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Science, Innovation and Electronic Information Division

Biotechnology Use and Development Survey: methodology, issues and responses

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This paper represents the views of the author and does not necessarily reflect the opinions of Statistics Canada.



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Working Papers

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The science and innovation information program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors:** are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities:** include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages:** are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes:** are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts:** are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical Information System**, Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at <http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193>.

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Biotechnology Use and Development Survey: methodology issues and responses

I Background

Scientific breakthroughs in genomics, proteomics and bioinformatics have given an “élan” to the development of biotechnology activities. This is apparent in 1) the increasing number of innovative firms in biotechnology and 2) the rise in the leading indicators of biotechnology activities, namely, the number of biotechnology employees, biotech revenues, the number of products at both developmental and production stages, and R&D expenditures.

Collecting sound data on biotechnology is a real challenge (Rose, 2000). Biotechnology is a pervasive technology used in several industrial sectors. Second, unlike most industrial activities where “physical” components are assembled to obtain the end product, biotechnology is a set of techniques that are used in current operation or to develop new products and processes.

In 1996, the first ever survey of biotechnology by a national statistical agency was undertaken by Statistics Canada. Entitled “Survey of Biotechnology Use in Canadian Industries – 1996”, it aimed at assessing the use of biotechnology by selected Canadian industries: Aquaculture and Forestry, Agro-industry, Wood, Pulp and Paper, Coal/Oil/Gas, and Chemicals. Strong indications of widespread biotechnology utilization by the Canadian industry gave rise to the Biotechnology Firm Survey - 1997. This was followed by the 1999 Biotechnology Use and Development (BUDS) and the 2001 BUDS. These last three surveys went beyond measuring the use of biotechnologies to emphasize the development of new products and processes using biotechnology. The objective of the extension in the scope of biotech surveys was two-fold: 1) to satisfy the information needs of both policy makers and the industry as they related to biotechnology adoption, development and diffusion; and, 2) to document and measure the characteristics of Canadian firms that are using biotechnology to develop new products and processes.

This paper explains the methodologies used in these surveys, the problems encountered, the responses to these problems, and the lessons learned. The organization of the paper is as follows: definitional issues will be presented in the second section; the target population and the sampling issues, as they relate to the management of response burden, in section 3; data quality in section 4; a brief description of the 1997 Biotechnology Firm Survey, the 1999 and the 2001 BUDS in section 5; issues related to the change in the survey methodology, as well as their impacts on the estimates, in section 6; the lessons learned in section 7; and the conclusions in section 8.

II Defining biotechnology and an Innovative Biotechnology Firm: Issues and Responses

2.1 What is Biotechnology?

Because of its pervasive nature, biotechnology is best thought of as a cross-sectoral or cross-industrial activity, rather than a sector or an industry. In fact, as a set of scientific techniques, it has multiple usage across sectors and industrial fields and does not fall under any single code of the North American Industry Classification System (NAICS)¹ (Statistics Canada, 1997). Consequently, defining biotechnology statistically is a challenge. Most of the earlier definitions are found in Rose (2000).

Statistics Canada uses a double-definition strategy: a “normative” or single definition and an “operational” or list-based definition. According to the single definition biotechnology is 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*”².

The problem associated with the use of such a general definition is that the interpretation of the definition can vary broadly and is left to the respondents. To help with the interpretation of this definition, a list-based approach was developed. The use of a list was preferred by respondents during questionnaire testing as being more precise.

In 1997, the list-based definition included 17 specific biotechnologies grouped under 3 main blocks (Appendix 1): DNA-based biotechnologies; Biochemistry/Immunology; and Bioprocessing-based biotechnologies. The same grouping was used in the 1999 BUDS, except that the last block was divided into Bioprocessing based biotechnologies and Environment (Appendix 2). In the 2001 BUDS, the list-based definition comprised 19 specific biotechnologies in 5 main blocks (Appendix 4): DNA – the coding, Proteins and Molecules – the Functional Blocks, Cell and Tissue Culture, and Engineering, Process Biotechnologies, Sub-cellular Organisms. The provisional definition of biotechnology adopted by the OECD used a similar structure (OECD, 2003).

2.2 What is an innovative biotechnology Firm?

Biotechnologies are techniques or set of techniques. Firms may use these techniques within their production processes for different reasons. For example, biotechnologies may be used for environmental purposes. Other firms may use them to develop products and processes. Many firms in this latter group, the main focus of the Biotechnology Use and Development Surveys, have no product on the market. For example, in 1997, 67% of the

¹ This is why, at Statistics Canada, the term “biotechnology activities” instead of “biotechnology sector” or “biotechnology industry” is used to describe the activities related to the use of biotechnology techniques to develop new products/processes.

² Under the leadership of Canada, the provisional single definition from the OECD to be used in the 2003 BUDS is as follows “*the application of S&T 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*”.

firms had no product on the market . This figure was 47% in 1999 and 52% in 2001. Thus, defining an innovative biotechnology firm solely in terms of the number of products on the market would have excluded a great number of firms. This problem was overcome by defining an innovative biotech firm as “a firm developing new products and processes that require the use of biotechnologies”.

