2	0.9	0.3		1.5	0.2
Germany	2007	496	4.1	2.2	0.0	0.1	1.3	1.5	0.4	1.0
Biotech firms										
Korea	2006	773	1.6	0.7	0.8	x	0.4	0.4	0.7	0.6

➔ X For Belgium (Flanders): "Agriculture" includes "Food and beverages processing" and for Korea: "Agriculture" includes "Natural resources". NA = Not available.

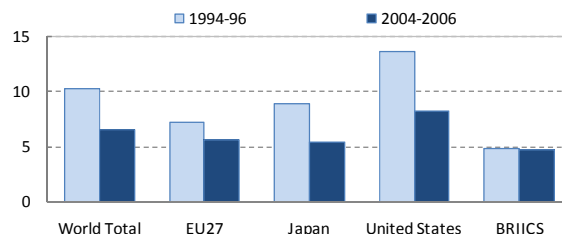
Source: OECD, Biotechnology statistics database, January 2009.



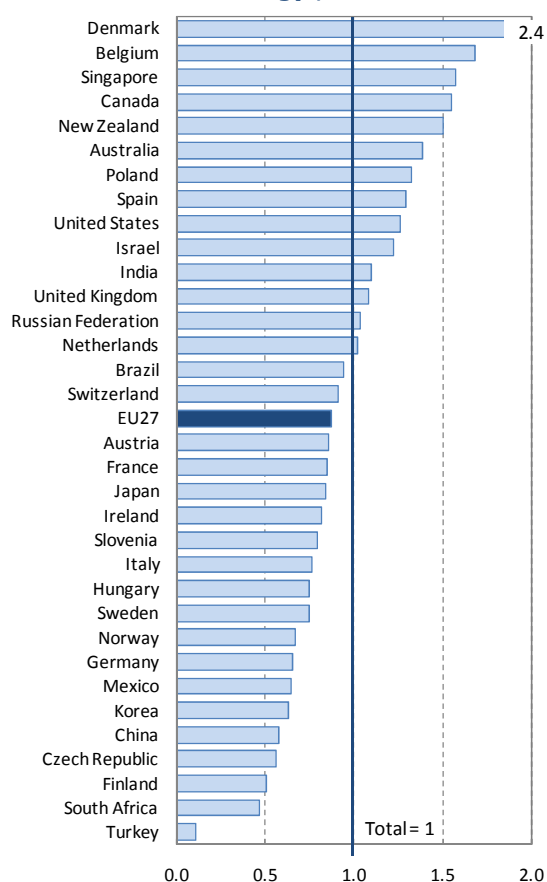
## 7. Biotechnology patents

- Biotechnology patents are identified using the International Patent Classification (IPC) system: one or several classification codes are attributed to the patent during the examination process. For emerging technologies, however, a specific category or class might not yet be incorporated into the patent classification system, which means that some biotechnology patent applications could be missed.
- Biotechnology patents are identified using the following list of IPC codes: A01H1/00, A01H4/00, A61K38/00, A61K39/00, A61K48/00, C02F3/34, C07G(11/00,13/00,15/00), C07K(4/00,14/00,16/00,17/00,19/00), C12M, C12N, C12P, C12Q, C12S, G01N27/327, G01N33/(53\*,54\*,55\*,57\*,68,74,76,78,88,92)]. For further details on the IPC, 8th edition, see: <http://www.wipo.int/classifications/ipc/ipc8/?lang=en>.
- The results in this Chapter are based on biotechnology patent applications filed under the Patent Co-operation Treaty (PCT). The PCT offers applicants the possibility to seek patent rights in a large number of countries by filing a single international application with a single patent office (receiving office). Applicants have an additional 18 months to decide whether to seek a national or regional patent e.g. at the European Patent Office (EPO) and if they so wish, they must do so within 30 months of the priority date (date of the first filing of the patent worldwide). Data on the number of PCT patent applications are more internationally comparable because they avoid home country advantages and cover inventions that are potentially worth patenting in more than one country (*OECD Patent Statistics Manual*, 2009).
- After steady growth in the 1990s, the number of biotechnology patent applications filed under the PCT decreased from more than 11 500 applications in 2000 to 8 700 in 2006 (-4.6% per year). Conversely, the total number of PCT patent applications increased by an average of 5.7% per year from 2000 to 2006.
- The surge in biotechnology patents in the late 1990s was partly due to patent applications pertaining to the human genome, while the recent decrease is often explained by more stringent criteria for granting patents on genetic material. Consequently, the relative weight of biotechnology in all international patent filings decreased between the mid-1990s and the early 2000s in many countries. On average, biotechnology patents represented 6.5% of countries' patent portfolios over 2004-06, compared to 10.3% in the mid 1990s.

### 7.1. Share of biotechnology PCT patent applications out of total PCT patent applications Percent



### 7.2. Revealed technological advantage in biotechnology<sup>1</sup>, 2004-06



→ Patent counts are based on the priority date, the inventor's country of residence and use fractional counts on PCT filings at international phase (EPO designations). BRIICS refers to Brazil, China, India, Indonesia, Russian Federation and South Africa.

1. Share of PCT biotechnology patent applications out of the total PCT patent applications for each country relative to the share of all PCT biotechnology patent applications out of the total number of all PCT patent applications. Only countries with more than 250 PCT patent applications between 2004 and 2006 are presented in the chart.

Sources: OECD, Patent database, January 2009; EPO Worldwide Statistical Patent database, September 2008.

### 7.3. Share of countries in biotechnology PCT patent applications, 2006

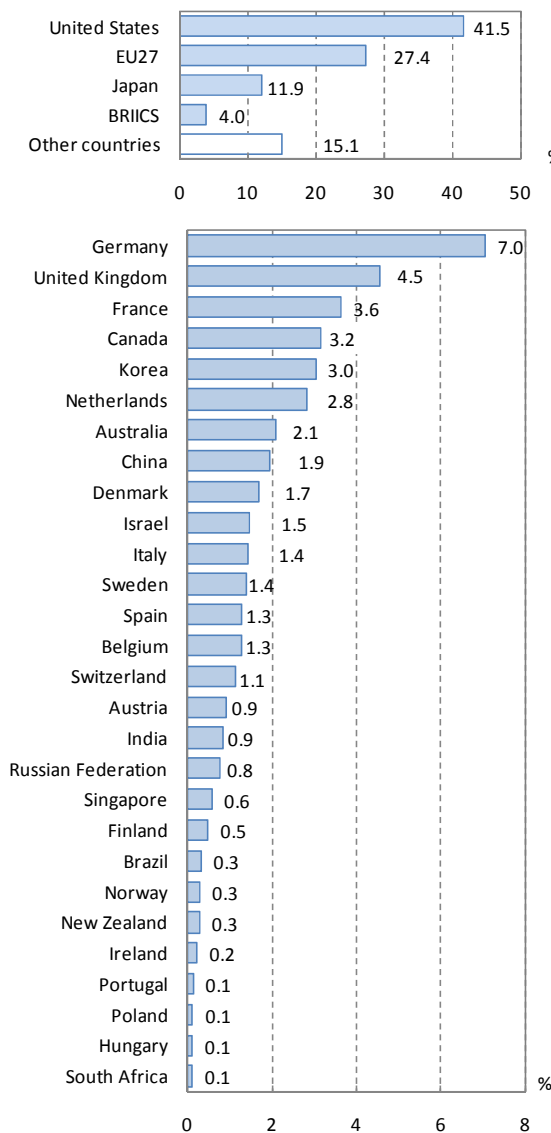


Table 7.1. Top 50 regions<sup>1</sup> in biotechnology PCT patent applications, 2004-2006

Region (Territorial Level 2)	Biotechnology patents	Share (%) in total
San Jose-San Francisco-Oakland	US 1 510	5.5
Boston-Worcester-Manchester	US 1 422	5.2
New York-Newark-Bridgeport	US 1 090	4.0
Washington-Baltimore-N.Virginia	US 811	3.0
Tokyo	JP 792	2.9
San Diego-Carlsbad-San Marcos	US 782	2.9
Los Angeles-Long Beach-Riverside	US 613	2.2
Philadelphia-Camden-Vineland	US 587	2.2
Nordrhein-Westfalen	DE 506	1.9
Hovedstadsregionen	DK 454	1.7
Capital region (Seoul - Incheon - Gyeonggi-do)	KR 404	1.5
Île de France	FR 379	1.4
Bayern	DE 375	1.4
Osaka	JP 368	1.3
West-Nederland	NL 351	1.3
Raleigh-Durham-Cary	US 336	1.2
Ontario	CA 302	1.1
Baden-Württemberg	DE 294	1.1
East of England	GB 262	1.0
Seattle-Tacoma-Olympia	US 261	1.0
Ibaraki	JP 248	0.9
South-East (England)	GB 246	0.9
Chicago-Naperville-Michigan City	US 235	0.9
Québec	CA 230	0.8
Houston-Baytown-Huntsville	US 219	0.8
Minneapolis-St. Paul-St. Cloud	US 213	0.8
Hessen	DE 209	0.8
London	GB 201	0.7
Berlin	DE 198	0.7
Vlaams Gewest	BE 196	0.7
Rhône-Alpes	FR 190	0.7
Kyoto	JP 189	0.7
Denver-Aurora-Boulder	US 186	0.7
Victoria	AU 176	0.6
Detroit-Warren-Flint	US 165	0.6
St. Louis-St. Charles-Farmington	US 162	0.6
Zuid-Nederland	NL 161	0.6
New South Wales	AU 158	0.6
Atlanta-Sandy Springs-Gainesville	US 148	0.5
Madison-Baraboo	US 144	0.5
Niedersachsen	DE 139	0.5
Chiba	JP 138	0.5
Beijing	CN 137	0.5
Chungcheong region	KR 134	0.5
Aichi	JP 129	0.5
Hyogo	JP 119	0.4
Stockholm	SE 116	0.4
Indianapolis-Anderson-Columbus	US 110	0.4
Saitama	JP 108	0.4
Etela-Suomi	FI 108	0.4

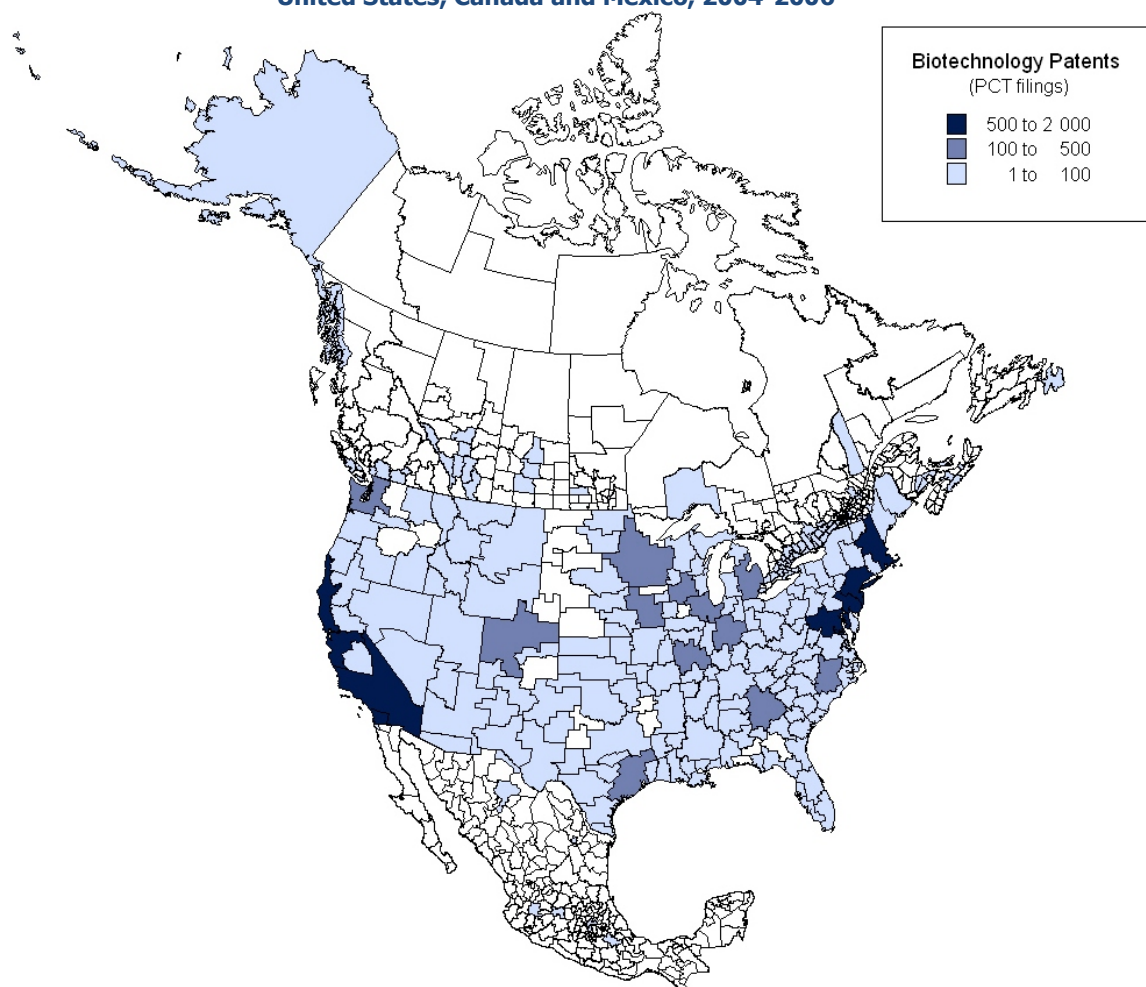
➔ Patent counts are based on the priority date, the inventor's country of residence and use fractional counts on PCT filings at international phase (EPO designations). BRIICS refers to Brazil, China, India, Indonesia, Russian Federation and South Africa. Regional allocation of PCT filings is based on the inventor's address, according to OECD's territorial grids (see Maraut et al., 2008).

1. The regional breakdown is presented at Territorial Level 2 (TL2), except for Japan and the United States (TL3).

Sources: OECD, Patent and REGPAT databases, January 2009; and EPO Worldwide Statistical Patent database, September 2008.

