Canadian Biotechnology Statistics

In support of the implementation of the Canadian Biotechnology Strategy

CBS THEME 9

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Ottawa, Canada

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Canadian Biotechnology Statistics is available electronically on the Industry Canada *Strategis* web site at:
http://strategis.ic.gc.ca/cbs

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Acknowledgment
This publication is a result of the collaborative work of the Canadian Biotechnology Strategy (CBS) Working Group on Biotechnology Statistics, which is composed of members from seven government departments (listed below). This is a summary of statistics on biotechnology compiled from a series of initiatives conducted by the Science and Technology Redesign Project of Statistics Canada in collaboration with the Life Sciences Branch of Industry Canada and BIOTECanada. The seven departments of the Canadian Biotechnology Strategy (CBS) are:

Agriculture and Agri-Food Canada
International Trade
Fisheries and Oceans
Environment Canada
Health Canada
Industry Canada
Natural Resources Canada

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A Note to Readers

This booklet presents basic statistics on biotechnology activity in Canada, as part of the work program of the Canadian Biotechnology Strategy. Canadian Biotechnology Strategy Theme 9 is "Improving Policy-relevant Data Collection and Analysis" in biotechnology.

Biotechnology is defined as the application of science and engineering in the direct or indirect use of living organisms or parts of organisms in their natural or modified forms in an innovative manner in the production of goods and services or to improve existing processes.

Producing statistics in biotechnology faces a number of challenges, including identification of the parameters of the biotechnology sector. Often the question of what constitutes the biotechnology domain is unclear. This difficulty can be attributed to the challenge of defining what is the biotechnology sector and biotechnology's dynamic nature. Innovative technologies and processes are introduced on a regular basis and firms appear and disappear in response to the demands of the market. Collection of biotechnology statistics remains a work in progress.

The data are presented in four major sections. Each section represents a different aspect of the biotechnology industry in Canada. The first section presents data on science and technology activities and biotechnology related R&D expenditures of the federal government and its departments and agencies. The second section reflects the biotechnology research and development activities of firms in Canadian industry as a whole. The third section reflects the use of biotechnology by firms in the manufacturing and resource sectors. The final section is based on the *Biotechnology Firm Survey*, a survey of firms that develop biotechnologies as a significant portion of their business activities.

The data presented here are derived from Statistics Canada sources. The sources examine different aspects of the biotechnology industry using varying definitions and classifications.

The data sources are:

- Arundel, Anthony. 1999. *Diffusion of Biotechnology in Canada: Results from the Survey of Biotechnology Use in Canadian Industries — 1996*. Science and Technology Redesign Project. Ottawa: Statistics Canada Catalogue # 88F-0017-MPB No. 6.
- Groote, J., P. Hough and R. Walter. 1999. "Canadian Biotechnology '98: Success from Excellence." *BIOTECanada's First Report on the Canadian Biotechnology Industry*. Ottawa.
- Rose, Antoine. 1998. *Biotechnology Use by Canadian Industry — 1996*. Science and Technology Redesign Project. Ottawa: Statistics Canada Catalogue # ST-998-05.
- Statistics Canada. 1997. "Biotechnology Research and Development in Canadian Industry." *Science Statistics* 21 (11). Statistics Canada Catalogue # 88-001-XPB.
- Statistics Canada. 1998. "Biotechnology Scientific Activities in Selected Federal Government Departments and Agencies, 1997–98." *Science Statistics* 22 (4). Statistics Canada Catalogue # 88-001-XIB.
- Statistics Canada. 1998. "Biotechnology Firm Survey, Data Release," The Daily, August 19, 1998.

Readers are advised to be attentive to the different aspects of the biotechnology activities presented, the various sources of data and time periods for each section. Survey details are available upon request from:

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In the tables and figures, some details may not add up exactly to totals stated because of rounding of numbers or in some cases multiple responses.

Biotechnology Science and Technology Activity in the Federal Government

These data are composed of R&D and related scientific activities expenditures for intramural and extramural activities. The criterion for collection of data from selected federal government departments and agencies was significant activity in the field of biotechnology scientific activity.

Biotechnology S&T expenditures reach $314 million, about 6% of federal S&T expenditures in 1997–98.

Some $310 million of the $314 million was devoted to R&D, almost 10% of total federal R&D spending.

Some 65% of biotechnology S&T activities was performed outside the federal government.

There were 1,007 person-years (full-time equivalents) or 3.5% of total S&T person-years that were devoted to biotech S&T activity in the federal government.

Federal Government S&T Expenditures on Biotechnology, by Activity and Performer, 1997–98 ($000)

	Intramural	Business Enterprises	Higher Education	Foreign Performers	Other	Total
Research and Experimental Development (R&D)	107,854	6,179	194,842	107	612	309,594
Related Scientific Activity (RSA)	3,225	880	334	30	10	4,479
Total S&T Expenditures	**111,079**	**7,059**	**195,176**	**137**	**622**	**314,073**

Source: Statistics Canada. 1998. *Science Statistics* 22 (4). Statistics Canada Catalogue # 88-001-XIB.

Federal Government S&T Expenditures on Biotechnology Activities, by Selected Government Department or Agency and Performer, 1997–98 ($000)

	Intramural	Business Enterprises	Higher Education	Foreign Performers	Other	Total
Government Department or Agency						
Agriculture and Agri-Food Canada	39,890	–	–	–	–	39,890
Environment Canada	759	1,199	136	40	–	2,134
Fisheries and Oceans	600	–	–	–	–	600
Health Canada	3,523	84	–	–	539	4,146
Industry Canada	754	5,542	–	–	–	6,296
Medical Research Council	–	–	104,000	–	–	104,000
National Research Council	59,559	20	21	–	–	59,600
Natural Resources Canada	5,994	214	–	–	83	6,291
Natural Sciences and Engineering Research Council	–	–	90,000	–	–	90,000
Social Sciences and Humanities Research Council	–	–	1,019	97	–	1,116
Total S&T Expenditures	**111,079**	**7,059**	**195,176**	**137**	**622**	**314,073**

Source: Statistics Canada. 1998. *Science Statistics* 22 (4). Statistics Canada Catalogue # 88-001-XIB.