In practice, an innovative biotech firms is identified by doing two things. First, respondent firms have to be using at least one biotechnology. Second, this use has to be geared toward developing new products or processes. This latter condition is met when a firm reports having at least one product or process at any developmental stage, in production, approved, or on the market that require the use of biotechnologies. More often than not, such firms have employees dedicated to biotechnology activities and are conducting biotechnology related R&D.

An innovative biotechnology firm is thus defined in terms of its ability to use biotechnologies in its production process (process innovation), rather than having introduced new products on the market (product innovation). In this respect, the definition used is more in line with the OECD/EUROSTAT’s definition of a process innovation, i.e. “the use of a technologically new or significantly technologically improved processes within a production process” (OECD/EUROSTAT, 1997).

III Target population, Sampling Unit

3.1 Target Population

The target population of the biotechnology surveys are all firms that use biotechnology in their production process or to develop products or processes. These firms are not found under any single NAICS code. Thus reaching them requires selecting specific NAICS codes. The choice of these NAICS codes is based on the probability of biotechnology use, past experiences, and expert opinion. It involves Statistics Canada, industry experts, and federal departments such as Industry Canada, and Agriculture and Agri-food Canada. Firms that provide only biotechnology related services are excluded.

The 1997 Biotechnology Firm survey was based on 475 firms the name and addresses of which were obtained from Industry Canada, the 1998 Canadian Biotechnology Directory maintained by Contact Canada (Contact Canada, 1997), and the Statistics Canada Industrial R&D survey (Traoré, 2001; Laroche, 2001). The 1999 and the 2001 BUDS included both a “must-take-all” list of firms put in place using the 1997 methodology and a sample of firms from Statistics Canada’s Business Register (BR). The specific NAICS codes from which the sample of firms were drawn are presented in Table 1.

Table 1: Selected NAICS from which the Survey Sample was drawn, 1999, 2001

NAICS	Associated Industry
1125	Animal Aquaculture
1132	Forest Nurseries and Gathering of Forest Products
2111	Oil and Gas Extraction
2122	Metal Ore Mining
2123	Non-Metal Mineral Mining and Quarrying
311	Food Manufacturing
3121	Beverage Manufacturing
31311 ^(a)	Fibre, Yarn and Thread Mills
3221	Pulp, Paper and Paperboard Mills
3222 ^(a)	Converted Paper Product Manufacturing
32411	Petroleum Refineries
325	Chemical Manufacturing
3254	Pharmaceutical and Medicine Manufacturing
4145	Pharmaceuticals, Toiletries, Cosmetics and Sundries Wholesalers-Distributors
4183	Agricultural Supplies Wholesalers-Distributors
5417 ^(a)	Scientific Research and Development Services
6215 ^(a)	Medical and Diagnostic Laboratories

Sources: Statistics Canada 1997. North American Industry Classification Systems, Cat.No. 12-501-XPE,
Note: (a) refers to NAICS codes that were surveyed only in 2001.

3.2 Sampling Unit

Two types of firms are found in the Biotechnology surveys: single location firms and multiple location firms. The former group is made of firms for which the enterprise and the establishment as defined by Statistics Canada are the same. The latter group concerns all the enterprises with multiple establishments. In some cases, not all these establishments are in the same NAICS code. In other words, some multiple location firms have more than one NAICS code.

The need for any Statistics Canada's survey to produce data at the provincial and territorial levels was an overriding reason for the choice of the sampling unit. Thus, for the multi-establishment firms, all the establishments in a given province or territory were grouped to form a single unit. The NAICS code assigned to this new statistical unit is that of the establishment with the largest share of gross business income (GBI). In cases where two or more establishments have the same GBI, the assigned NAICS code is randomly chosen among these units (Morin et al., 2001; Lavigne, 2003). Consequently, the sampling unit is the "provincial" enterprise³.

³ The "provincial" enterprise as a sampling unit was also used in the 1999 Innovation Survey. Because of increased demand by data users for data at the Census Agglomerations (CA) and the Census Metropolitan Areas (CMA) levels, the survey on Innovation in Services and the 2003 Biotechnology Use and Development surveys will be using the "establishment" as the sampling unit. This refers to an operation, in contrast to the "provincial" enterprise which is the "sum" of all the operations of a given firm in a province.

3.3 Data strata

Producing estimates at the provincial and territorial levels is an important requirement for all the surveys at Statistics Canada. Consequently, province/territory was an important dimension in stratifying the sample. This dimension has 12 levels: 10 provinces and 2 territories⁴. Two other dimensions, namely, the NAICS code (industrial sector) and firm size were deemed appropriate levels at which to produce estimates. The former is made of the 13 NAICS codes shown in table 2 for the 1999 BUDS; and 17 NAICS codes in the 2001 BUDS (Table 1). Size has 3 levels, small, medium, and large. As shown in Table 2, in 1999, this resulted in 468 (= 12*13*3) different strata and in 2001, 612 strata (=12*17*3).