- Denmark remains an active country in biotechnology patenting. Its share of biotechnology patents out of all patents (15.7%) is more than three times the share, for all countries combined, of biotechnology patents out of all patent applications between 2004 and 2006. Belgium, Canada and Singapore follow with biotechnology patents accounting for over 10% of their total patents.
- The United States contributed to 41.5% of all biotechnology PCT patent applications in 2006. Japan and Germany followed with respective shares of 12% and 7%. Seven US regions are among the top ten leading regions in biotechnology patenting between 2004 and 2006, along with Tokyo for Japan, Nordrhein region in Germany and the region of Copenhagen in Denmark.

#### 7.4. Number of biotechnology patents: United States, Canada and Mexico, 2004-2006



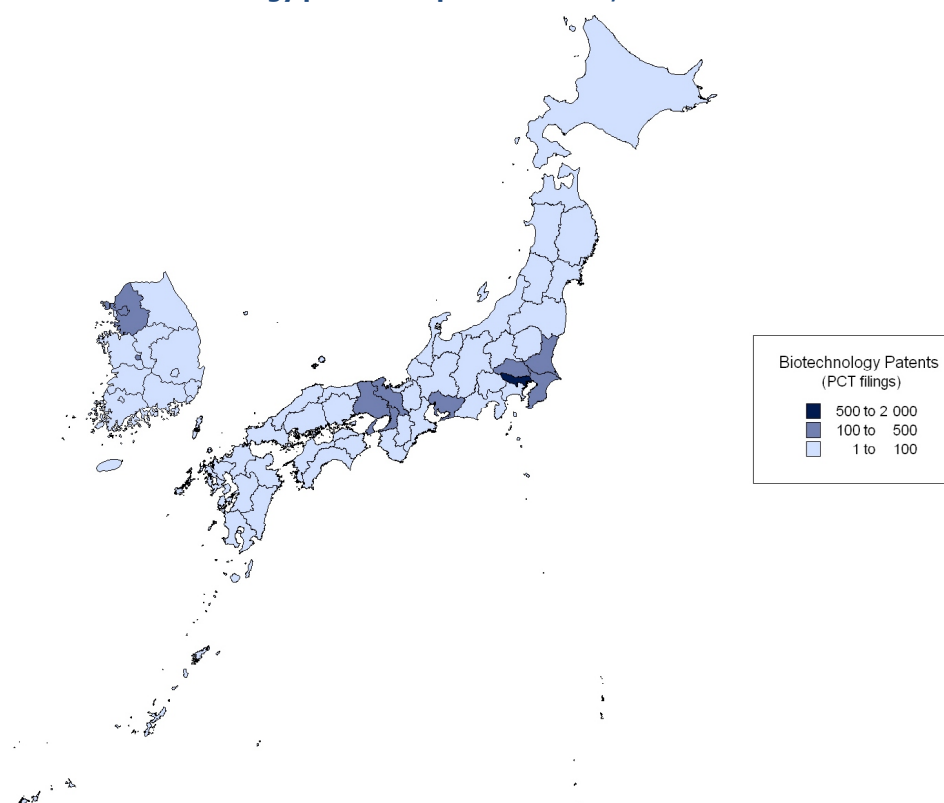
➔ Patent counts are based on the priority date, the inventor's country of residence and use fractional counts on PCT filings at international phase (EPO designations). Regional allocation of PCT filings is based on the inventor's address, according to OECD's territorial grids – TL 3 (see Maraut et al., 2008).

Sources: OECD, Patent and REGPAT databases, January 2009; and EPO Worldwide Statistical Patent database, September 2008.

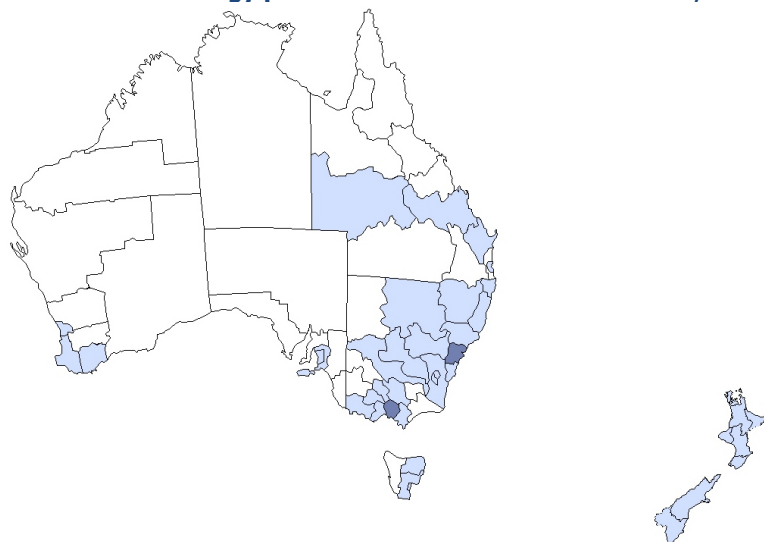
- In the United States, four regions account for nearly 18% of all international applications in biotechnology and 42% of the biotechnology patents originating from the United States, for the 2004-2006 period: California, with the areas of San Jose/San Francisco (1 510 patents) and on the east coast, the regions of Boston (1 422), New York City (1 090) and Washington D.C. (811).
- Tokyo is the top-ranking region in Japan with almost 800 patents taken over the period 2004-06, and is fifth among all biotechnology patenting regions. The prefectures of Ibaraki and Osaka contributed to 248 and 368 biotechnology patents, respectively. The Capital Region of Korea (Seoul, etc.) ranks at the 11<sup>th</sup> position regarding the number of biotechnology patents.



### 7.5. Number of biotechnology patents: Japan and Korea, 2004-2006



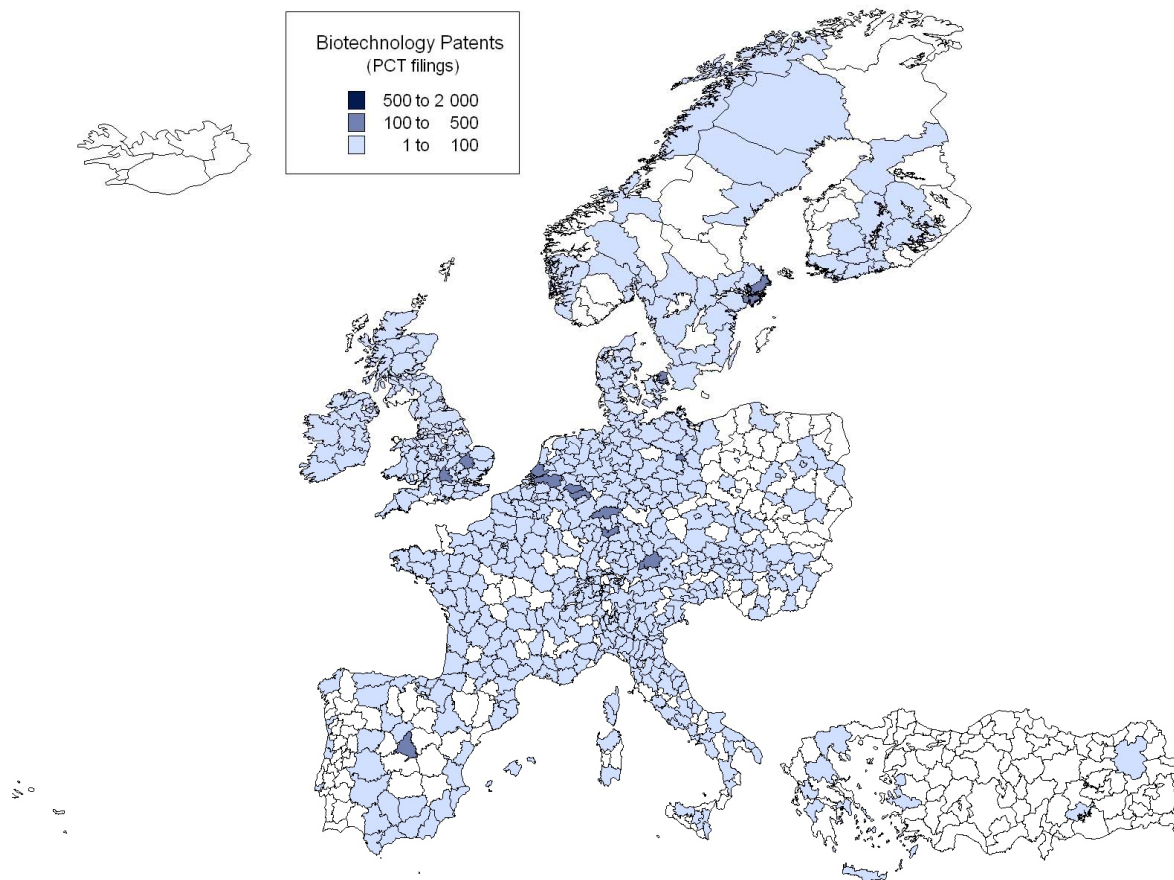
### 7.6. Number of biotechnology patents: Australia and New Zealand, 2004-2006



➔ Patent counts are based on the priority date, the inventor's country of residence and use fractional counts on PCT filings at international phase (EPO designations). Regional allocation of PCT filings is based on the inventor's address, according to OECD's territorial grids – TL 3 (see Maraut et al., 2008).

Sources: OECD, Patent and REGPAT databases, January 2009; and EPO Worldwide Statistical Patent database, September 2008.

## 7.7. Number of biotechnology patents: Europe, 2004-2006



➔ Patent counts are based on the priority date, the inventor's country of residence and use fractional counts on PCT filings at international phase (EPO designations). Regional allocation of PCT filings is based on the inventor's address, according to OECD's territorial grids – TL 3 (see Maraut et al., 2008). No regional breakdown is available for Iceland.

Sources: OECD, Patent and REGPAT databases, January 2009; and EPO Worldwide Statistical Patent database, September 2008.

- Four German regions with more than 200 biotechnology patents represent 18% of the PCT biotechnology patents applications in the European Union (506 patents from Nordrhein-Westfalen, 375 from Bayern, 294 from Baden-Württemberg and 209 from Hessen), representing more than two-thirds of German biotechnology patents.
- Hovedstadsregionen, the region of Copenhagen, contributes 86% of PCT biotechnology patent applications by Danish residents and to 1.7% of total biotechnology patents. The region of Île de France applied for 379 patents between 2004 and 2006.

**Table 7.2. Biotechnology PCT patent applications and total PCT patent applications**

	1994-1996		2004-2006	
	Biotechnology	Total	Biotechnology	Total
Australia	297	2 566	556	6 152
Austria	68	1 119	193	3 456
Belgium	143	1 168	327	2 982
Canada	437	2 950	809	8 031
Czech Republic	11	108	14	393
Denmark	284	1 660	525	3 348
Finland	94	2 109	148	4 523
France	577	6 405	991	17 970
Germany	895	18 505	2 106	49 190
Greece	4	107	11	245
Hungary	16	244	27	564
Iceland	1	24	13	116
Ireland	34	299	50	935
Italy	180	2 365	421	8 509
Japan	894	10 065	3 720	68 011
Korea	59	643	653	15 780
Luxembourg	1	66	2	134
Mexico	10	89	22	520
Netherlands	273	3 813	643	9 689
New Zealand	36	456	104	1 057
Norway	32	971	81	1 837
Poland	4	77	30	347
Portugal	1	30	22	231
Slovak Republic	3	48	4	106
Spain	61	819	312	3 696
Sweden	246	5 082	362	7 452
Switzerland	161	2 318	354	5 965
Turkey	1	32	5	712
United Kingdom	985	9 787	1 264	17 891
United States	7 757	56 656	11 474	139 261
European Union	3 900	54 019	7 487	132 327
OECD total	13 566	130 583	25 242	379 104
World total	13 891	134 746	27 296	418 472
BRIICS	92	1 899	887	18 747
Brazil	6	220	67	1 098
China	22	358	423	11 310
India	7	49	213	2 977
Indonesia	0	7	1	45
Israel	156	1 210	428	5 374
Philippines	1	13	0	108
Russian Federation	48	1 011	147	2 173
Slovenia	11	95	15	288
South Africa	10	254	35	1 145

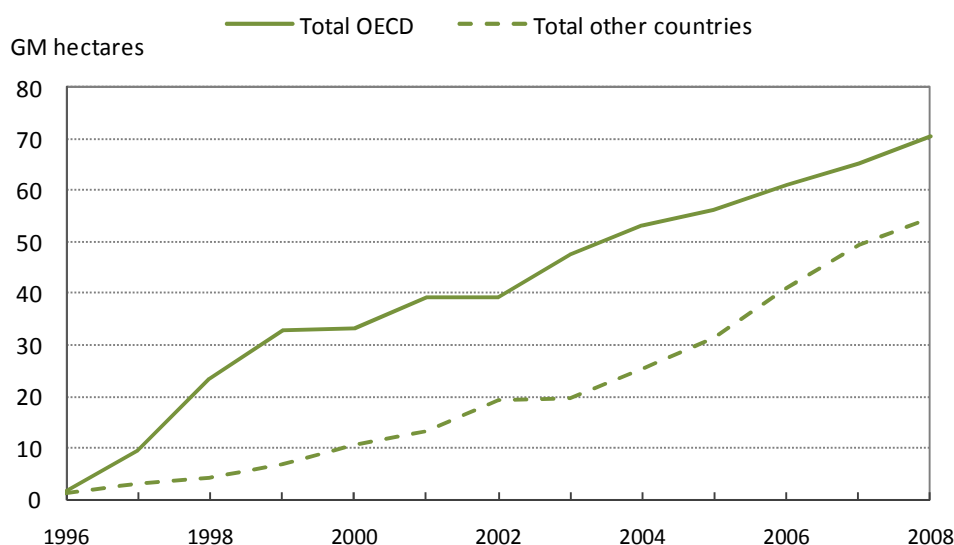
➔ Patent counts are based on the priority date, the inventor's country of residence and use fractional counts on PCT filings at international phase (EPO designations). BRIICS refers to Brazil, China, India, Indonesia, Russian Federation and South Africa.