Federal Government R&D Expenditures on Biotechnology Activities, by Selected Government Department or Agency and Performer, 1997–98 ($000)

	Intramural	Business Enterprises	Higher Education	Foreign Performers	Other	Total
Government Department or Agency						
Agriculture and Agri-Food Canada	39,881	–	–	–	–	39,881
Environment Canada	577	419	88	40	–	1,124
Fisheries and Oceans	580	–	–	–	–	580
Health Canada	2,181	84	–	–	539	2,804
Industry Canada	–	5,442	–	–	–	5,442
Medical Research Council	–	–	104,000	–	–	104,000
National Research Council	58,589	20	20	–	–	58,899
Natural Resources Canada	5,776	214	–	–	73	6,063
Natural Sciences and Engineering Research Council	–	–	90,000	–	–	90,000
Social Sciences and Humanities Research Council	–	–	734	67	–	801
Total R&D Expenditures	**107,854**	**6,179**	**194,842**	**107**	**612**	**309,594**

Source: Statistics Canada. 1998. *Science Statistics* 22 (4). Statistics Canada Catalogue # 88-001-XIB.

Comparison of Federal Government S&T Expenditures and Biotechnology Expenditures, by Department or Agency, 1997–98 ($000)

	S&T Expenditures	Biotechnology S&T Expenditures	Share of Total (%)
Government Department or Agency			
Agriculture and Agri-Food Canada	274,086	39,890	14.6
Environment Canada	373,908	2,134	0.6
Fisheries and Oceans	187,927	600	0.3
Health Canada	193,227	4,146	2.1
Industry Canada	364,335	6,296	1.7
Medical Research Council	237,542	104,000	43.8
National Research Council	513,476	59,600	11.6
Natural Resources Canada	358,001	6,291	1.8
Natural Sciences and Engineering Research Council	435,949	90,000	20.6
Social Sciences and Humanities Research Council	94,779	1,116	1.2
Other	2,084,357	–	–
Total S&T Expenditures	**5,117,605**	**314,073**	**6.1**

Source: Statistics Canada. 1998. *Science Statistics* 22 (4). Statistics Canada Catalogue # 88-001-XIB.

Comparison of Federal Government R&D Expenditures and Biotechnology R&D Expenditures, by Department or Agency, 1997–98 ($000)

Government Department or Agency	R&D Expenditures	Biotechnology R&D Expenditures	Share of Total (%)
Agriculture and Agri-Food Canada	259,217	39,881	15.4
Environment Canada	108,988	1,124	1.0
Fisheries and Oceans	71,898	580	0.8
Health Canada	60,908	2,804	4.6
Industry Canada	303,564	5,442	1.8
Medical Research Council	228,562	104,000	45.5
National Research Council	433,859	58,899	13.6
Natural Resources Canada	310,244	6,063	2.0
Natural Sciences and Engineering Research Council	391,832	90,000	23.0
Social Sciences and Humanities Research Council	64,079	801	1.3
Other	827,657	–	–
Total R&D Expenditures	**3,060,808**	**309,594**	**10.1**

Source: Statistics Canada. 1998. *Science Statistics* 22 (4). Statistics Canada Catalogue # 88-001-XIB.

Biotechnology Research and Development Activity in Canadian Industry

These statistics reveal the level of investment in biotechnology R&D and demonstrate the trends in spending on R&D among Canadian industry as a whole. The survey collected data on R&D activities by Canadian industry with activities in biotechnology. The data are derived from the Statistics Canada Service Bulletin *Science Statistics* 21 (11).

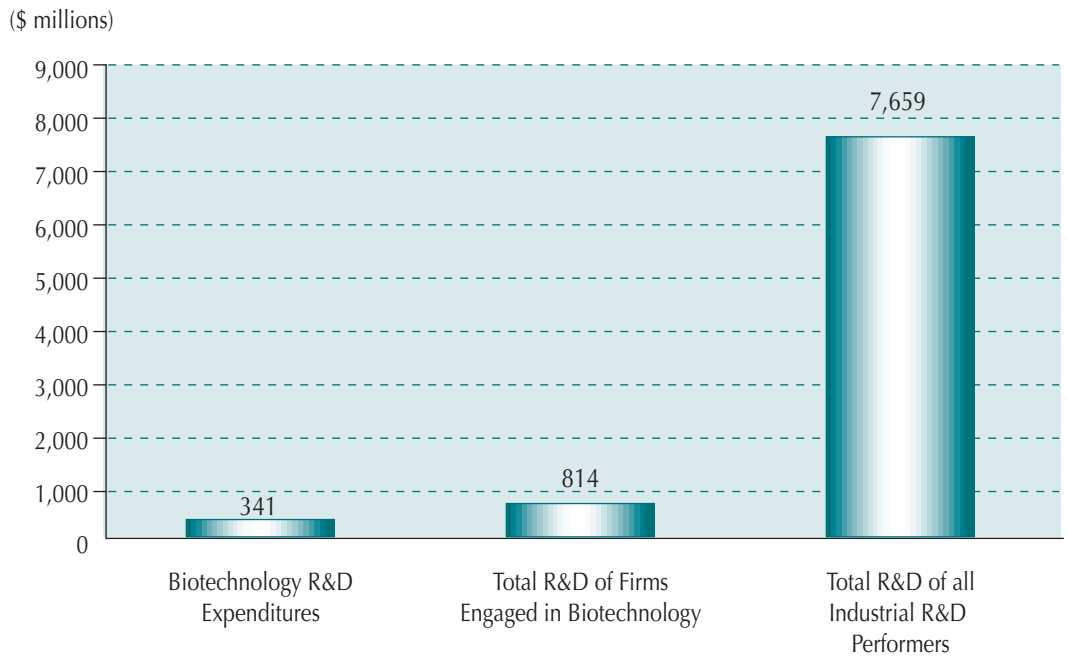
Between 1989 and 1995, biotechnology R&D expenditures grew from $116 million to $341 million, growing at an annual compound rate of 19.6%, which was more than double the industrial R&D growth rate of 8%.

In 1995, 57% of biotechnology R&D expenditures was centred in the health sector. Spending averaged $2.4 million per firm (24% of all firms' revenues) on biotechnology R&D.

In 1995, 73% of biotechnology R&D expenditures was under Canadian control, with 13% under United States control and 15% under other foreign control (these shares remained constant between 1989 and 1995).