Given that 1) Statistics Canada has no single standardized definition of “small businesses” and 2) most innovative biotechnology firms are years away from any revenues, it was not deemed appropriate to define size in terms of revenues. Instead, it was decided to use the number of employees in any given firm. As a result, small biotech firms are all the firms with 50 employees or fewer, medium-sized firms are firms that have between 51 and 150 employees, and large firms have over 150 employees. The choice of these size thresholds came about in the 1997 Biotechnology Firm Survey. Statistics Canada wanted to retain some measure of comparability with other existing sources of biotechnology data in Canada. Subsequently, to enable comparison of the estimates from one survey to the other, these thresholds were retained and continue to be used⁵. We use Statistics Canada’s standard classes in any subsequent surveys.

Table 2: Number of Strata Used in the 1999 and 2001 BUDS

	1999	2001
Number of provinces and territories ^(a)	12	12
Number of industries (NAICS)	13	17
Number of firm size categories	3	3
Total	468	612

Source: Statistics Canada, BUDS 1999 & 2001

Note:

^(a) Nunavut was not surveyed

3.4 Respondent Selection and Respondent Burden

3.4.1 Respondent Selection

Respondent selection was undertaken based on two main considerations: to reach the target population; and, to minimize respondent burden. To this end, 1) GBI, R&D expenditures and number of employees were used as selection criteria, 2) industries were

⁴ Nunavut was not surveyed.

⁵ Size classes in the BR are less than 50 employees, 50 to 149 employees and 150 employees and up. While the use of different size classes in the Biotechnology surveys results in an insignificant difference in the results, the BR classes will be used as soon as resources are available to reanalyze the earlier surveys.

surveyed at levels other than 4-digits, and 3) small firms with 50 employees or fewer were not rotated out of the survey even after being included in two consecutive surveys.

Based on results from the 1997 Biotechnology Firm Survey, 65% of firms conducting 35% of all R&D in biotechnology would have been excluded had the GBI been the only selection criterion. This problem was overcome by using the GBI along with the number of employees and the amount of R&D expenditures to select respondents from both the BR and the must-take-all list.

Firms with less than 5 employees and spending less than \$100,000 in R&D expenditures. These firms contribute less than 1% to both expenditures in R&D and to the number of new products/processes. Thus, the exclusion does not result in any noticeable bias in the estimates. In addition, it reduces respondent burden.

Furthermore, as shown in table 1, even though most industries were surveyed at the 4-digit level, some industries such as Food Manufacturing (NAICS 311) and Chemical Manufacturing (NAICS 325) were surveyed at the 3-digit level. Petroleum Refineries was surveyed at the 5-digit level (NAICS 32411).

The universe of firms involved in using biotechnology to develop new products and processes was made of 282 firms in 1997, 358 in 1999, and 375 in 2001. Over 70% of these are small firms with 50 employees or fewer. Thus, rotating these firms out of the sample after two years in the survey would invalidate the estimates.

3.4.2 Respondent Burden

Based on respondent reports, 90 minutes were necessary to answer to the full 1997 Biotechnology Firm Survey. In the 1999 BUDS, a multi-stage screening process was implemented. It helped in reducing the response burden by progressively screening out firms based on the extent of their biotechnology activities. Thus, the time required to fill in the survey was 15 minutes for non-users of biotechnology, 30 minutes for users, and 90 minutes for innovative biotech firms. In 2001, the pre-contact questionnaire could be filled in within 5 minutes. Applying the same screening technique as in 1999, in the 2001 BUDS, users were able to complete the full questionnaire of the second phase within 30 minutes and innovative firms, within 90 minutes.

3.5 Other exclusions from the survey

In addition to small firms with less than 5 employees and spending less than \$100,000 in R&D, additional exclusions from the surveys include not-for-profit organizations, universities, government laboratories, and hospitals. Also excluded from the survey are contract research organizations (CROs) that provide only services to biotechnology firms. These entities, even though related to biotechnologies through the provision of R&D services and the creation of spin-off firms, do not meet the main criterion of biotechnology surveys, i.e. to provide information on firms that use biotechnology to develop new products and processes.

IV Data Quality, Data Collection, Edit and Imputation

In all the biotechnology surveys, the data quality was insured by taking into account and applying throughout the survey process all 6 dimensions of data quality control at Statistics Canada, namely, relevance of data collected, their accuracy, their timeliness, their accessibility, their interpretability, and their coherence (Statistics Canada, 2003; 2002; 1998).

4.1 Data Quality

4.1.1 Relevance of the data

To insure the relevance of the data to policy makers, industry and analysts, all the questionnaires were designed by the Life Sciences Unit of the Science, Innovation and Electronic Division at Statistics Canada in collaboration with industry experts and federal stakeholders such as Industry Canada and Agriculture and Agri-Food Canada. Also, as shown below, the relevance of the data was insured by making the survey results and data available to users in a timely manner.