Sources: OECD, Patent and REGPAT databases, January 2009; and EPO Worldwide Statistical Patent database, September 2008.

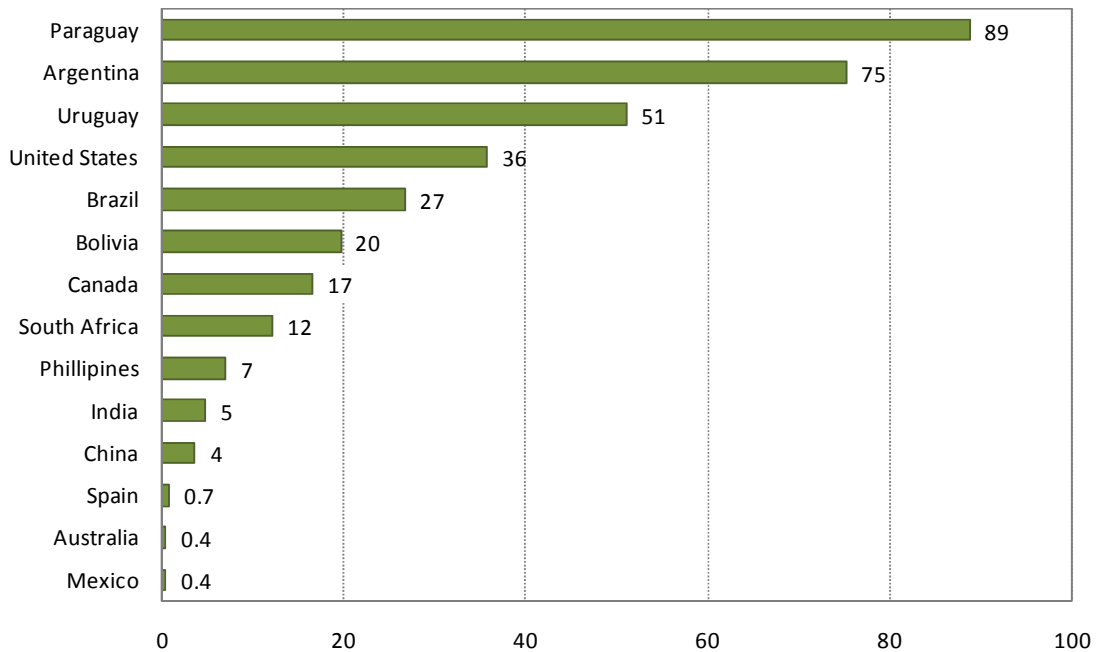
## 8. Biotechnology in agriculture

- Biotechnology has many applications in agriculture, including diagnostics, vaccines and therapeutics for animal health; DNA fingerprinting for managing animal stocks and identifying specific plant varieties, animal and plant propagation; and the use of marker assisted selection, intragenics and genetic modification (GM) to develop improved plant and animal varieties
- Internationally comparable data for biotechnology applications in agriculture are limited to GM plant varieties. Two types of data are available: hectares planted to GM crops and field tests of plant varieties with GM traits
- **Hectares planted with GM crops**
- GM crops were first extensively commercialised in 1996. Some commercial GM crops were reported in 2008 for 10 OECD member countries and for 15 other countries.
- In 2008, the United States and Canada combined accounted for 99.2% of GM crop hectares within the OECD.
- GM hectares have been increasing rapidly outside of the OECD. Since 2005, the number of hectares planted to GM crops within the OECD increased by 5.8% per year and by 15.1% per year outside of the OECD. The annual growth rates were 55.5% in India, 13.9% in Brazil, 10.5% in Paraguay, and 8.7% in South Africa. At observed growth rates since 2005, GM hectares in developing countries will pass that of the OECD in 2013.
- The maximum area that can be planted to GM crops partly depends on the total arable land under cultivation. Paraguay has the highest percentage of arable land planted to GM crops in 2008, at 89%, followed by Argentina (75%), Uruguay (51%), the United States (36%), and Brazil (27%).
- Two other main factors that determine the area planted to GM crops are regulations and the types of crops grown in each country. GM use is highest for countries with suitable growing conditions for the main GM crops to date: soybeans, maize, cotton, and rapeseed (canola).

### 8.1. Million hectares planted to GM crops, 1996 to 2008



Sources: GM hectares: Clive James, 1997, 1999 'Global Review of Transgenic Crops', ISAAA Briefs, The International Service for the Acquisition of Agri-biotech applications (ISAAA), Ithaca New York; Clive James (2004, 2005, 2006, 2007, 2008), 'Global Status of Commercialized Biotech/GM Crops', ISAAA, Ithaca, New York. Total arable land: World Bank (2009), World Development Indicators database.

8.2. Percent of all arable land<sup>1,2</sup> planted with GM crops, 2008

1. Data for arable land is for the most recent available year. This is 2005 for the United States, India, Australia, and Spain and 2003 for all other countries.

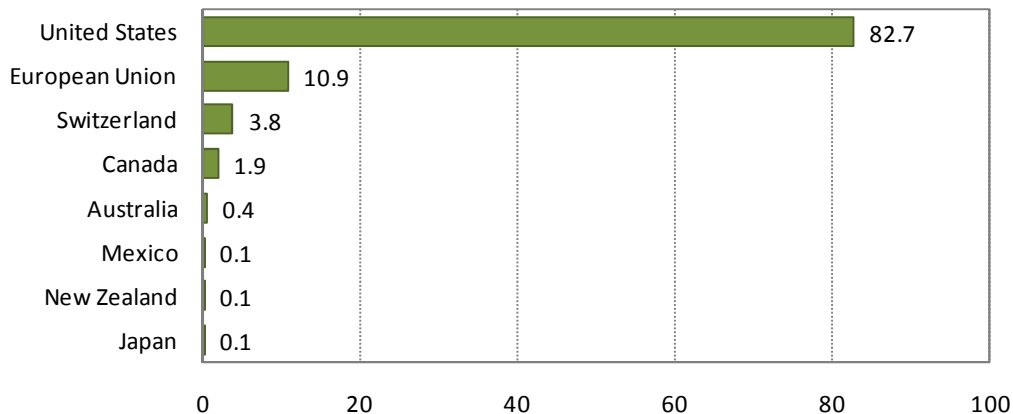
2. Arable land is defined as land under annual crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category. Data for "Arable land" does not measure the amount of land that is potentially cultivable.

Sources: GM hectares: Clive James, 1997, 1999 'Global Review of Transgenic Crops', ISAAA Briefs, The International Service for the Acquisition of Agri-biotech applications (ISAAA), Ithaca New York; Clive James (2004, 2005, 2006, 2007, 2008), 'Global Status of Commercialized Biotech/GM Crops', ISAAA, Ithaca, New York. Total arable land: World Bank (2009), World Development Indicators database.

**Field trials of GM varieties**

- For regulatory reasons, most OECD countries maintain publicly available databases of field trials of GM plant varieties. The data presented here are derived from the UNU-MERIT GM Field trials database, which contains field trial data for 26 of the 30 OECD member countries, plus non-OECD members of the European Union. The database does not include results for field trials conducted in Korea or Turkey, while no field trials were reported up to December 31, 2008 in Iceland and Norway.
- Field test data provide information on both the amount of development work to produce new GM plant varieties and the types of GM traits under development. Due to national differences in how field trial data are treated, Canada tends to be over-represented and New Zealand under represented when using count data (see the methodological note).
- Field trials can be undertaken for one genetic trait or for two or more traits simultaneously (stacked traits). There are four main classes of traits with commercial value: tolerance to commercial herbicides, pest resistance to viruses, bacteria, insects, nematodes or fungi; improvements to product quality such as the type of oils, starches, sugars or cellulose in the plant, and improvements to agronomic characteristics such as yield or salt, drought and cold tolerance. Several different traits can be tested within the same class.
- A fifth trait class covers technical and other traits, many of which do not have direct applications in agriculture, but are required to implement other types of traits. This class of traits includes genes for markers, genetic containment, sterility, and other traits that are unclassifiable.
- The field trial data are aggregated over 2006 – 2008 inclusive because of the low number of trials in most countries, with the exception of the United States and Canada. No field trials were conducted over these three years in 10 of the 27 EU member countries.
- Between 2006 and 2008 inclusive, 3 849 field trials for plant varieties were conducted by private firms or research institutes in Australia, Canada, the European Union, Japan, Mexico, New Zealand, Switzerland and the United States combined. The United States accounted for 62.9% of the total, Canada for 26.5%, the European Union for 7.6%, Mexico for 1.4%, and Japan for 0.8%. However, 38.0% of all field trials between 2006 and 2008 were conducted by foreign subsidiaries of international firms. Using the location of the head office of the controlling firm or government research institute, 82.7% of the 3 849 field trials were performed by organisations with head offices in the United States, 10.9% by organisations based in the European Union, and 3.8% by organisations based in Switzerland.
- Between 2006 and 2008, 74.5% of field trials by European Union firms were located outside of Europe, compared to less than 40% between 1992 and 1996. Between 2006 and 2008, American firms conducted 32.0% of their field trials outside the United States.
- The 3 849 field trials tested 6 637 separate traits, with 35.7% of all field trials testing two traits and 9.7% testing three or more traits. By location, the United States accounted for 3 924 or 59.1% of all trait field trials, Canada for 2 102 or 31.7% of the total, and the European Union for 453 or 6.8% of the total.
- Canada has the highest intensity by the location of trait field trials between 2006 and 2008, with 64.4 traits field tested per million population, followed by the United States (13.1) and New Zealand (3.3).
- The non-profit research sector (universities, government research institutes and private non-profit organisations) conducted, on average, 19.3% of the 6 637 trait trials between 2006 and 2008. The non-profit sector conducted 23.3% of all trait trials in the United States, versus 17.2% in the European Union.
- Between 1990 and 1999, 68.1% of trials for specific traits concerned either pest resistance (36.8%) or herbicide tolerance (31.3%), followed by product quality (15.8%), and technical and other traits (14.0%). Trials of agronomic traits only accounted for 2.1% of the total.
- Between 2000 and 2008, the largest growth rate in the number of trait field trials has been for agronomic traits, which increased 260% from 185 in 2000 to 480 in 2008. Since 2006, the United States and Canada accounted for 99.1% of all field trials for agronomic traits.
- Between 2006 and 2008, trials of herbicide tolerance accounted for 27.0% of the total trait trials, agronomic traits for 24.0%, technical and other traits for 18.9%, pest resistance for 17.3%, and product quality for 12.9% of all trait trials.
- Between 2006 and 2008, trials of leading edge agronomic and product quality traits accounted for only 2.9% of all trait trials in Mexico, 4.8% in Japan, and 10.2% in the European Union. In all other countries and regions, these two trait classes accounted for over 30% of all trials: 34.7% in Canada, 41.9% in the United States, 50.0% in New Zealand, and 56.3% in Australia.

### 8.3. Percent of 3 849 field trials between 2006 and 2008 inclusive by country of head office



Source: UNU-MERIT GM Field trials database, Maastricht, the Netherlands, April 2009.

#### Methodology

In most OECD countries, field trials of new GM plant varieties are registered and the data are publicly available. Field trials cover a comparatively late stage of the development of GM varieties, as they do not include greenhouse and laboratory trials. Consequently, field trials provide evidence of relatively late stage research into new plant varieties that could be ready for commercialization within two to six years.

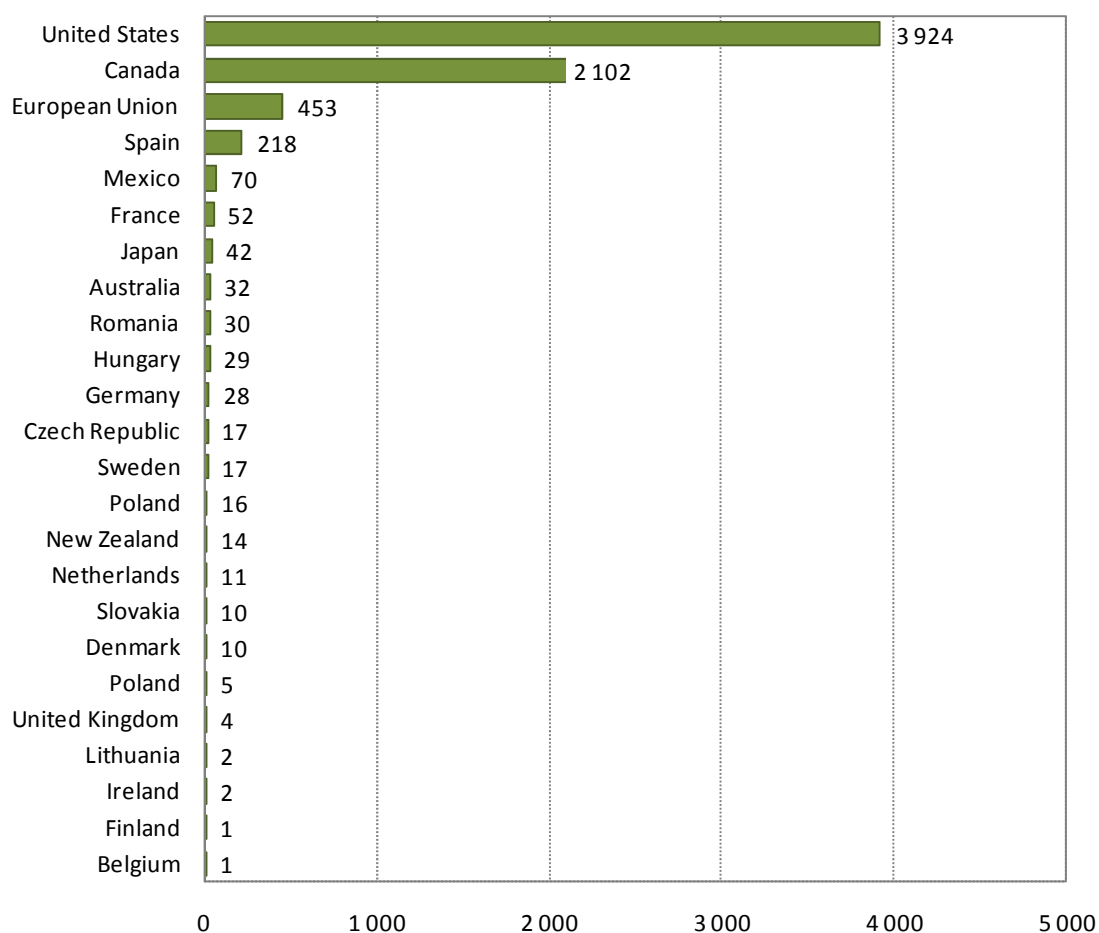
Field trial data have many of the advantages and limitations of patents. Both provide a measure of investment in particular lines of research by firms and public sector institutions to develop new plant varieties (field trials) or inventions (patents), but in both cases there is no direct relationship between the number of trials or patents and the outcome in terms of commercialised GM varieties or inventions. A series of trials can be abandoned, with no commercialisation of the GM variety, and there is large range in the number of field trials required to develop a GM variety. For example, several hundred field trials were conducted in the United States to alter the ripening characteristics of a tomato variety whereas only 15 trials were required to develop a virus resistant papaya variety. Furthermore, field trials are not fully comparable across countries, as they can vary by size (number of hectares) and by the number of years for which they are valid. In Canada, the number of field trials is increased by regulatory limits on the size of each individual trial, while in New Zealand a field trial can last for multiple years.