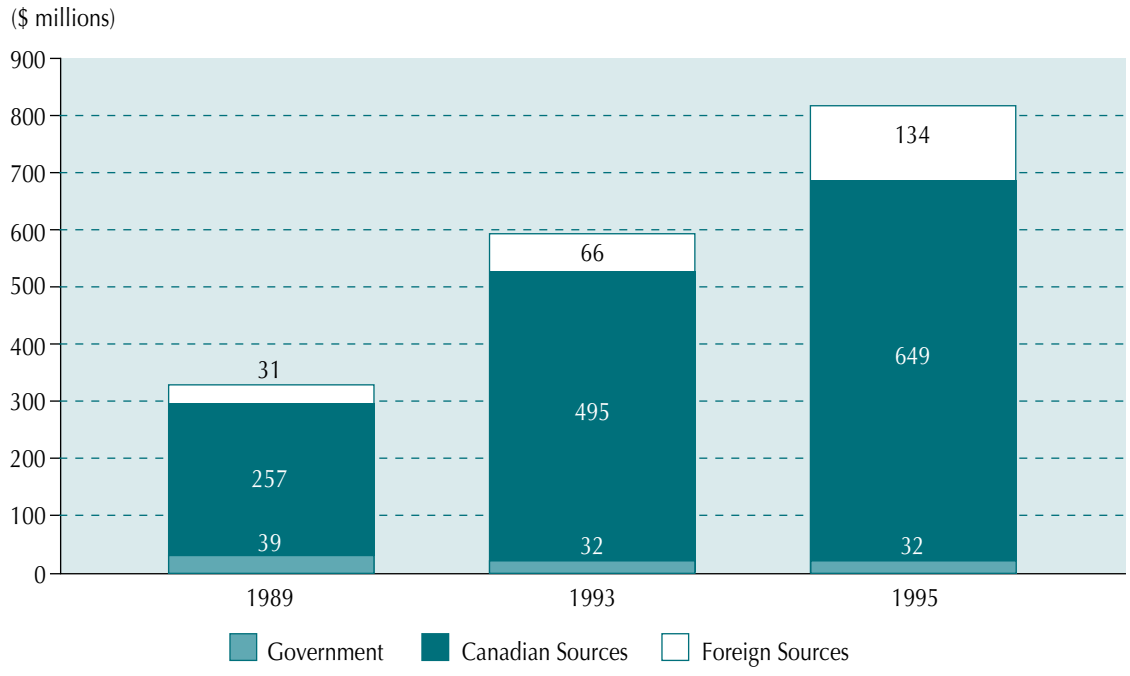
The share of biotechnology R&D undertaken by larger firms, based on revenue, was increasing, moving from 30% of total biotechnology R&D in 1989 to 45% in 1995.

Comparison of R&D Expenditures and Biotech R&D Expenditures by Industrial Firms, 1995



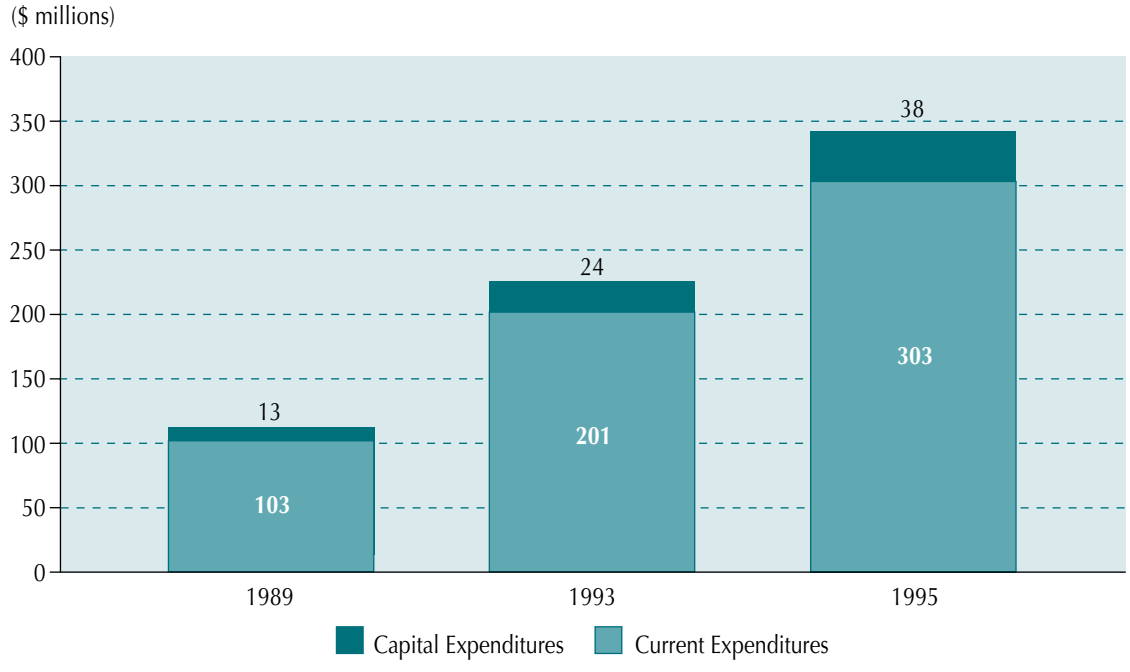
Source: Statistics Canada. 1997. *Science Statistics* 21 (11). Statistics Canada Catalogue # 88-001-XPB.

Sources of Funds for Industrial Firms Conducting Biotechnology R&D



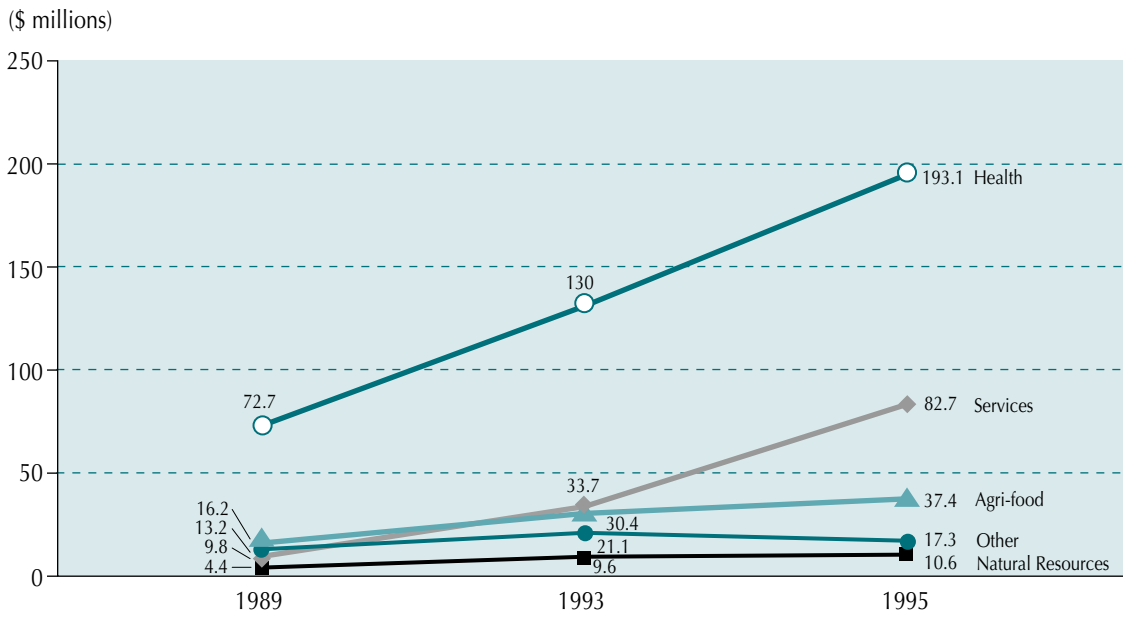
Source: Statistics Canada. 1997. *Science Statistics* 21 (11). Statistics Canada Catalogue # 88-001-XPB.