4.1.2 Accuracy of the data

Accuracy of data collected was insured by conducting cognitive interviews with small samples of respondents in both official languages with help from the Questionnaire Design Resource Centre (QDRC). Feedbacks and comments from these interviews were integrated into the questionnaire to improve the design and most importantly, to insure that the questions were well understood by respondents.

A knowledgeable person in the respondent firms, such as an R&D manager or a production manager, was asked to answer the questionnaire. Such individuals were able to provide with accuracy the type of information requested in the questionnaires.

As shown below, further checks into the accuracy of the data were conducted by analyzing non-response rate. Furthermore, the sampling process was specifically designed to reach the target population.

4.1.3 Timeliness of the data

To date, all the biotech surveys, from the inception period to the publication of the results, have been completed on time, i.e. within a year time. For example, the consultation process for the 2001 BUDS began in the Fall of 2001 and the survey results were published in the Fall of 2002.

4.1.4 Accessibility to the data

Data from the biotechnology surveys are made available to users through a number of venues, including the sharing of data and statistics with provincial statistical institutions. Other venues include the Facilitated access program whereby researchers from academia are given access to the survey data to conduct research on their own topics.

Analytical and working papers by staff of the Life Sciences section of the Science, Innovation and Electronic Information Division are published in scientific journal or made available on the web-site of Statistics Canada. Some of these studies are also presented in international conferences. These are in addition to descriptive tables provided to different stakeholders such as Industry Canada and Agriculture and Agri-Food Canada.

4.1.5 Interpretability

All the Biotechnology surveys are registered in the Integrated Metadatabase (IMDB). The information available concern the definitions of the underlying concepts, the classifications used, the methodology of data collection and processing, and indications of the accuracy of the data and other related statistical information. These records are available to data users on Statistics Canada web-site.

4.1.6 Coherence

Coherence in the data is insured by using the same definitions from across surveys, as well as the same classifications. The target population has remained the same so as the data collection process.

There was a methodology change between the 1997 Biotechnology Firm survey and the 1999 Biotechnology Use and Development survey. However, as shown below, this change had minor effects on the estimates.

4.1.7 Response Rates⁶

Of the 475 firms that were sent the 1997 Biotechnology Firm Survey, 392 filled out and returned the questionnaires, resulting into an overall response rate of 83%. The 1999 BUDS was mailed to 3,377 firms. The response rate was 66% or 2,229 returned questionnaires. In the 2001 BUDS, the first phase or “pre-contact” questionnaire was mailed in the Winter of 2002 to a sample of 11,262 firms. The response rate was 70%. The full or second stage questionnaire was mailed in the Spring of 2002 to 900 firms and had a response rate of 84%.

In each of the surveys, analyses of non-respondents were conducted. No evidence of bias was found as these analyses showed that non-respondents had the same characteristics as respondents to the surveys. Consequently, estimates from the surveys provide a clear picture of the biotechnology universe for each period and are a valid representation of the Canadian biotechnology firm population in each year.

4.2 Data Collection, Edit and Imputation

⁶ The detailed response rates are found in tables in section 5 below

4.2.1 Data Collection and Edit

The data collection was done by staff of the Science, Innovation and Electronic Information Division. The surveys were direct and mandatory, meaning that the data were requested directly from respondents who were required to provide the requested information. The surveys were mail-out/mail back surveys. Reminder cards and telephone calls were used for subsequent follow-ups.

Post collection edits were undertaken in collaboration with the Business Survey Methodology Division (BSMD) to insure consistency in the data. These edits were applied to complete questionnaires. In 1997, a questionnaire was considered completed when questions 2, 3, 5 and 7 (Appendix 1) were answered. In 1999, it referred to one with responses to questions 1, 5, 7, and 13 (Appendix 2); and in 2001, it applied to a questionnaire with answers to questions 1, 4, 9, 10, and 16 (Appendix 4)⁷.

4.2.2 Imputation techniques and Imputation rates

Two imputation techniques were used, namely, deterministic and hot-deck. Deterministic or deductive imputation was used in cases where logical relations existed among variables. In such cases, the “revealed” behavior of the respondent unit in a preceding question influenced the response to a subsequent question(s). Consequently, the revealed answer was used to impute the logical value of the missing response. Examples of such related questions were skip pattern questions. For instance, in the 2001 BUDS, in question 5a, respondents were asked if they had any unfilled biotechnology position. Those that answered “NO” to that question were asked to skip to question 5b. Otherwise, they were to fill-in a table. In cases where the table was filled and question 5a was not either answered or the given answer was “NO”, the response was changed to “YES”.

In cases where deterministic imputation did not apply, hot-deck imputation was used. It consisted of choosing a random donor from the same homogenous response group as the non-respondent, starting with the smallest, i.e. Province/NAICS/Size. For example, to find a donor for a small firm active in Agriculture in Quebec, the search would start in the Quebec/Agriculture/Small response group. If no donor is found in this group, the response group is extended to Province/NAICS. This process continues until a donor is found.