In the United States, field tests of GM varieties that have already received approval do not need to be registered, which decreases the comparability between Europe and the United States. The UNU-MERIT GM Field trials database used here includes American data for both releases and notifications (an expedited type of release permit). For all countries, the results given here exclude non-plant field tests.

The United States provides ten identifiers for the purpose of each trait. These identifiers were used by UNU-MERIT to identify field trials of specific traits for herbicide tolerance, pest resistance, product quality, agronomic characteristics, and other types of traits. The European Union, Canada, and Australia provide information on the trait but do not include an identifier. UNU-MERIT used the data from the United States and other sources to assign each trait in these countries to one of the five main categories. This classification system contains an unknown but small amount of error because some genetic traits can be used for different purposes. In a small number of trials insufficient detail is provided to accurately determine the purpose of a trial. These are assigned to an 'other' category.

Ownership is based on the country of the head office of the organisation performing the field trial in the year in which the trial is conducted. Ownership is revised annually to take account of mergers and acquisitions.

## 8.4. Total number of trait field trials by location, 2006 to 2008 inclusive

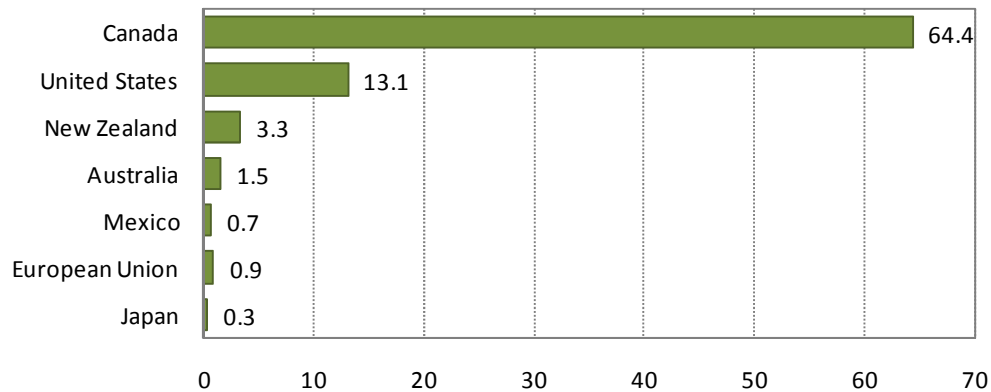


➔ No GM field trials were conducted in Switzerland between 2006 and 2008.

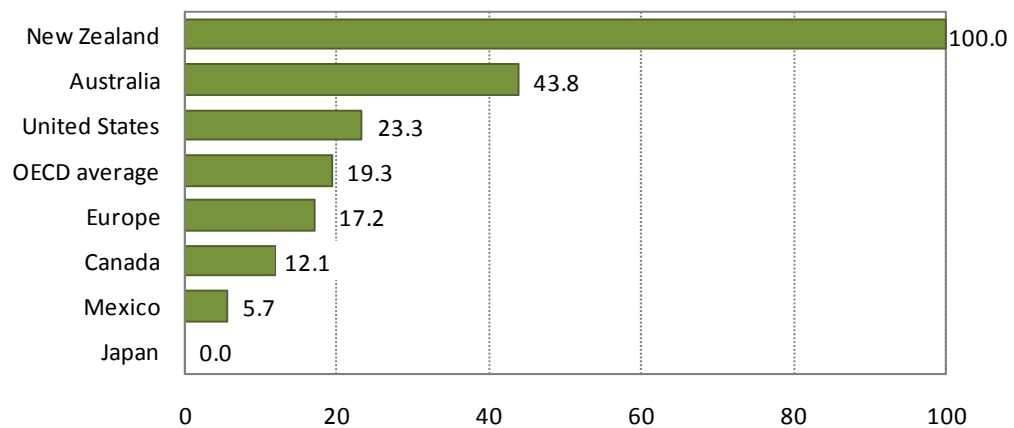
Source: UNU-MERIT GM Field trials database, Maastricht, the Netherlands, April 2009.



### 8.5. Trait field trials by location per million 2006 population, 2006 to 2008 inclusive

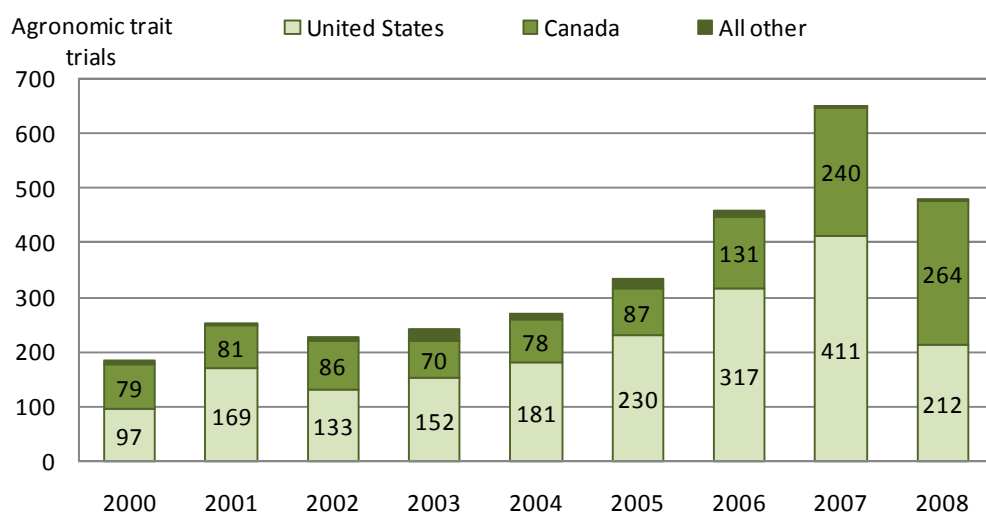


### 8.6. Share of national trait field trials by the non-profit research sector, 2006 to 2008 inclusive



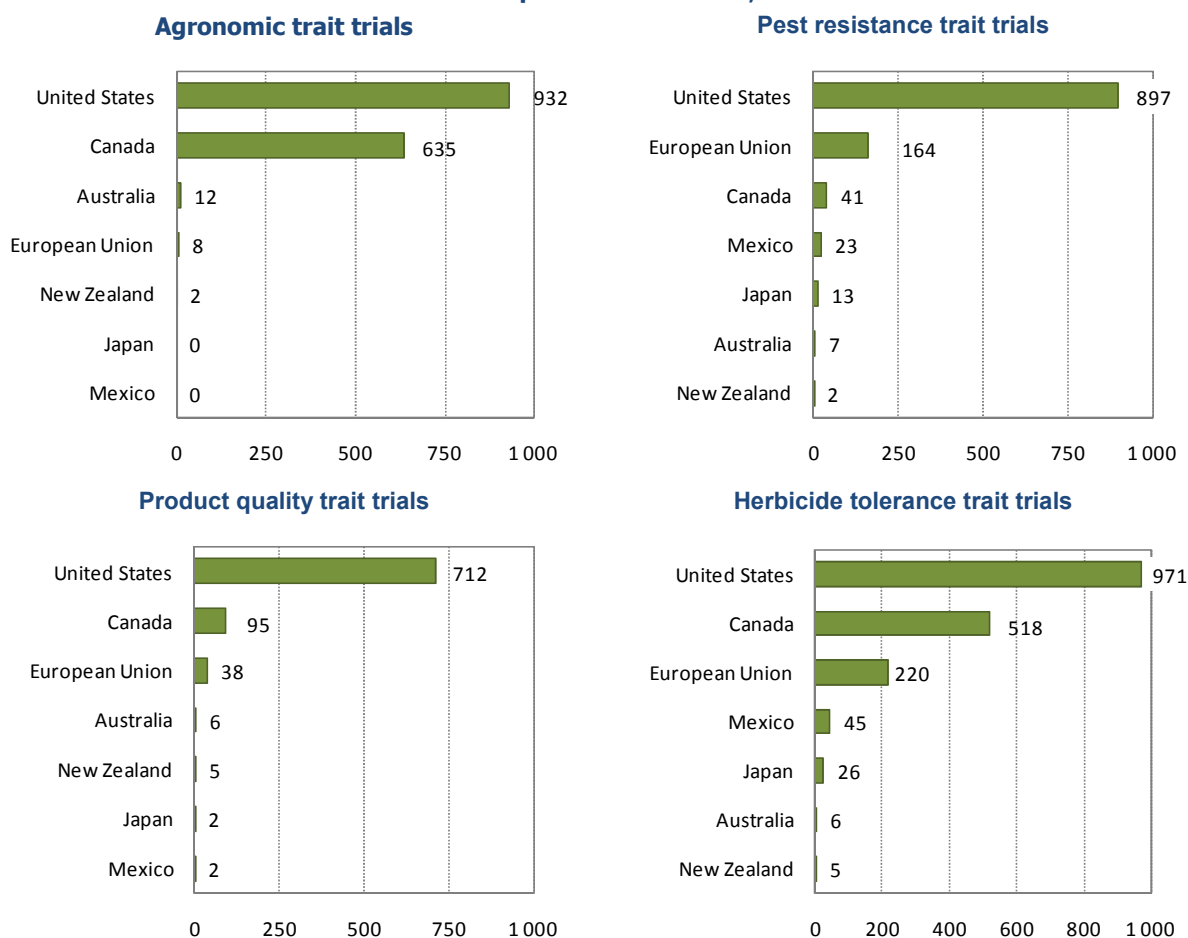
→ The non-profit research sector includes universities, government research institutes, and private non-profit research institutes.

### 8.7. Number of trait field trials for agronomic traits by location, 2000 to 2008 inclusive

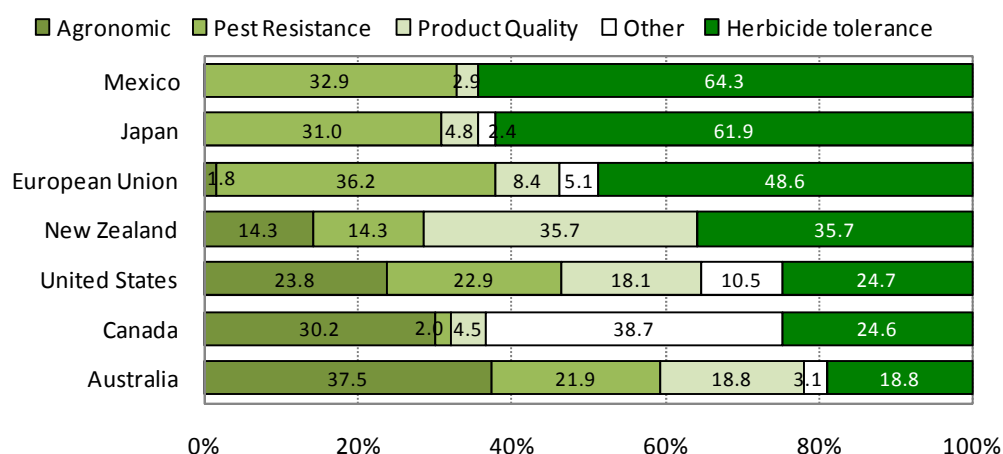


Source: UNU-MERIT GM Field trials database, Maastricht, the Netherlands, April 2009.

# 8.8. Number of field trials for specific trait classes, 2006 to 2008 inclusive



# 8.9. Percent of all trait trials by class of trait, 2006 to 2008 inclusive



Source: UNU-MERIT GM Field trials database, Maastricht, the Netherlands, April 2009.

**Table 8.1. Million hectares planted to GM crops, 1996 to 2008**

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
United States	1.5	8.1	20.5	28.7	30.3	35.7	39.0	42.8	47.6	49.8	54.6	57.7	62.5
Argentina	0.1	1.4	4.3	6.7	10.0	11.8	13.5	13.9	16.2	17.1	18.0	19.1	21.0
Brazil	..	..	..	..	..	..	3.5	3.0	5.0	9.4	11.5	15.0	15.8
Canada	0.1	1.3	2.8	4.0	3.0	3.2	..	4.4	5.4	5.8	6.1	7.0	7.6
India	..	..	..	..	..	..	..	0.1	..	1.3	3.8	6.2	7.6
China	1.1	1.8	..	0.3	0.5	1.5	2.1	2.8	3.7	3.3	3.5	3.8	3.8
Paraguay	..	..	..	..	..	..	..	..	..	..	2.0	2.6	2.7
South Africa	..	..	..	..	..	..	..	..	..	..	1.4	1.8	1.8
Uruguay	..	..	..	..	..	..	..	..	..	..	0.4	0.5	0.7
Bolivia	..	..	..	..	..	..	..	..	..	..	..	..	0.6
Philippines	..	..	..	..	..	..	..	..	..	..	0.2	0.3	0.4
Australia	..	0.1	0.1	..	0.1	0.2	..	0.1	0.2	0.3	0.2	0.1	0.2
Mexico	..	..	..	..	..	..	..	..	0.1	0.1	0.1	0.1	0.1
Spain	..	..	..	..	..	..	..	..	0.1	0.1	0.1	0.1	0.1
Romania	..	..	..	..	..	..	..	..	..	..	0.1	..	..
Other (estimated)	..	..	0.1	0.2	0.0	0.0	0.2	0.2	0.6	0.2	0.4	0.5	0.3
Total	2.8	12.7	27.8	39.9	43.9	52.4	58.3	67.3	78.9	87.4	102.4	114.8	125.2

Sources: Clive James, 1997, 1999 'Global Review of Transgenic Crops', ISAAA Briefs, The International Service for the Acquisition of Agri-biotech applications (ISAAA), Ithaca New York; Clive James (2004, 2005, 2006, 2007, 2008, 2009), 'Global Status of Commercialized Biotech/GM Crops', ISAAA, Ithaca, New York.