Capital and Current Expenditures



Source: Statistics Canada. 1997. *Science Statistics* 21 (11). Statistics Canada Catalogue # 88-001-XPB.

Industry's Biotechnology R&D Expenditures, by Sector, 1989–95



Source: Statistics Canada. 1997. *Science Statistics* 21 (11). Statistics Canada Catalogue # 88-001-XPB.

Biotechnology Use by Canadian Industry, 1996

Data presented in this section measure the use and diffusion of biotechnology and the factors influencing biotechnology adoption by industrial firms. Firms in resource and manufacturing sectors where biotechnologies had proven or potential applications were questioned about their use of biotechnologies in three major technology classes. Data were derived from Statistics Canada's survey of biotechnology use by Canadian industry, 1996, and were summarized in two papers:

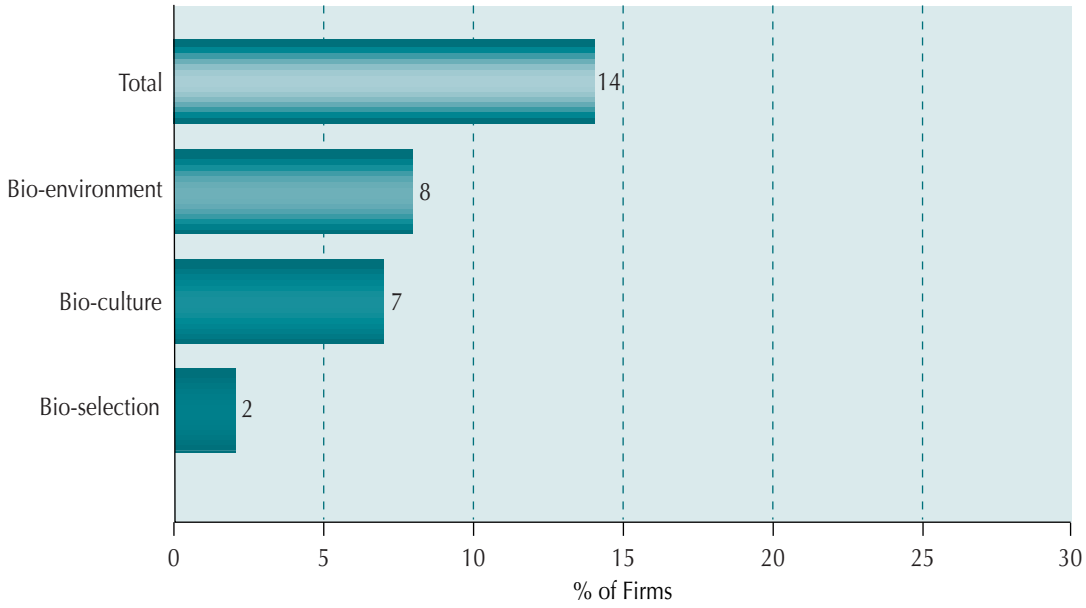
- Rose, Antoine. 1998. *Biotechnology Use by Canadian Industry — 1996*. Science and Technology Redesign Project. Ottawa: Statistics Canada.
- Arundel, Anthony. 1999. *Diffusion of Biotechnology in Canada: Results from the Survey of Biotechnology Use in Canadian Industries — 1996*. Science and Technology Redesign Project. Ottawa: Statistics Canada.

In 1996, 14% of 2,010 responding firms reported using at least one form of biotechnology, and an additional 3% of the firms anticipated becoming biotechnology users within two years.

Over 70% of firms using biotechnology used only one or two biotechnologies.

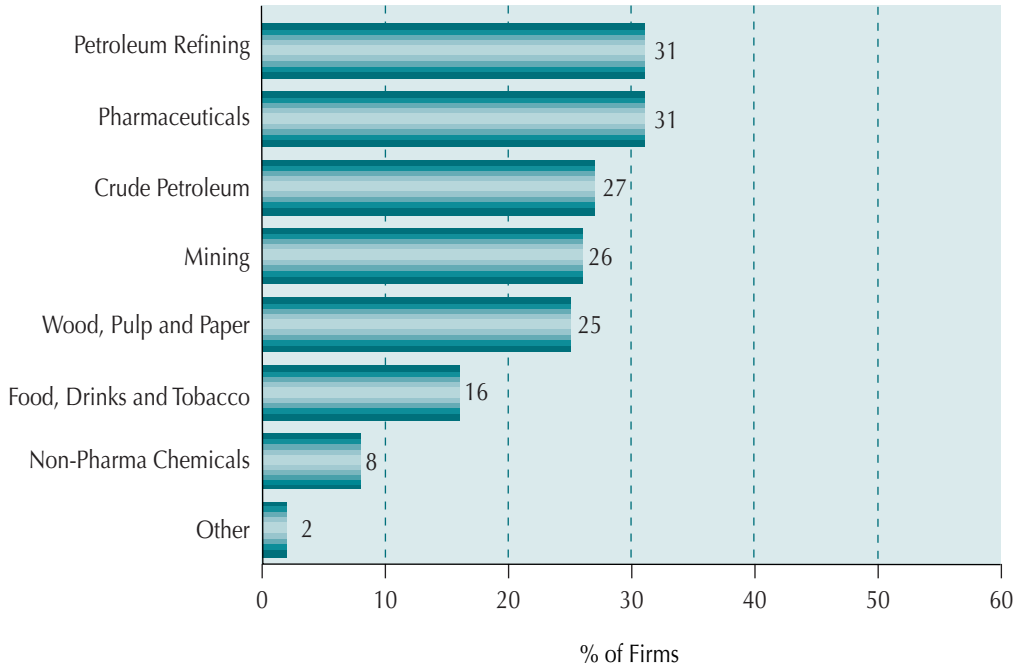
Some 60% of firms earning more than $500 million in revenues made use of biotechnology, with almost half (47%) of those being active in biotechnologies related to the environment.