Overall, the imputation rates, obtained by dividing the number of imputed respondents to a question by the total number of respondents, were low for all three biotechnology surveys: on average 3.7% in 1997, 12.9% in 1999 and about 7% in 2001. For the 1997 Biotechnology Firm Survey, the rates of imputation range from 0 for a series of questions to a high of 5.3% for Q8. In the 1999 BUDS, except for Q11, i.e. where the imputation rate was 35%, all other questions had a rate of imputation between 0, for Q2, and 19.5%

⁷ In all the cases, these questions referred to 1) the use of biotechnologies in either current production or for environmental purposes, 2) the presence in the firm of employees dedicated to biotechnology, 3) the development of products/processes using biotechnologies, 4) having biotechnology products/processes at either developmental or approved/production stages, and 5) conducting biotechnology R&D.

for Q13. As for the 2001 BUDS, the rates range from 1.9% to a high of 18.3%. The imputation rates for “quantitative” questions were quite low, 2.9% for Q4, i.e. Human resources, .8% for Q10, biotechnology products, 7% for Intellectual Properties, 3.8% for Capital raised, 4.8% for Exports and Imports question (Table 3).

Table 3: Imputation rates, Biotechnology Firm Survey – 1997, BUDS 1999, BUDS 2001

Questions	Imputation rates (%)		
	<i>Biotechnology Firm Survey - 1997</i>	<i>BUDS - 1999</i>	<i>BUDS - 2001</i>
Q1	1	7.21	6.70
Q2	5.19	0	7.74
Q3	0	15.13	8.96
Q4	2.75	15.76	2.95
Q5	9	13.62	7.98
Q6	8	16.83	5.99
Q7	0	12.89	5.34
Q8	5.20	1.46	9.29
Q9	0	16.38	8.99
Q10	10	16.7	.79
Q11	0	34.96	17.99
Q12		16.59	8.80
Q13		19.45	3.16
Q14			6.98
Q15			10.18
Q16			7.35
Q17			8.96
Q18			2.57
Q19			9.47
Q20			1.98
Q21			1.98
Q22			3.49
Q23			3.81
Q24			12.38
Q25			18.26
Q26			4.77
Q27			1.93
Q28			9.52
Q29			9.25

Source: Statistics Canada

4.3 Estimates

Estimates from surveys are used to produce population estimates. This requires that the sample weights of the responding units be adjusted to take into account non-respondents.

This procedure was applied to all the biotechnology surveys. All the estimates were produced using the Generalized Estimation System (GES) in the Statistical Analysis System (SAS) computer package (Statistics Canada, 2002). Estimates were produced at the firm size, industry and province/territory levels. However for this latter level, to meet confidentiality requirements, no estimates could be produced separately for the Atlantic provinces. It was then decided to produce a single estimate for this region, under Atlantic. Similarly, no estimates could be produced for the two territories that were surveyed, namely, Yukon and the Northwest Territories.

Publication of the estimates follows Statistics Canada's guidelines in this matter (Table 4). In cases where the estimates were either unreliable because of high coefficient of variations (CV), i.e. CV above 50%, or did not meet the confidentiality requirements of the Statistics Act, they were suppressed and replaced by the appropriate symbol (Table 4). Whenever the estimates had a low reliability, i.e. a CV between 30% and 50%, they were marked with an E to warn data users that they should be used with some caution (Table 4).

Table 4: Symbols Used When Publishing the Estimates

Symbol	Meaning
.	Not available for any reference period
..	Not available for a specific reference period
...	Not applicable
P	Preliminary
r	Revised
X	Suppressed to meet the requirements of the Statistics Act
E	Use with caution, (CV between 30% and 50%)
F	Too unreliable to be published, (CV more than 50%).

Source: Statistics Canada

V Brief Description of the Surveys

5.1 1997 Biotechnology Firm Survey - 1997

The 1997 Biotechnology Firm Survey was based on a list of 475 firms⁸. Of these, 138 were out of scope, 44 were out of business, 51 could not be reached or refused to answer the questionnaire, 32 did not return any questionnaire and 210 provided the requested data (Table 5). These resulted in 392 returned questionnaires of 83% survey response rate. After accounting for non-responses and applying post-stratification techniques, it was estimated that 282 firms constituted the core of Canadian biotechnology activities in 1997.

⁸ More information on the 1997 Biotechnology Firm Survey may be found in Traoré (2001) and Laroche (2001).

**Table 5: Response Categories and Corresponding Number of Respondents,
Biotechnology Firm Survey – 1997**

Response categories	Number of respondents
Out of scope	138
Out of business	44
Could not be reached or refused to answer	51
Provided requested information	210
Non-response	32
Total	475

Source: Statistics Canada, Biotechnology Firm Survey - 1997

5.2 Biotechnology Use and Development Survey – 1999

Drawing upon the 1997 Biotechnology Firm Survey, the 1999 BUDS contained additional questions. They related to 1) the barriers to using biotechnologies, 2) the sources of information on biotechnology, 3) the benefits from using biotechnology, and 4) Intellectual property (Appendix 2).