**Table 8.2. Number of field trials for specific trait classes, 2006 to 2008 inclusive**

	Agronomic	Pest resistance	Product quality	Herbicide tolerance	Technical, sterility, other	Total
United States	932	897	712	971	412	3924
Canada	635	41	95	518	813	2102
European Union	8	164	38	220	23	453
Mexico	0	23	2	45	0	70
Japan	0	13	2	26	1	42
Australia	12	7	6	6	1	32
New Zealand	2	2	5	5	0	14
Total	1589	1147	860	1791	1250	6637

**Table 8.3. Head office location of firms and institutions conducting 3 849 field trials, 2006 to 2008 inclusive**

Head office location	Total field trials	Percent conducted outside home country/region
United States	3184	32.0%
European Union	419	74.5%
Switzerland	147	100.0%
Canada	72	11.1%
Australia	17	23.5%
New-Zealand	4	0.0%
Mexico	3	0.0%
Japan	3	33.3%
Total	3849	

➔ For European Union firms, percent conducted outside the home country or region consists of field trials conducted outside Europe.

Source: UNU-MERIT GM Field trials database, Maastricht, the Netherlands, April 2009.

**Table 8.4. Number of 6 637 trait field trials conducted by the private and non-profit sectors, 2006 to 2008 inclusive**

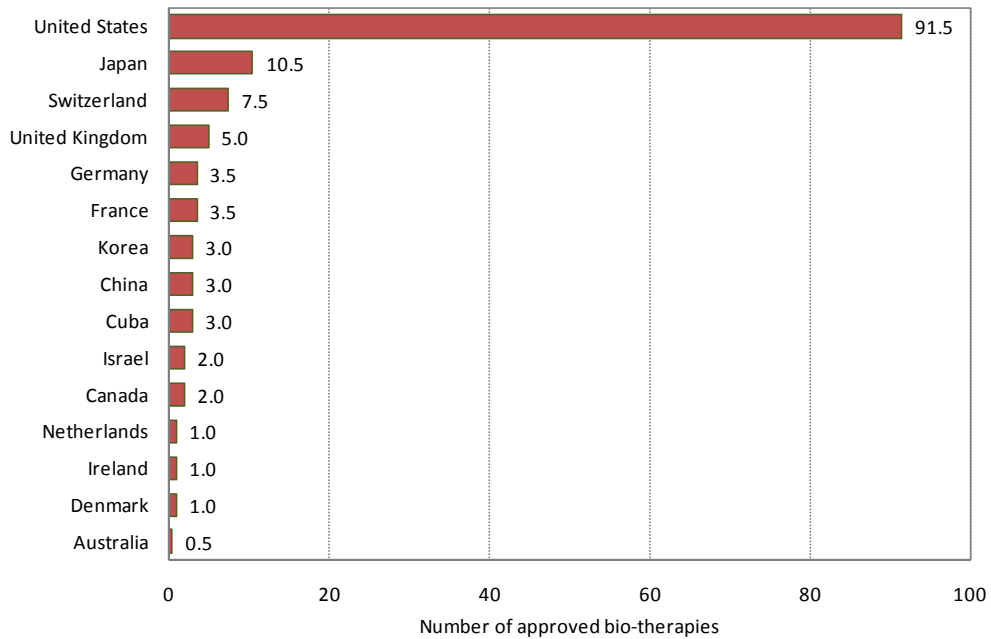
	Private sector	Non-profit research sector	Percent non-profit
United States	3008	916	23.3%
Canada	1847	255	12.1%
European Union	375	78	17.2%
Mexico	66	4	5.7%
Japan	42	0	0.0%
Australia	18	14	43.8%
New Zealand	0	14	100.0%
Total	5356	1281	19.3%

➔ Non-profit sector includes universities, government research institutes, and private non-profit organisations.

## 9. Biotechnology in health

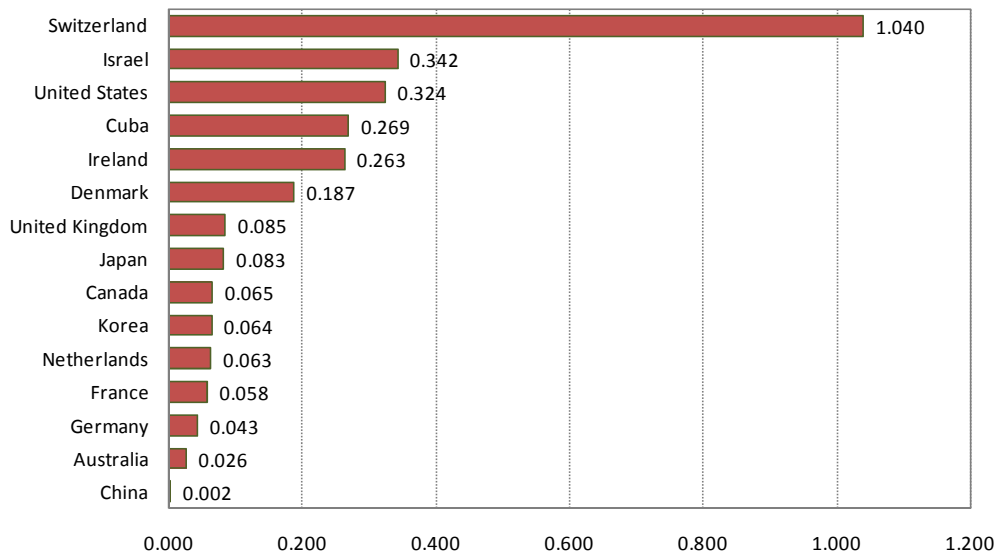
- Biotechnology is used in the development, production, and prescribing of therapeutics, *in vivo* diagnostics, and vaccines for both humans and animals. Other uses include *in vitro* genetic diagnostics and the development of functional foods or nutraceuticals.
  - Bio-therapeutics include large molecule recombinant proteins such as enzymes and hormones and monoclonal antibodies. Experimental bio-therapeutics cover tissue engineering, therapeutic vaccines, stem cell research, lytic viruses, and gene, antisense, and RNAi therapies. They are defined as 'experimental' because only a few of them have received marketing approval in one or more jurisdictions. They also form the leading edge of biotechnology research in health. All of these therapeutics, plus biotechnological vaccines and large molecule *in vivo* diagnostics can be defined as bio-therapies. They can be identified in private databases of clinical trials and in the marketing approval systems of regulatory agencies such as the FDA for the United States and the EMEA for Europe.
  - Biotechnology is also increasingly used to develop, test, produce and manage the use of small molecule pharmaceuticals. The contribution of biotechnology to small molecule pharmaceuticals, while growing rapidly, is difficult to identify in private and regulatory databases.
  - Internationally comparable data for biotechnology applications in health include the head office country for the firm that developed each human bio-therapy that received marketing approval in at least one country and the current head office of firms running clinical trials of all types of bio-therapies and experimental biotechnology therapies for humans. There are no internationally comparable data for animal health, *in vitro* diagnostics, functional foods, or nutraceuticals.
- Developer of approved bio-therapies**
- Between January 1989 and January 2009, 138 bio-therapies received marketing approval in one or more national jurisdictions in the world. These consisted of 2 experimental therapies, 10 *in vivo* diagnostics, 11 bio-vaccines and 115 therapeutics.
  - A review of the ownership and development records for all 138 approved bio-therapies identified the firm that originally developed the bio-therapy and the current owner of the bio-therapy. For 56 (40.6%) of the 138 bio-therapies, the firm that originally developed the molecule differs from the current owner. For most of these cases, the developer was a small dedicated biotechnology firm that was later purchased by a large pharmaceutical firm. In total, only 21 (15.2%) of the 138 bio-therapies were originally developed by one of the major pharmaceutical firms. Bio-therapies that were jointly developed by two firms were assigned a value of 0.5 to the head office country of each firm.
  - One or more approved bio-therapies were developed by firms based in 12 OECD and 3 non-OECD countries (China, Cuba, and Israel). Firms based in the United States developed 91.5 (66.3%) of the 138 bio-therapies that received marketing approval between January 1989 and January 2009. European firms developed 21.5 (15.6%) and Japanese firms developed 10.5 (7.6%) of the approved bio-therapies. In the last five years (since January 2004), the share of approved bio-therapies developed by US firms declined slightly to 63.2% (24 of 38 bio-therapies).
  - The number of approved bio-therapies per million population in 2000 of the head office country of the developer firm ranges from 1.040 bio-therapies per million in Switzerland to 0.002 bio-therapies per million in China. Other leading countries include Israel (0.342 per million) and the United States (0.324 per million).

### 9.1. Nationality of the developer firm for 138 approved bio-therapies, Jan 1989 - Jan 2009



→ Six biopharmaceuticals that were jointly developed by two firms in two different countries were assigned a share of 0.5 to each country.

### 9.2. Number of approved bio-therapies per million population (2000), Jan 1989 - Jan 2009



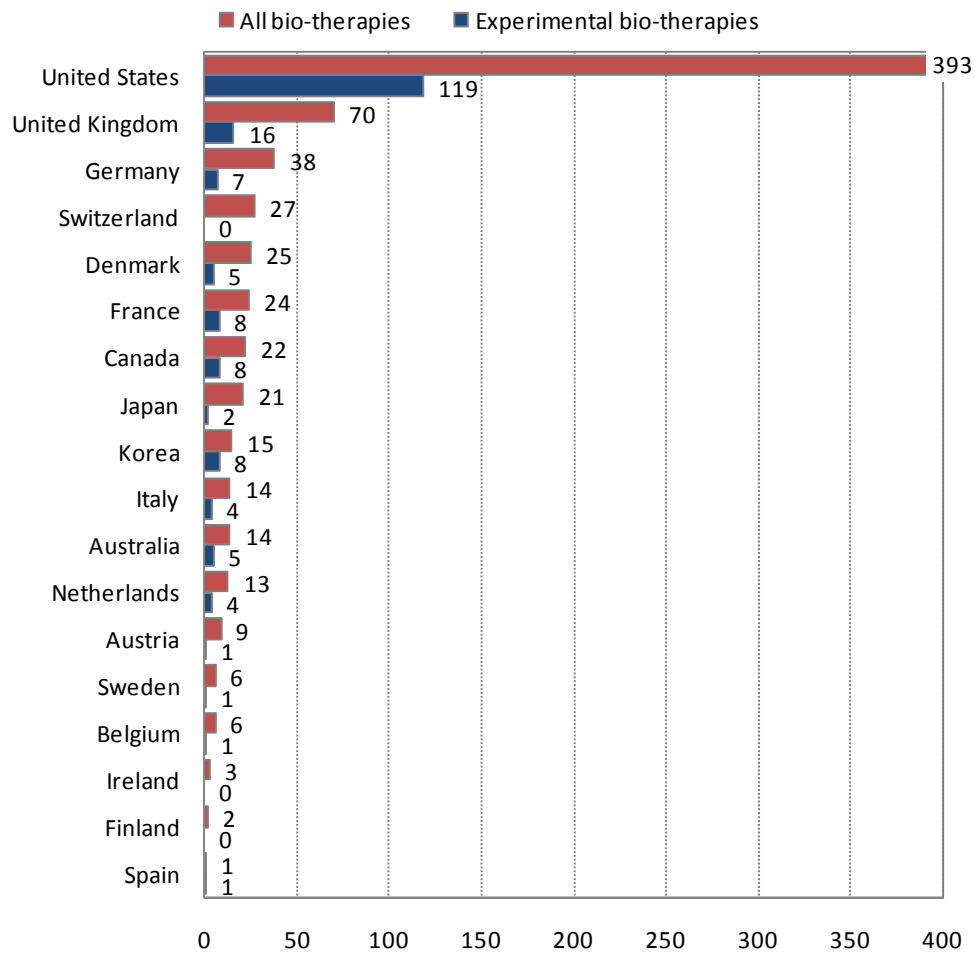
→ Based on the head office of the firm that originally developed the bio-therapy.

Source: Authors, based on data from Pharmaprojects, February 2008; FDA and EMEA websites accessed April 2009.