Percentage of Firms Using Biotechnology, 1996



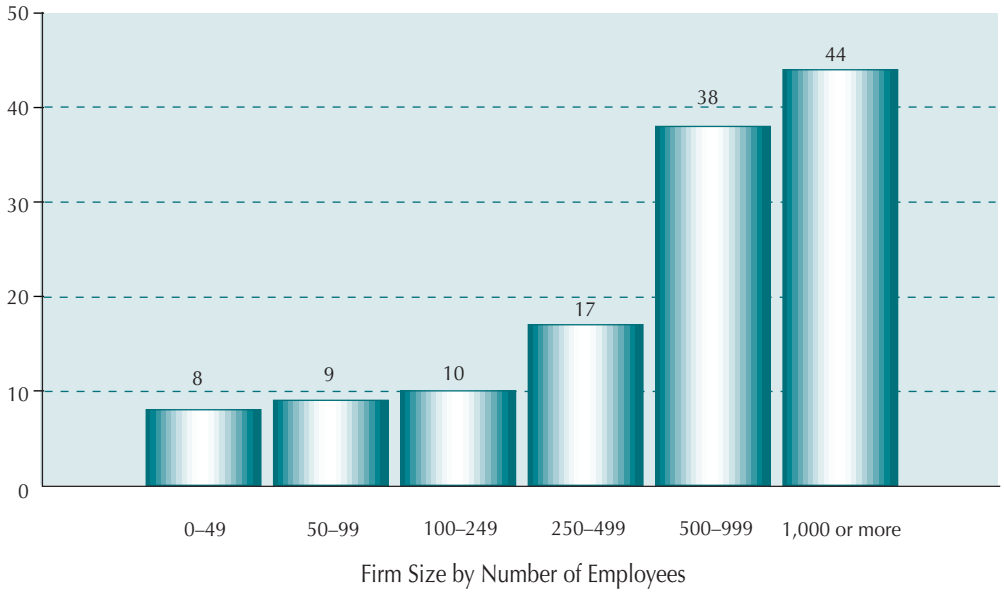
Source: Rose, 1998; Statistics Canada.

Percentage of Firms Using Biotechnology, by Sector



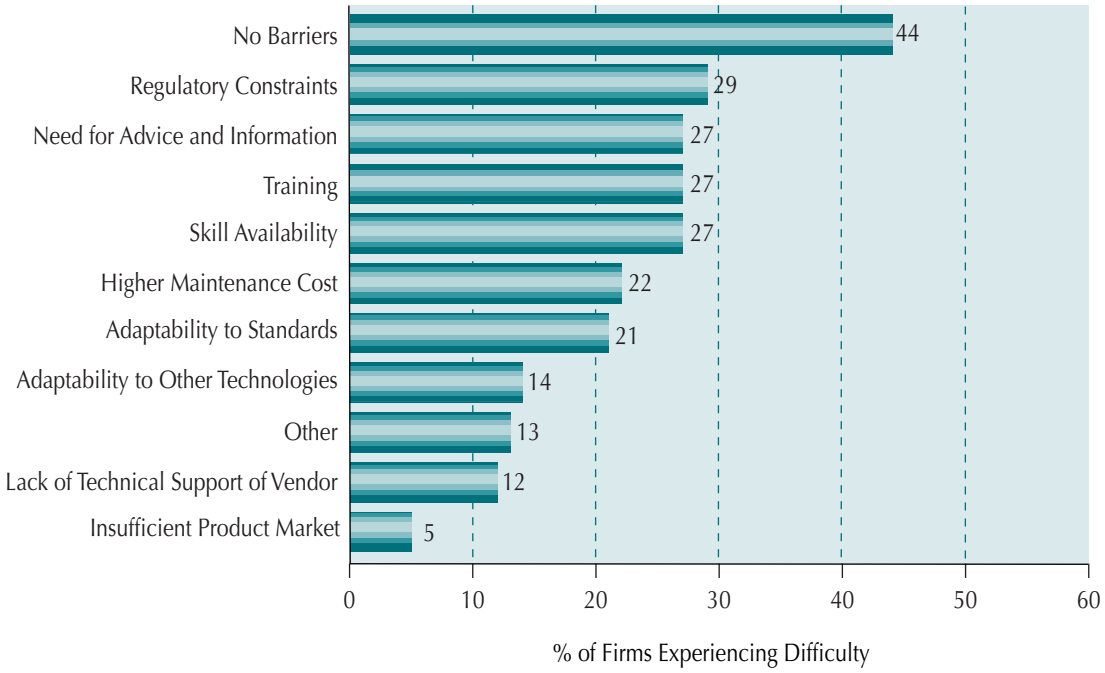
Source: Arundel, 1999; Statistics Canada.

Percentage of Firms by Size Using One or More Biotechnologies



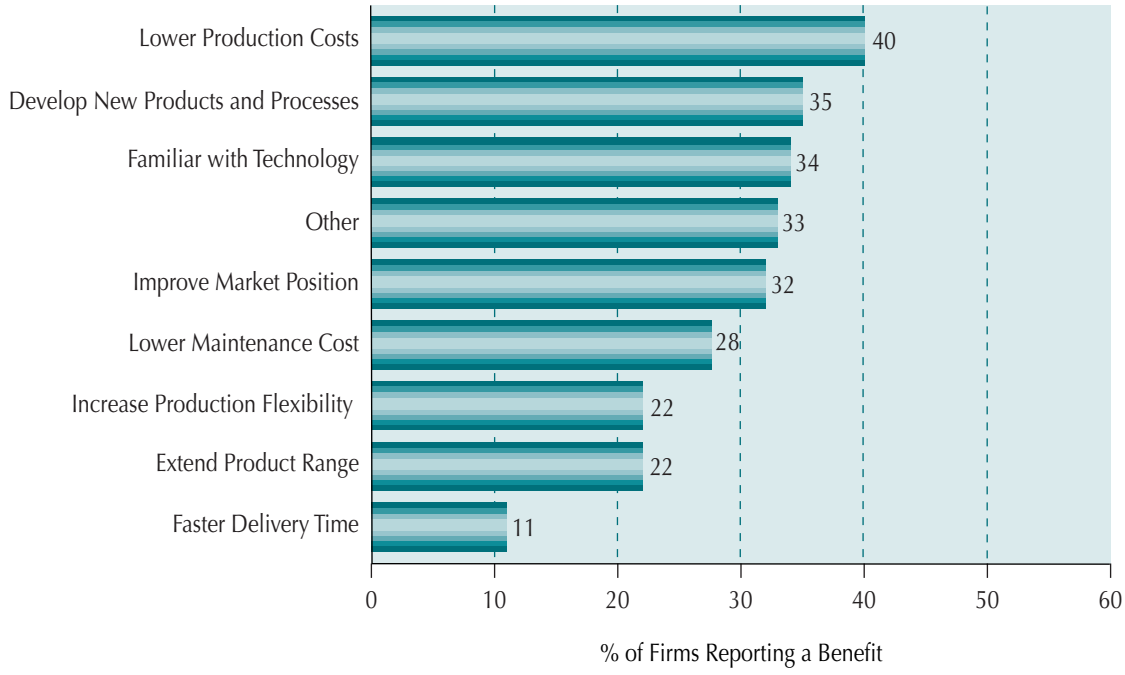
Source: Arundel, 1999; Statistics Canada.