The sample was made of 3,377 firms of which 2,999 came from the BR and 378 from a must-take-all list of firms provided by Statistics Canada and industry experts. Sixty two (62) of these firms were out of business, 40 were out of scope, 13 had either merged with or were acquired by other firms, 123 could not be reached, 20 refused to answer the questionnaire, 1,982 filled out and returned the questionnaire, and no response was received from 1,148 firms (Table 6). Of the 1,982 returned questionnaires, 1,568 were not involved in biotechnology, 192 were biotechnology users, and 223 were classified as innovative firms. As shown in Table 7, 35 of the 223 innovative firms came from the BR and 188 from the Must-take-all list. Likewise, 165 of the users came from the BR and 27 from the Must-take-all list.

After accounting for non-respondents, it was estimated that 358 firms made up the population of innovative biotechnology population in Canada in 1999.

**Table 6: Response Categories and Corresponding Number of Respondents,
Biotechnology Use and Development Survey – 1999**

Response categories	Number of respondents
Out of scope	40
Out of business	62
Could not be reached	123
Refused to answer	20
Merger/Acquisition	13
Provided requested data	1,982
Non-response	1,148
Total	3,377

Source: Statistics Canada, Biotechnology Use and Development Survey – 1999

Table 7: Distribution of Innovative, Users among Respondents in the BR Sample and the Must-take-all List, 1999

Origin	Status		Total
	<i>Innovative</i>	<i>Users</i>	
Sample from the BR	35	165	200
Must-take-all	188	27	215
Total	223	192	415

Source: Statistics Canada, 1999 BUDS

5.3 Biotechnology Use and Development Survey – 2001

The 2001 BUDS was done in two phases. The pre-contact or first phase questionnaire was a one page questionnaire (Appendix 3) and was mailed out to 11,262 firms from the BR. It was intended to identify firms that used biotechnology as part of their activities. Seven thousand eight hundred and eighty three (7,883) firms returned the questionnaire. Of these, 512 firms or 6.5% reported using or developing biotechnology products/processes in their daily activities.

This list of 512 firms was supplemented by a “must-take-all” list of 388 firms. The list was constructed using the following sources: Statistics Canada, Agriculture and Agri-Food Canada. The resulting 900 firms were sent the full questionnaire in the Spring of 2002 (Appendix 4). Twenty three (23) were out of scope, 10 were out of business, 45 had either merged with or been acquired by another firm, 24 could not be reached, 9 refused to answer the questionnaire, no questionnaire was received from 143 (Table 8). Of the 646 completed questionnaires, 334 were not involved in biotechnology, 59 were biotechnology users, and 253 were involved in developing biotechnology products/processes. As shown in Table 9, 65 of the innovative came from the BR and 188 came from the Must-take-all list. Forty one (41) of the users came from the BR and 18 from the Must-take-all list.

Taking into account non-respondents, estimates from this second stage indicated that the core of Canadian biotechnology was made of 375 innovative firms in 2001.

Table 8: Response Categories and Corresponding Number of Respondents, Biotechnology Use and Development Survey – 2001

Response categories	Number of respondents
Out of scope	23
Out of business	10
Could not be reached	24
Refused to answer	9
Merger/Acquisition	45
Provided requested data	646
Non-response	143
Total	900

Source: Statistics Canada, Biotechnology Use and Development Survey - 2001

Table 9: Distribution of Innovative, Users among Respondents in the BR Sample and the Must-take-all List, 2001

Origin	Status		Total
	<i>Innovative</i>	<i>Users</i>	
Sample from the BR	65	41	106
Must-take-all	188	18	206
Total	253	59	312

Source: Statistics Canada, 2001 BUDS

VI Changes in the Survey Methodology and their Impacts on the Estimates

6.1 1997 Biotechnology Firm Survey Vs 1999 BUDS

As stated earlier, the 1997 Biotechnology Firm survey was based on a list of 475 firms (Traoré, 2001; Laroche, 2001). The 1999 BUDS was a combination of a sample of 2,999 firms from the BR and a must-take-all list of 378 firms (McNiven 2001 a&b). Altogether, they returned 2,229 questionnaires of which 1,971 came from the BR and 258 from the must-take-all list. As shown by figures in Table 4, 188 of these 258 firms from the must-take-all list were classified as innovative biotech firms. This amounts to 84% of the 223 firms on which the 1999 biotechnology population estimates were based. Comparatively, 35 firms or 16% of the innovative firms came from the BR sample. In other words, 16% of the 223 innovative firms would not have been accounted for had the must-take-all list been the sole source of firms surveyed in 1999. When the population weights are taken into account, this translates into one third (1/3) of the 358 innovative firms in 1999 coming from the BR and two thirds (2/3) from the must-take-all list. Applying these percentages to the 76 additional firms accounted for in 1999, gives 25 firms from the BR and 51 from the must-take-all list. Thus, 25 additional firms have been identified by the sampling procedure. Put differently, had the 1997 survey methodology been applied in 1999, this would have resulted in an underestimation of the biotechnology firm population by 25 firms.