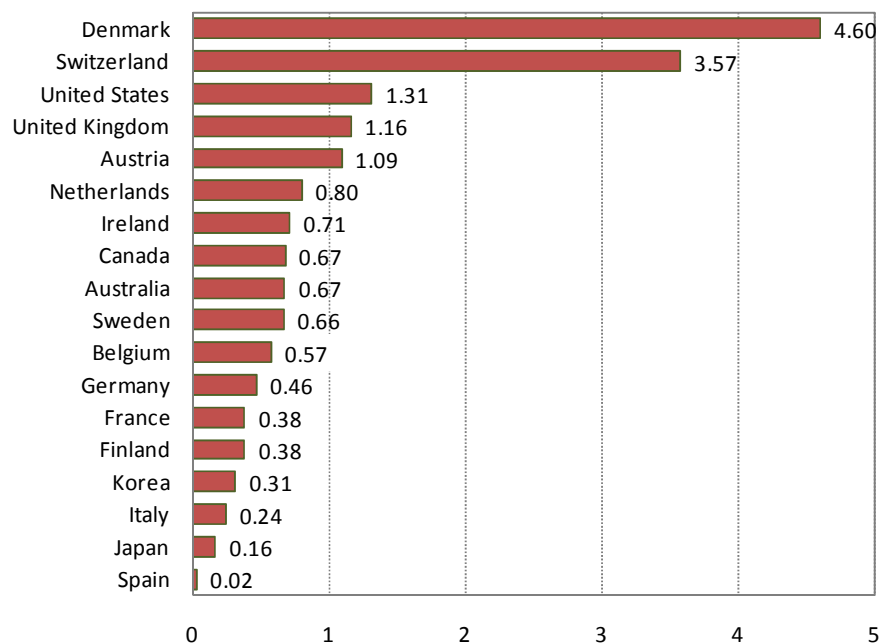
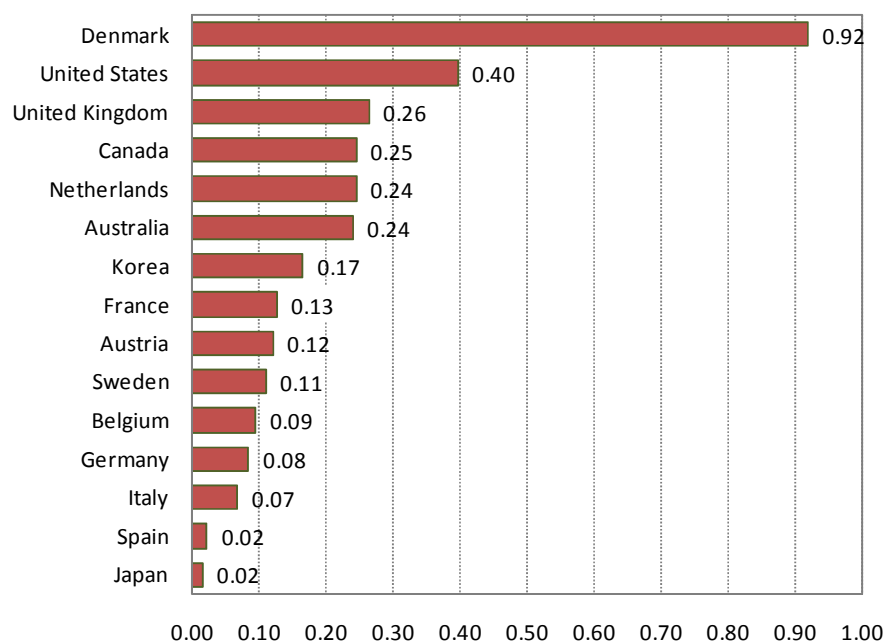
**Clinical trials**

- Clinical trials of new molecular entities (NMEs) are leading indicators that measure current research investments to develop future products. An NME contains an active ingredient that has never received marketing approval in a specific jurisdiction, such as the Food and Drug Administration in the United States. Clinical trial data are available for all types of biotechnology pharmaceuticals (therapeutics, vaccines, and *in vivo* diagnostics) and for the subgroup of experimental biopharmaceuticals. The data refer to active clinical trials of bio-NMEs as of December 2007. The NME remains 'active' until it is withdrawn from further development or obtains marketing approval.
- Clinical trials are mostly assigned to the head office country of the firm that owns the NME. Of note, clinical trials by Genentech are assigned to the United States, even though the firm was majority-owned by a Swiss firm. This is because Genentech continued to make independent strategic and research decisions. In some cases the current owner will differ from the nationality of the firm that conducted the original R&D to develop the NME. The results are limited to the OECD countries.
- As of December 2007, there were 703 active clinical trials of all bio-NMEs and 190 active clinical trials of experimental bio-NMEs. Firms conducting these clinical trials were based in 18 OECD countries. The United States leads all other countries in the total number of clinical trials of bio-NMEs (393 or 55.9%) and in the number of clinical trials of experimental bio-NMEs (119 or 62.6%). The United Kingdom is second, with a total of 70 clinical trials of bio-NMEs (10.0%) and 16 trials of experimental bio-NMEs (8.4%).
- Based on the population of the country where each firm is based, Denmark has the highest number of all clinical trials of bio-therapies (4.6 per million population) and of clinical trials of experimental bio-therapies (0.9 per million). Switzerland ranks second for all clinical trials of bio-therapies (3.57 per million), but no Swiss firm controls clinical trials of experimental bio-therapies. The United States is in third place for all clinical trials of bio-therapies and in second place for experimental bio-therapies.

## 9.3 Number of bio-therapies and experimental bio-therapies in clinical trials, December, 2007



Source: Sawaya, D., based on data from Pharmaprojects, February 2008.

**9.4. Number of all bio-therapies in clinical trials, per million population****9.5. Number of experimental bio-therapies in clinical trials, per million population**

➔ As the 2007 population data were incomplete, 2006 data were used. Results are for active bio-therapies as of December, 2007.

Sources: Sawaya, D., based on data from Pharmaprojects, February 2008; OECD, MSTI 2008/1, April 2009.

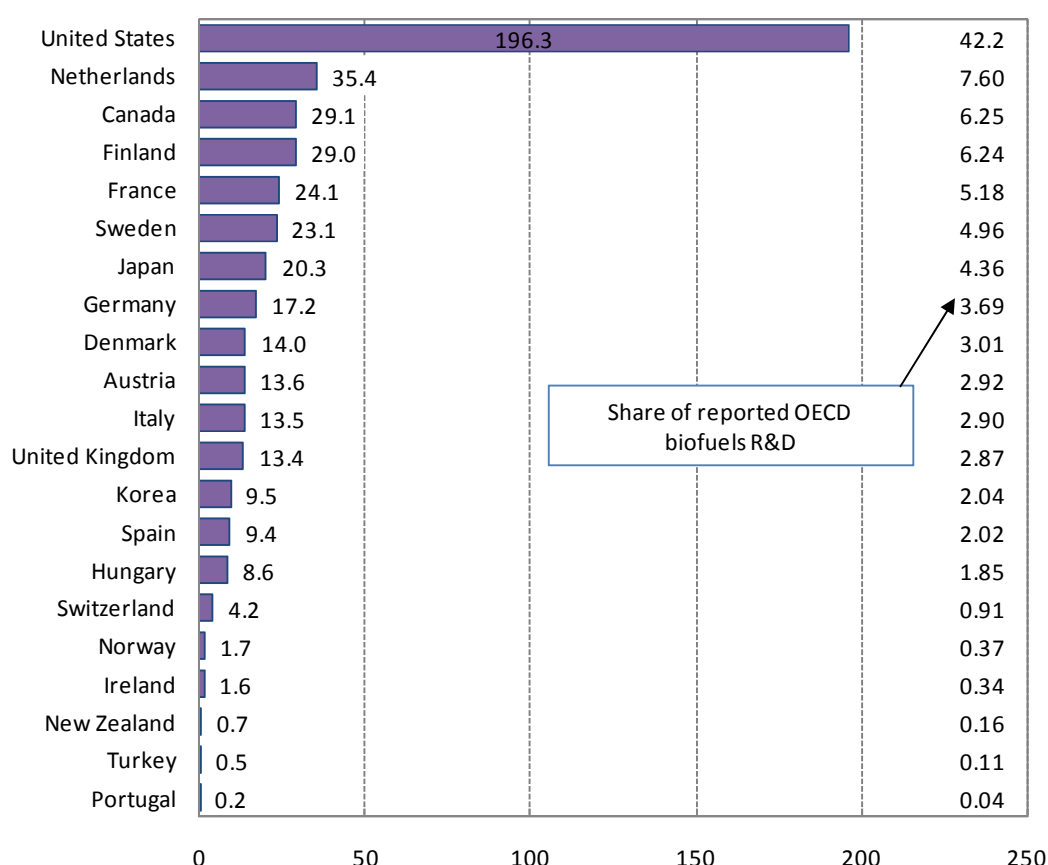




## 10. Industrial biotechnology

- Biotechnology has many industrial applications in the production of bulk and specialty chemicals, enzymes, plastics, biofuels, bioremediation, and the extraction of natural resources such as metals and petroleum.
- Unfortunately, there are almost no internationally comparable data on industrial biotechnology, other than the survey data given in Chapter 6. An exception is for government budgets for energy R&D. This includes a sub-category for biofuels (R&D for transport biofuels, other biomass fuels, applications for heat and electricity, and an 'other' category). Results are available for 21 OECD countries.
- The 21 reporting countries budgeted a total of USD 465.3 million PPP to biofuels R&D in 2007 out of a total energy budget of USD 11.1 billion PPP. The United States accounted for 42.2% of the total for biofuels. Thirteen countries of the European Union accounted for 43.6% of the total.
- Several Scandinavian countries rank highest for per capita government budgets for biofuel R&D, with Finland allocating USD 5.51 PPP, Denmark USD 2.58 PPP, and Sweden USD 2.54 PPP per capita. The average per capita budget in the OECD is USD 0.95 PPP.
- In Hungary, biofuels accounted for 80.4% of the government budget for energy R&D. Biofuels in Sweden and Finland accounted for over 25% of government energy R&D budgets.

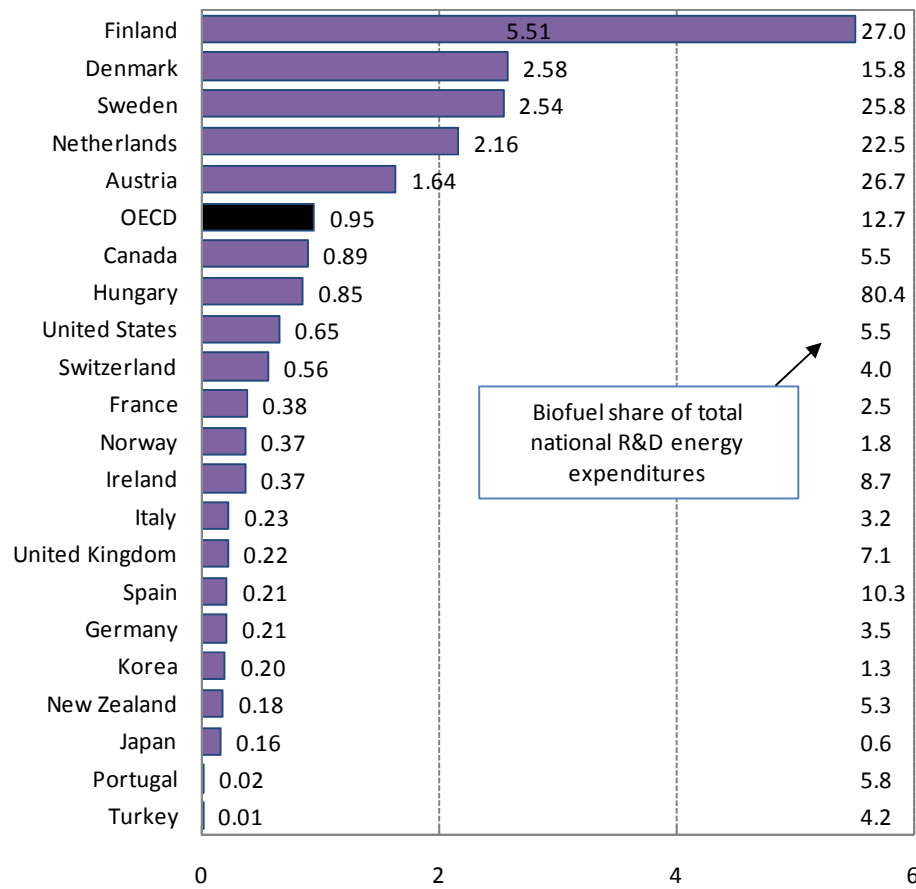
### 10.1. Government budgets for biofuel R&D, Million PPP\$, 2007



➔ Results for Austria, France, Finland and the Netherlands are for 2006.

Source: OECD, based on data from the International Energy Agency, Energy Technology R&D database 2008 Edition, April 2009.

## 10.2. Per capita government budgets for biofuel R&amp;D, PPP\$, 2007



→ Energy allocation data for Austria, France, Finland and the Netherlands are for 2006.

Source: OECD, based on data from the International Energy Agency, Energy Technology database R&D 2008 Edition; and OECD, MSTI 2008/1 data for national populations in 2006 (latest available year for all countries), April 2009.