Difficulties Experienced by Firms in Implementing Biotechnologies



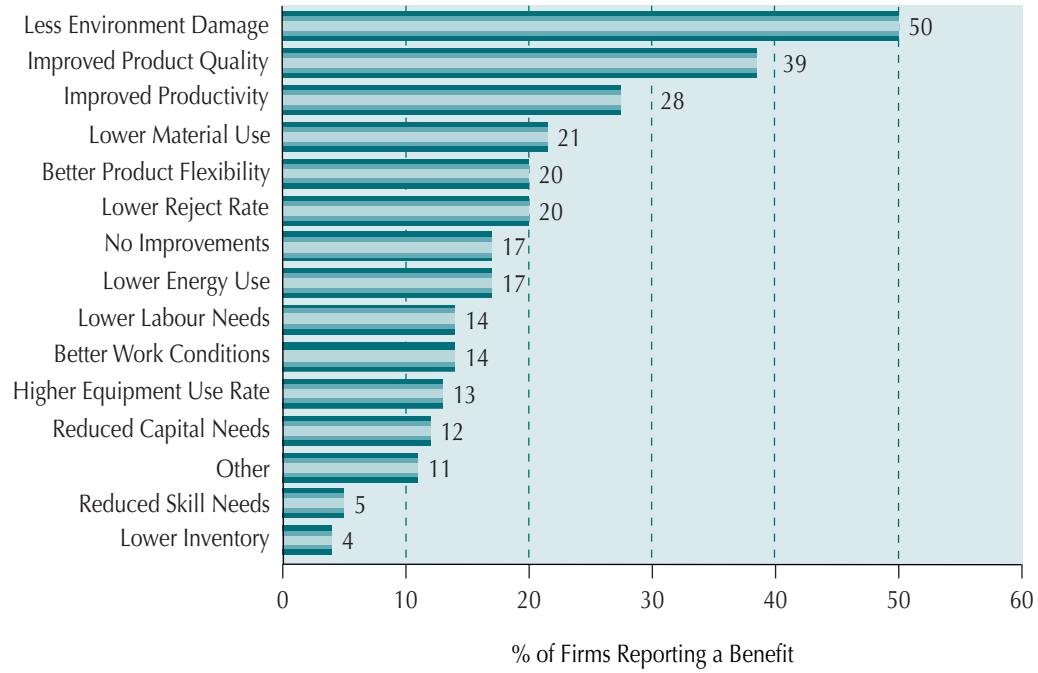
Source: Arundel, 1999; Statistics Canada.

Positive Influences Associated with Adoption of Biotechnologies



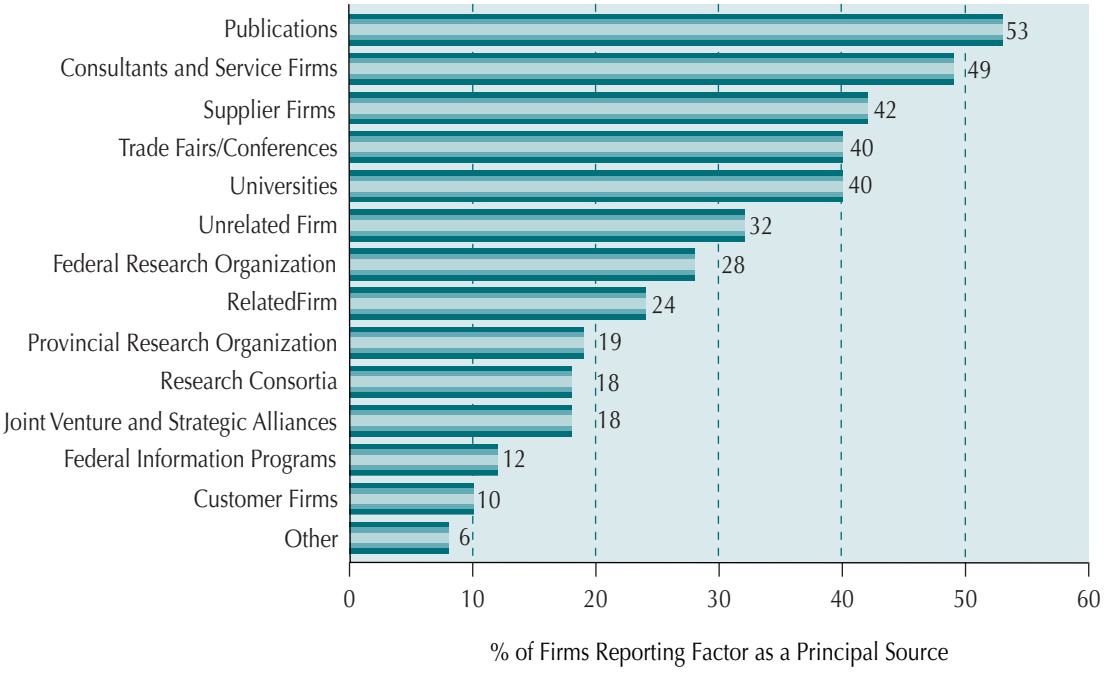
Source: Arundel, 1999; Statistics Canada.

Benefits Associated with Adoption of Biotechnologies



Source: Arundel, 1999; Statistics Canada.

External Sources of Information



Source: Arundel, 1999; Statistics Canada.