Since these 76 additional firms represent a 27% increase in biotech firm population over the 1997-1999 period, the actual impact of the change in the survey methodology on the change in any biotechnology activity indicator is $27\% \times (1/3) = 9\%$. For biotechnology leading indicators, this implies that \$121 million of the \$1.35 billion increase in biotech revenues are the arte-fact of the change in the survey methodology; so are \$30 million of the \$333 million increase in biotech R&D, \$37 million of the \$407 million increase in biotech exports, 119 employees in the 1,324 decrease in biotech employment, \$151 million of the \$1.68 billion increase in the amount of capital raised, and 779 products in the 8,650 increase in the total number of biotech products (Table 10).

Comparison between the list of firms in 1997 and the must-take-all list in 1999 shows: 1) 81% of the 258 must-take-all firms that returned their questionnaires in 1999 were from the 1997 survey and 2) all the 388 firms on the must-take-all list in 1999 were from the same NAICS as firms in the 1997 survey. Thus, the 1997 list of firms and the 1999 must-take-all list are two samples from the same population. Consequently, they are representative samples of the same population.

Table 10: Share of the Change in the Leading Biotechnology Activity Indicators Attributed to the Change in the Survey Methodology between 1997 and 1999

Indicators	Actual Impact
Number of innovative biotech firms	25
Biotech R&D	\$30 million
Biotech Revenues	\$121 million
Biotech employment	(119) employees ^(a)
Biotech Exports	\$37 million
Biotech products	779 products
Amount of capital raised	\$151 million

Source: Statistics Canada, 1997 Biotechnology Firm Survey and 1999 BUDS

Note:

^(a) Implies that the figure is negative

6.2 1999 BUDS Vs 2001 BUDS

No methodology changes occurred between the last two surveys, i.e. 1999 and 2001 surveys, only the population surveyed in 2001 was larger and the “pre-contact” was done by mail. Like for the 1997 and 1999 surveys, the must-take-all list in 2001 came from the same NAICS as that of 1999. Thus, the two must-take-all lists are representative of the same population. Also all the NAICS codes of 1999 were surveyed in 2001 and represented 80% of the sample in the 2001 BUDS. The remaining 20% came from 4 new NAICS codes, namely, 31311, 3222, 5417, and 6215 (Table 1). The first NAICS code contributed nothing to the final count of innovative firms and the second contributed only one unit. In other words, the increase in the sample in 2001 came principally from the same population surveyed in 1999. Furthermore, this larger population size resulted in 17 additional firms, less than 5% of the estimated biotechnology firm population in 2001.

6.3 Impacts of the Change in Survey Methodology on the Estimates

Given the aforementioned facts, changes in survey methodology resulted in 25 additional firms being captured in 1999. In other words, had the methodology remained unchanged between 1997 and 1999, the biotechnology firm population would have been underestimated by 25 firms or 7%. However, as shown in Table 10, the impact of this under-estimation on the key biotechnology activity indicators is small. Between 1999 and 2001, the larger sample size resulted in 17 additional firms, less than 5% of the 2001 biotech firm population in 2001.

VII Lessons Learned

7.1 Defining biotechnology

Comments from respondents in the cognitive interviews during the questionnaire testing showed that the strategy consisting in using a double-definition of biotechnology is very helpful. Even though concise, the wording of the single definition was not clear to all the respondents. In fact, some respondents were not sure of the meaning or interpretation of key words such as science, living organisms or parts of living organisms, innovative manner. In contrast, the list based-definition which used specific biotechnologies grouped under different domains, was well understood. Second, by so doing, it allowed them to know whether or not their activities fell into the biotechnology domain. Otherwise, they could quickly exit the survey and save time. Thus, an additional advantage of the double-definition strategy was to minimize respondent burden.

7.2 Defining an Innovative biotech firm

According to the Oslo Manual (OECD/EUROSTAT, 1997), a technological product/process (TPP) innovating firm is “one that has implemented technologically new or significantly technologically improved products or processes”. A TPP innovation has been implemented if “it has been introduced on the market (product innovation) or used within a production process (process innovation)”.

Given that most firms in the target population of the Biotechnology Use and Development surveys do not have any product on the market, and given Biotechnology is best thought as a set techniques which may be used by firms in their production processes, an innovative biotech firms has been defined along the lines of process innovation. This allows to capture the target population of the biotech surveys.