**Table 10.1. Government budgets for biofuel energy R&D, Million PPP\$**

	2000	2001	2002	2003	2004	2005	2006	2007
Austria	4.7	6.5	7.5	6.7	8.9	11.5	13.6	..
Canada	10.3	8.9	13.2	19.0	12.6	19.6	43.1	29.1
Denmark	4.4	5.4	0.7	1.2	9.2	9.8	11.9	14.0
Finland	8.8	7.4	8.5	9.7	16.1	11.0	29.0	..
France	3.8	3.0	5.5	4.6	6.9	12.3	24.1	..
Germany	8.3	4.9	13.0	9.0	4.7	12.5	15.1	17.2
Hungary	0.8	1.6	2.2	2.7	5.6	7.1	8.1	8.6
Ireland	..	..	0.1	0.3	1.4	0.5	0.5	1.6
Italy	3.1	3.0	3.1	3.0	3.1	2.5	2.4	13.5
Japan	0.0	15.4	30.9	28.5	59.7	68.8	61.5	20.3
Korea	..	..	3.1	3.6	5.8	5.8	10.6	9.5
Netherlands	14.6	16.3	14.7	29.0	..	26.4	35.4	..
New Zealand	0.4	0.7	0.4	0.4	1.1	1.1	0.8	0.7
Norway	1.1	1.1	0.7	0.5	0.8	1.0	1.2	1.7
Portugal	0.3	0.2	0.2	0.2	0.8	0.7	0.1	0.2
Spain	6.3	7.0	4.9	6.1	5.2	5.3	7.2	9.4
Sweden	18.6	20.2	15.9	12.5	27.1	12.4	26.3	23.1
Switzerland	4.4	4.3	4.8	4.5	3.5	3.3	3.7	4.2
Turkey	1.2	0.2	0.2	0.3	0.5	0.8	0.9	0.5
United Kingdom	3.3	3.4	2.8	5.4	4.9	7.1	6.8	13.4
United States	83.0	100.8	100.6	95.9	92.4	92.6	92.1	196.3

**Table 10.2. Total Government budgets for energy R&D, Million PPP\$**

	2000	2001	2002	2003	2004	2005	2006	2007
Austria	30.9	38.9	37.4	31.6	41.6	41.0	50.8	..
Canada	259.2	282.0	305.6	335.2	279.8	430.6	511.0	528.5
Denmark	45.7	44.7	22.4	23.2	44.6	65.0	73.3	88.9
Finland	74.2	69.0	76.5	64.4	86.8	85.2	107.5	..
France	760.0	560.8	995.9	967.9	904.9	937.2	949.0	..
Germany	334.7	360.2	321.3	452.9	438.7	461.5	463.5	494.2
Hungary	6.4	5.7	7.4	6.1	7.0	9.0	10.1	10.7
Ireland	..	..	4.3	7.7	10.7	10.1	6.7	17.9
Italy	372.3	389.4	399.3	376.3	357.7	316.8	437.6	416.6
Japan	3322.3	3344.4	4047.6	3698.0	3448.2	3456.8	3465.2	3343.0
Korea	..	..	159.0	..	500.3	464.4	612.9	704.7
Netherlands	174.0	208.5	176.9	158.3	..	144.7	157.4	..
New Zealand	5.2	6.9	7.8	8.8	9.8	9.6	11.7	14.0
Norway	55.9	57.0	59.4	56.4	66.1	71.0	82.1	95.0
Portugal	2.6	1.6	3.3	4.2	4.6	3.5	1.9	2.8
Spain	84.2	81.4	71.9	83.7	63.8	69.2	79.0	91.5
Sweden	80.4	93.0	102.4	102.5	108.2	62.1	91.4	89.5
Switzerland	106.8	109.8	113.4	115.1	100.3	96.7	100.8	107.3
Turkey	8.6	9.4	7.3	7.4	1.9	4.7	7.7	11.9
United Kingdom	93.3	57.8	65.1	61.2	84.8	122.1	192.3	187.5
United States	2711.0	3287.1	3268.1	3091.2	3155.0	3186.3	3139.5	3584.5

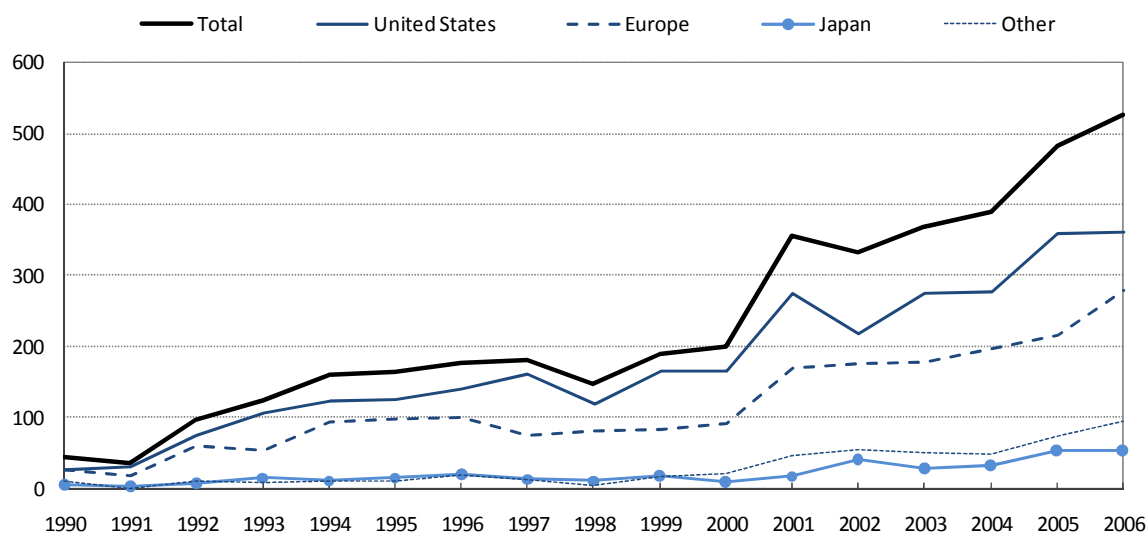
Source: OECD, based on data from the International Energy Agency, Energy Technology R&D database 2008 Edition, April 2009.



## 11. Biotechnology alliances

- The UNU-MERIT CATI database collects information on strategic alliances by domestic and multinational firms for technology transfer or joint research in biotechnology from announcements or articles in newspapers and professional journals, many of which are in English.
- Whether or not an alliance is made public and subject to a newspaper report will depend on the interests of the partners and the importance of the alliance to readers. Therefore, the UNU-MERIT CATI database is likely to exclude small alliances and those that the partners do not wish to publicly disclose. In addition, the database favours publications in English and consequently alliances from English-speaking countries such as the United States are likely to be over represented.
- Results are only available by major countries or regions: the United States, Europe, Japan, and non-triad (NT) countries (involving a country outside the previous three countries or regions). The number of alliances has increased from 45 in 1990 to 526 in 2006.
- For the last three years for which data are available (2004 to 2006), 1 396 biotechnology alliances were included in the UNU-MERIT CATI database. An alliance can include firms from two or more of the four countries or regions, or it can only include domestic firms.
- The share of alliances that involved one or more partners from the United States reached a peak in the late 1990s. The United States accounted for 86.1% of the 519 biotechnology alliances between 1997 and 1999, compared to 71.3% of the 1 396 biotechnology alliances between 2004 and 2006. Between 1997 to 1999 and 2004 to 2006, the share of alliances involving European firms increased from 46.2% to 49.7% and the share of alliances involving Japanese firms increased from 8.1% to 10.0%. The largest increase is for alliances involving firms from NT countries. This share more than doubled, from 7.3% of all alliances between 1997 and 1999 to 15.8% of alliances between 2004 and 2006.

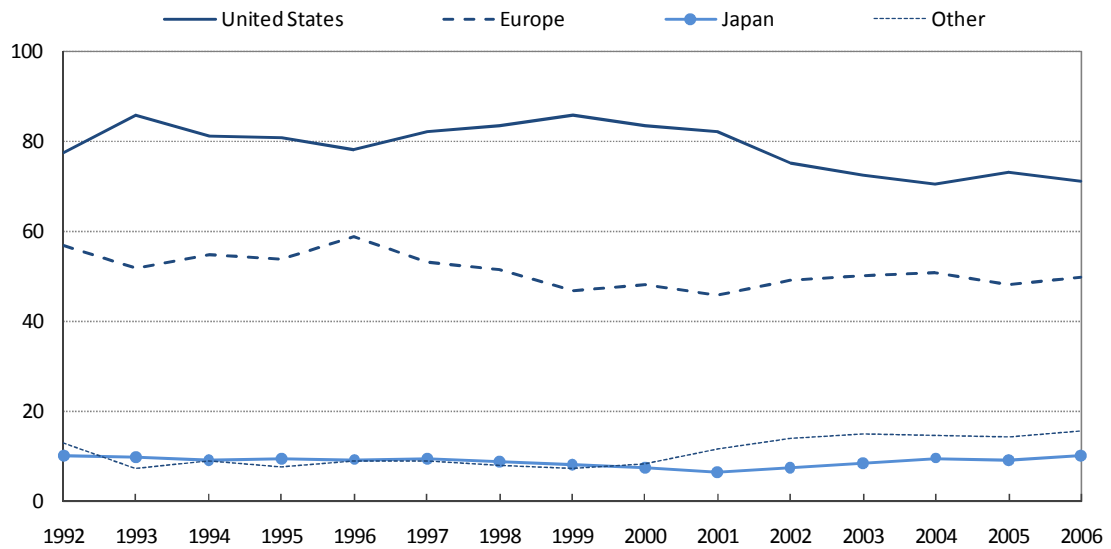
### 11.1. Number of biotechnology alliances, 1990 to 2006



→ Other: non-triad (alliance partners outside of the United States, Europe or Japan).

Source: UNU-MERIT CATI database, Maastricht, the Netherlands, April 2009.

### 11.2. Percent of biotechnology alliances with a partner from each region, 1990 to 2006



→ Other: non-triad (alliance partners outside of the United States, Europe or Japan).

Source: UNU-MERIT CATI database, Maastricht, the Netherlands, April 2009.

**Table 11.1. Number of biotechnology alliances for research or technology transfer, 1990 to 2005**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
United States	28	33	77	108	125	127	141	162	120	165	165	274	219	274	277	358	360
Europe	26	18	61	53	95	98	101	76	81	83	91	171	177	178	197	217	280
Japan	6	3	8	15	11	15	20	13	11	18	9	17	41	28	32	54	53
Other	11	1	11	9	12	12	20	14	6	18	22	48	56	52	50	75	96
Total	45	36	98	124	161	164	177	182	147	190	200	355	332	368	389	481	526

→ Other: non-triad (alliance partners outside of the United States, Europe or Japan).

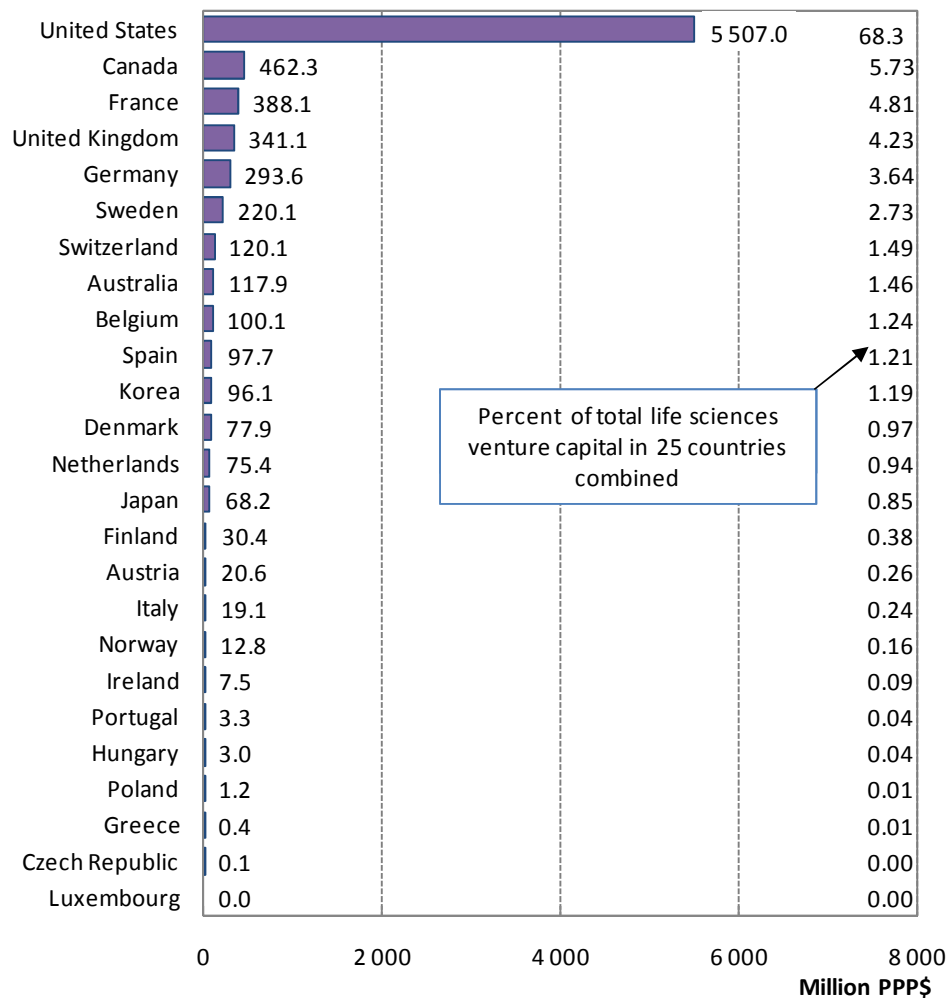
Source: UNU-MERIT CATI database, Maastricht, the Netherlands, April 2009.

## 12. Biotechnology venture capital

- Venture capital investment data for the life sciences for 2007 are available for up to 25 OECD countries from several venture capital associations. Comparable data are not available for biotechnology alone. The life sciences include biotechnology, pharmaceuticals, health services, and medical devices and equipment.
- For five countries (United States, Australia, United Kingdom, Germany and Canada) disaggregated data are available for biotechnology, although the definition of biotechnology varies. The average national share of 'biotechnology' out of life science venture capital investment for 2007 in these five countries is 47.5%. Biotechnology is likely to account for a higher share than this, as many firms active in medical devices such as diagnostics and tissue engineering use biotechnology.
- Venture capital is defined here to cover investments in seed, start-up, early development, and expansion stages. Later stage venture capital investment in replacements and buy-outs are not included.
- Data for Europe are by the country of the venture capital investment company and not by the location of the investment. The original life sciences investment data for Australia include buy-outs. The result excluding buy-outs has been estimated by subtracting the share of all Australian venture capital investments for buy-outs (43.45%) from the total investment in life sciences of USD 249 million PPP.
- The total 2007 venture capital investments in the life sciences for all 25 reporting OECD countries is USD 8 064 million PPP. The United States accounted for 68.3% of the total, Canada for 5.7%, and France for 4.8%. The EU members of the OECD accounted for 20.8%.
- There were no detectable venture capital investments in the life sciences in 2007 from Luxembourg. Life science investments were less than USD 1 million PPP in two countries: Greece (USD 0.42 million PPP) and the Czech Republic (USD 0.055 million PPP).
- Sweden had the highest share of GDP in 2007 from venture capital investments in biotechnology at 0.089%, followed by Denmark (0.062%), and Switzerland (0.054%). The OECD country average is 0.019%.
- Sweden also had the highest life sciences share of total venture capital investments in 2007, at 36.9%. Canada was second, at 30.7%, followed by the United States (29.9%). The OECD country average is 14.7%.
- Data on the average size of a venture capital life sciences investment are available for 23 OECD countries. The average size was highest in the United States, at USD 10.255 million PPP, followed by Canada (5.708 million) and Switzerland (3.002 million). The OECD country average venture capital investment in the life sciences is USD 1.841 million PPP.
- In Canada, the average venture capital investment in life sciences is 173.5% of the average for all types of venture capital investments or 73.5% larger than the average for Canada. In Germany, the average life science investment is 42.1% greater than the German average for all venture capital investments and the average life science investment in the United States is 26.4% greater than the American average. In contrast, life science investments are less than 0.03% of the average venture capital investment in the Czech Republic and 7.2% of the average in Poland.