Biotechnology Firm Characteristics

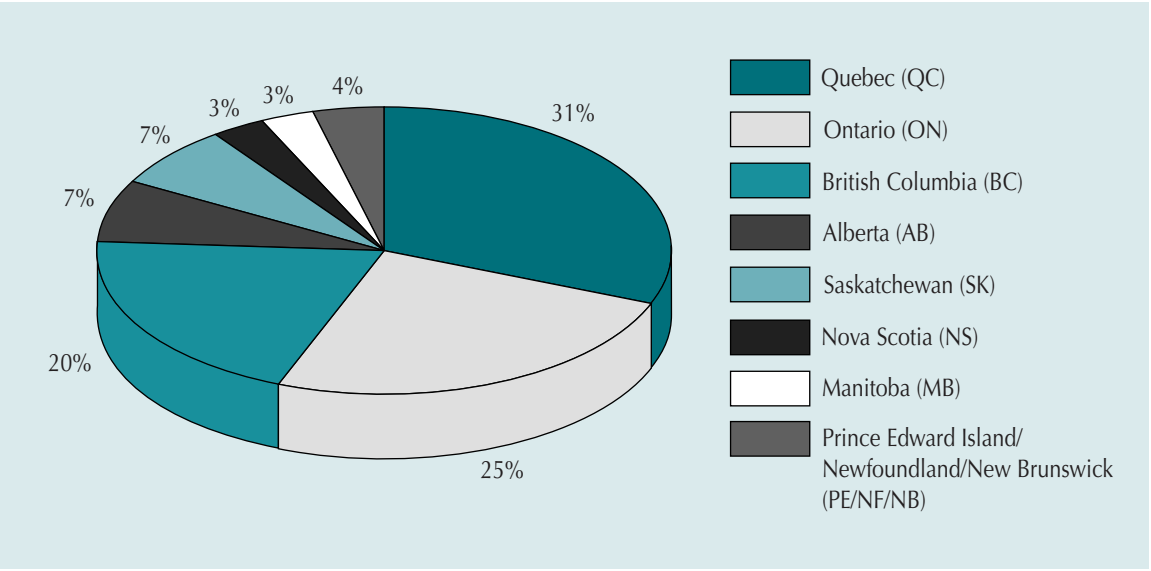
The *Biotechnology Firm Survey* examines the characteristics of firms that develop biotechnologies as a significant component of their activities. The following tables and charts profile the activities of those firms.

Biotechnology firms are primarily privately owned, smaller in size than public firms. Private firms combined have 27% of total revenues despite comprising over 70% of the total number of biotechnology firms.

Biotechnology was centred in Quebec (31%), Ontario (25%) and British Columbia (20%).

Human health biotechnologies were carried out by 46% of firms, followed by agriculture biotechnology by 22% of firms.

Distribution of Biotechnology Firms, by Province, 1997



Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Provincial Employment Profiles, 1997

	Canada	QC	ON	BC	AB	SK	NS	MB	PE/NF/NB
Number of Firms	**282**	86	71	56	19	21	9	8	11
Biotech Employment (March 1998)	**9,823**	3,092	3,221	1,307	978	439	226	295	264
Unfilled Positions	**1,899**	567	560	467	86	50	108	32	29
Biotech Employment 2001	**15,800**	4,630	4,352	3,043	1,457	751	891	299	377

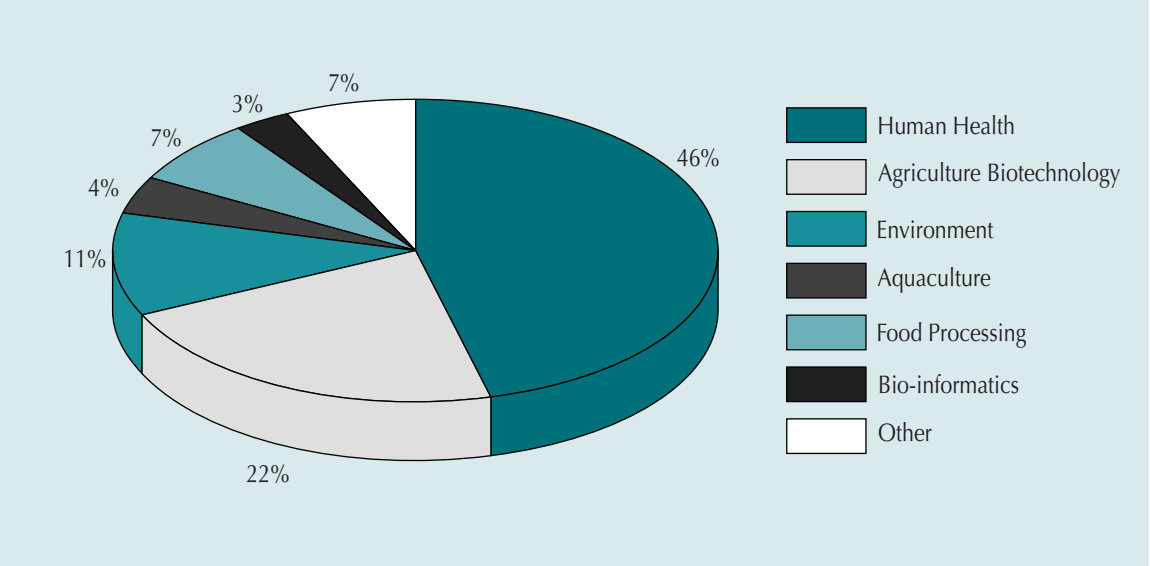
Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Provincial Financial Profiles, 1997 ($ millions)

	Canada	QC	ON	BC	AB	SK	NS	MB	PE/NF/NB
Number of Firms	**282**	86	71	56	19	21	9	8	11
Biotech R&D	**585**	141	244	106	44	26	9	9	6
Total R&D	**838**	329	283	106	51	42	9	13	6
Biotech Sales	**1,017**	349	365	43	93	86	16	58	7
Total Revenue	**11,227**	4,043	1,049	48	99	2,601	21	3,357	9
Biotech Exports	**413**	101	175	36	79	2	11	4	5
Total Exports	**4,871**	1,620	352	37	83	775	11	1,989	5

Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Distribution of Biotech Firms, by Sector, 1997



Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Sector Employment Profiles, 1997

	Total	Health	Ag-Bio	Environ	Aqua	Food	Bio-Info	Other
Number of Firms	**282**	129	62	32	12	20	8	19
Biotech Employment (March 1999)	**9,823**	6,706	1,693	270	93	202	216	643
Unfilled Positions	**1,899**	1,368	223	140	29	43	22	75
Biotech Employment 2001	**15,800**	10,391	2,629	695	152	391	437	1,104

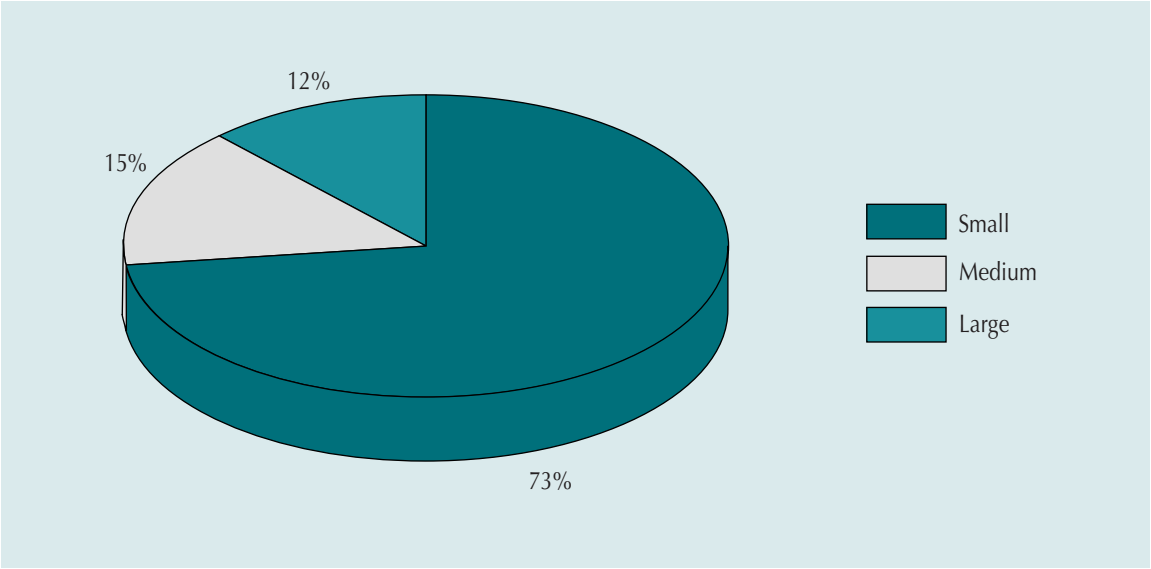
Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Sector Financial Profiles, 1997 ($ millions)

	Total	Health	Ag-Bio	Environ	Aqua	Food	Bio-Info	Other
Number of Firms	**282**	129	62	32	12	20	8	19
Biotech R&D	**585**	506	29	6	2	11	15	17
Total R&D	**838**	635	62	49	2	20	16	53
Biotech Sales	**1,017**	510	235	25	11	214	4	18
Total Revenue	**11,227**	1,735	6,226	1,439	14	1,654	62	97
Biotech Exports	**413**	240	88	4	5	74	_	2
Total Exports	**4,871**	628	2,891	1,039	5	259	7	42

Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Distribution of Biotech Firms, by Size, 1997



Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Employment in Biotechnology Firms, 1997

Firm Size	# of Firms	Total Employment	Biotech Employment	Unfilled Positions	Estimate for 2001
Small (50 or less employees)	204	3,330	3,125	1,031	6,903
Medium (51–150 employees)	43	3,857	2,397	281	3,461
Large (151 or more employees)	35	26,833	4,302	587	5,347
Total	**282**	**34,019**	**9,823**	**1,899**	**15,800**

Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Revenues by Biotechnology Firms, 1997 ($ millions)

Firm Size	# of Firms	Total Revenue	Biotech Sales	Total Exports	Biotech Exports	Total R&D	Biotech R&D
Small (50 or less employees)	204	328	183	107	95	239	192
Medium (51–150 employees)	43	974	137	286	43	168	153
Large (151 or more employees)	35	10,448	698	4,478	275	430	240
Total	**282**	**11,227**	**1,017**	**4,871**	**413**	**838**	**585**

Source: Statistics Canada, *Biotechnology Firm Survey*; estimates by Industry Canada and BIOTECanada.

Appendix: Definitions

Biotechnology Use Definitions (from Rose, 1998)

Bio-culture: biotechnologies where living organisms or parts of living organisms are used in production processes.

Bio-environment: biotechnologies where microorganisms are put to special use in the treatment of industrial waste.

Bio-selection: biotechnologies where the components and processes of living organisms are analysed in order to understand or modify characteristics.

Bio-industry Sector Definitions

Agriculture biotechnology (ag-bio): plant biotechnology (e.g. tissue culture, embryogenesis, genetic markers and genetic engineering); animal biotechnology (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering); bio-fertilizers/bio-pesticides/bio-herbicides/biological feed additives (e.g. bacteria, fungi, yeast); non-food applications of agricultural products (e.g. fuels, lubricants, commodity and fine chemical feedstock, cosmetics).

Aquaculture (aqua): fish health (e.g. diagnostics, therapeutics); broodstock genetics (e.g. tracking superior traits, genetic modification/engineering); bio-extraction (e.g. carrageenan from seaweed, antifreeze proteins from fish, flavours).

Bio-informatics (bio-info): genomics and molecular modelling (e.g. DNA/RNA/protein sequencing and databases for humans, plants, animals and microorganisms).

Environment (environ): bio-filtration (e.g. treatment of organic emissions to air/water); bioremediation and phytoremediation (e.g. clean-up of toxic waste sites using microorganisms); diagnostics (e.g. detection of toxic substances using bio-indicators, bio-sensors, immunodiagnostics).

Food processing (food): bio-processing (e.g. using enzymes and bacteria culture); nutriceuticals/functional foods (e.g. probiotics, unsaturated fatty acids).

Human health — bio (health): diagnostics (e.g. immunodiagnostics, gene probes, bio-sensors); therapeutics (e.g. vaccines, immune stimulants, bio-pharmaceuticals, rational drug design, drug delivery, combinatorial chemistry); gene therapy (e.g. gene identification, gene constructs, gene delivery).

Other (includes mining/energy/petroleum/chemicals and forest products): custom synthesis, chemical or biological (e.g. peptides, proteins, nucleotides, hormones, growth factors, biochemical); microbiologically enhanced petroleum/mineral recovery (cleaner); industrial bio-processing (e.g. bio-desulphurization, bio-cracking, bio-recovery); silviculture (e.g. ectomycorrhizae, tissue culture, somatic embryogenesis, genetic markers, genetic engineering); and other technologies.