### 12.1. Total venture capital investments<sup>1</sup> in the life sciences, Million PPP\$, 2007

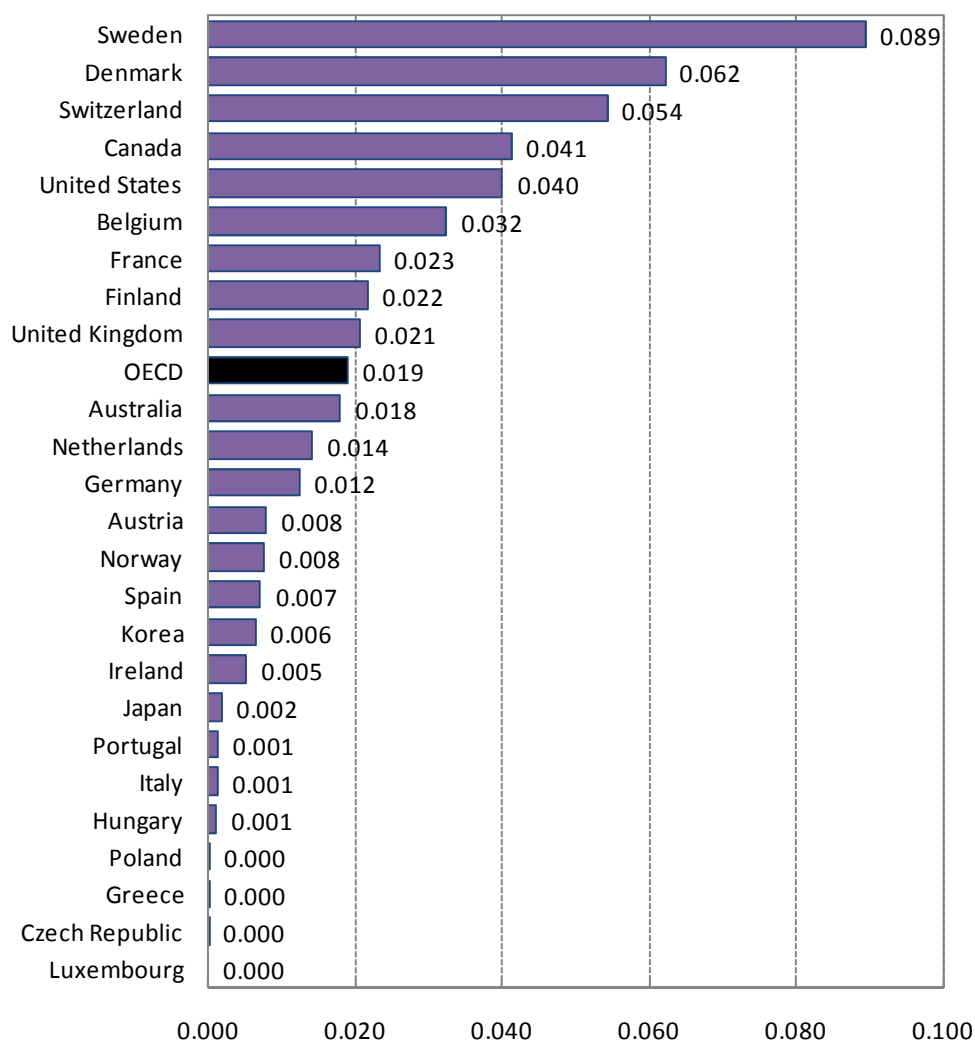


→ Results for Japan are for 2006.

1. Venture capital is limited to investment in seed, start-up, early development and expansion stages. Later stage replacement and buy-out investments are excluded.

Sources: OECD, based on data from Thomson Financial, PwC, EVCA, and National Venture Capital Associations.

## 12.2. Life sciences venture capital investments<sup>1</sup> as a percentage of GDP, 2007

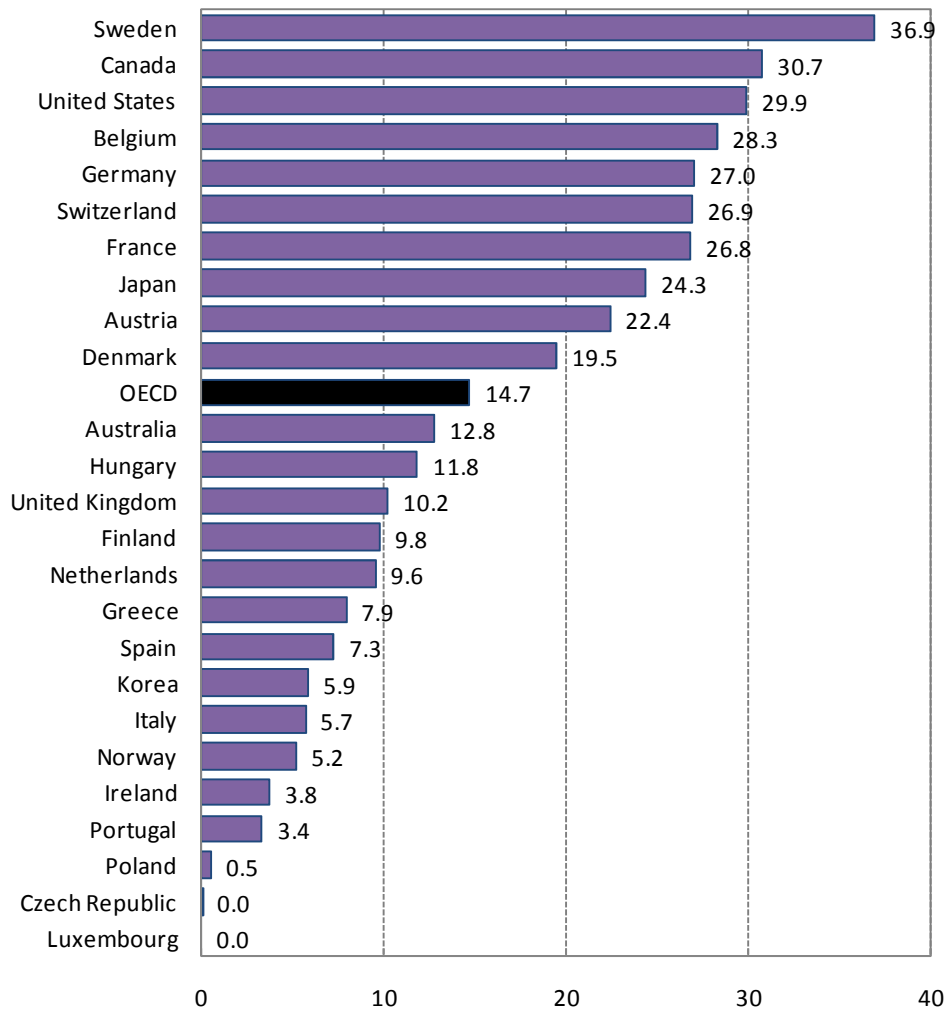


→ Results for Japan are for 2006.

1. Venture capital is limited to investment in seed, start-up, early development and expansion stages. Later stage replacement and buy-out investments are excluded.

Sources: OECD, based on data from Thomson Financial, PwC, EVCA, and National Venture Capital Associations.

### 12.3. Life sciences venture capital<sup>1</sup> as a share of all national venture capital investments, 2007

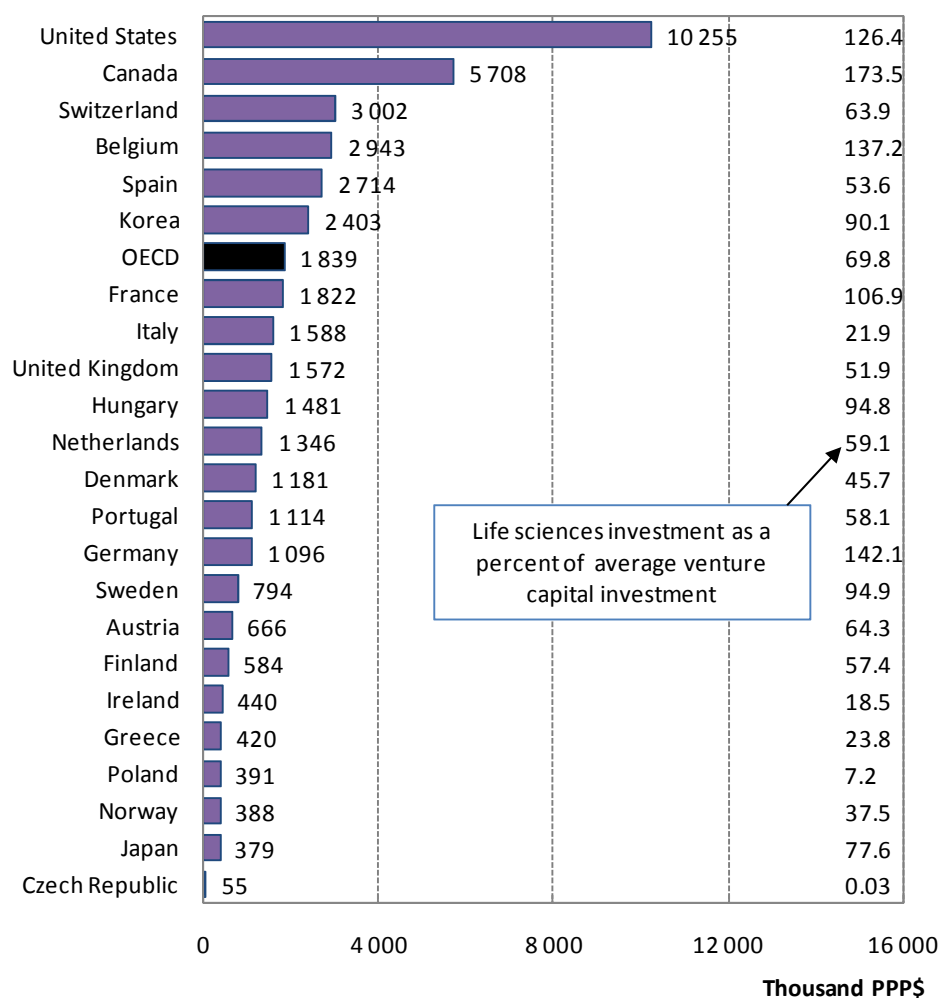


→ Results for Japan are for 2006.

1. Venture capital is limited to investment in seed, start-up, early development and expansion stages. Later stage replacement and buy-out investments are excluded.

Sources: OECD, based on data from Thomson Financial, PwC, EVCA, and National Venture Capital Associations.

#### 12.4. Average size of venture capital investments<sup>1</sup> in the life sciences, Thousand PPP\$, 2007



→ Results for Japan are for 2006.

1. Venture capital is limited to investment in seed, start-up, early development and expansion stages. Later stage replacement and buy-out investments are excluded.

Sources: OECD, based on data from Thomson Financial, PwC, EVCA, and National Venture Capital Associations.

**Table 12.1. Venture capital investments in the life sciences, 2007**

	Life sciences				All venture capital	
	Total (Million PPP\$)	Total (million USD)	Average size per investment (Thousand PPP\$)	Average size per investment (Thousand USD)	Total (Million USD)	Average size per investment (Thousand USD)
Australia	117.9	140.8	..	..	1 104.0	..
Austria	20.6	24.5	666.0	791.6	109.6	1 231.1
Belgium	100.1	121.9	2 943.0	3 584.4	431.2	2 613.4
Canada	462.3	523.3	5 708.0	6 460.9	1 702.3	3 724.9
Czech Republic	0.1	0.0	55.0	39.0	112.1	7 474.7
Denmark	77.9	122.0	1 181.0	1 848.7	627.0	4 045.0
Finland	30.4	39.8	584.0	765.3	406.5	1 332.9
France	388.1	483.1	1 822.0	2 268.2	1 802.1	2 130.1
Germany	293.6	351.9	1 096.0	1 312.9	1 302.8	924.0
Greece	0.4	0.4	420.0	406.0	5.1	1 704.4
Hungary	3.0	2.2	1 481.0	1 080.9	18.3	1 140.8
Ireland	7.5	10.3	440.0	605.1	274.2	3 264.6
Italy	19.1	22.7	1 588.0	1 887.8	397.4	8 639.7
Japan	68.2	73.0	379.0	405.8	710.0	522.8
Korea	96.1	77.5	2 403.0	1 937.0	1 322.5	2 150.4
Luxembourg	0.0	0.0	..	..	107.9	8 988.0
Netherlands	75.4	91.2	1 346.0	1 628.2	953.4	2 755.4
Norway	12.8	19.2	388.0	582.5	369.2	1 551.5
Poland	1.2	0.8	391.0	269.9	158.1	3 764.8
Portugal	3.3	3.2	1 114.0	1 074.8	96.2	1 850.9
Spain	97.7	101.9	2 714.0	2 830.2	1 399.4	5 280.7
Sweden	220.1	299.5	794.0	1 081.4	811.2	1 139.3
Switzerland	120.1	167.4	3 002.0	4 184.6	622.2	6 549.4
United Kingdom	341.1	447.6	1 572.0	2 062.6	4 388.6	3 971.6
United States	5 507.0	5 507.0	10 255.0	10 255.1	30 885.9	8 110.8
OECD	8 064.0	8 631.3	1 841.0	2 059.3	50 117.2	3 535.9

→ Results for Japan are for 2006.

1. Venture capital is limited to investment in seed, start-up, early development and expansion stages. Later stage replacement and buy-out investments are excluded.

Sources: OECD, based on data from Thomson Financial, PwC, EVCA, and National Venture Capital Associations.

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