7.3 Targeting the right population

Biotechnology is a cross-sectoral activity that cannot be classified under any single NAICS code. Two things were done to solve this problem. NAICS codes where the use of biotechnology was probable were selected. Then, within these NAICS, care was taken to insure that only innovative biotechnology firms, i.e. firms are actively involved in using biotechnologies to develop new biotechnology products and processes are captured.

To this end, a screening process was put in place. First and foremost, respondents have to be using at least one of a series of biotechnologies. Second, they have to be using biotechnologies to develop new products and processes. This latter condition implies that the firm has at least one product or process in development, in production, or on the market. Only respondents that fulfilled all these conditions were classified as innovative biotechnology firms.

Firms with biotech employees and using biotechnologies in their current production process for purposes other than developing new products and processes are classified as biotechnology users.

Using this screening scheme allows to target and survey the right population and to attain the main objective of the biotechnology survey, i.e. to collect information on firms that use biotechnology to develop products and processes.

7.4 Measuring Biotechnology Employment

A large percentage of firms are involved in activities other than biotechnology. As a result, any given employee may be involved in multiple tasks, including those related to biotechnology. Consequently, more than the level of education, an employee's involvement in biotechnology activities better measures if he/she is classified as a full-time or part-time biotech employee or not. During the data collection, it was observed that the number of biotechnology employees in question 4b in the 2001 BUDS, was less than the sum of 4c and 4d (Appendix 4). And more often than not, this difference corresponded to the number of employees in production, finance, marketing and management. In other words, most respondents equate employment in biotechnology to research and clinical activities. This could potentially lead to an under-estimation of the number of employees dedicated to biotechnology. By using an activity-based accounting, we avoid this problem.

VIII Conclusion

From its beginning in 1996 with the “Survey of Biotechnology Use in Canadian Industries – 1996”, to the 2001 Biotechnology Use and Development Survey, surveying biotechnology has evolved in many ways. First of all, the focus of the surveys has changed from investigating the use of biotechnologies to include the use of biotechnologies to develop new products and processes. Second, along this change in focus, have emerged new questions such as those related to intellectual property (IP) rights. Third, the definition of Biotechnology has been refined and international comparability, mainly between OECD countries, is now possible.

Measures of biotechnology activity have been developed. These allow for a better understanding of Biotechnology, not only as a set of techniques, but also as a means to develop new products and processes. NAICS codes where the use of Biotechnology is probable are now clearly identified.

The quality of the data is improving along common standards, allowing for comparability between the survey data and other data sources, be it national or international.

Whenever needed, appropriate adjustments to definitions and concepts were made to better capture the target population. For example, in selecting the respondents, the Gross Business Income (GBI) was used in conjunction with R&D expenditures and the number of employees. Likewise, innovative biotech firms were defined in terms of their use of biotechnologies to develop new products and processes (process innovation), rather than having new products on the market (product innovation).

Insights gained from the iteration of the biotech surveys have allowed a better understanding of both the extent and the intensity of biotechnology activities in Canada. The lessons learned will help improve upcoming surveys.

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Appendix 1: Biotechnology Firm Survey – 1997



Biotechnology Firm Survey - 1997

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Purpose

Statistics Canada is undertaking this survey under the sponsorship of Industry Canada and BIOTECANADA to produce information of use to firms engaged in biotechnology activities by addressing the following question: What are the main characteristics of the firms which choose to develop biotechnologies as an important component of their business? The information from the survey can be used by businesses for market analysis, by trade associations to study performance and other characteristics of their industries, by government to develop national and regional economic policies, and by other users involved in research or policy making. Statistics Canada will create a database combining survey responses with existing Revenue Canada and Statistics Canada records.

Confidentiality

While participation in this survey is voluntary, your cooperation is important to ensure that the information collected in this survey is as accurate and as comprehensive as possible. Statistics Canada is prohibited by law from publishing or releasing, in any manner, any statistics which would divulge information obtained from this survey that relates to any identifiable business without the previous written consent of that business. The data reported on the survey questionnaire will be treated in strict confidence, used for statistical purposes and released in aggregated form only. The confidentiality provisions of the Statistics Act are not affected by either the Access to Information Act or any other Legislation.

Biotechnology Definition

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.

Please report only on Canadian biotechnology activities of your company. Complete a separate questionnaire for each company engaged in biotechnology activities in Canada.

Questions?

If you require assistance in the completion of this questionnaire or have any questions regarding this survey please contact Lloyd Lizotte (tel: 613-951-2188 (call collect), fax: 613-951-9920 or e-mail: lizollo@statcan.ca)

Survey Contact

Please indicate the name of the person completing this form so we know who to contact should we have questions about this report.

Name	Title
Telephone Number <input type="text"/> <input type="text"/> <input type="text"/> - <input type="text"/> <input type="text"/> <input type="text"/> - <input type="text"/> <input type="text"/> <input type="text"/>	Fax Number <input type="text"/> <input type="text"/> <input type="text"/> - <input type="text"/> <input type="text"/> <input type="text"/> - <input type="text"/> <input type="text"/> <input type="text"/>

Combined Report

1. If your records do not permit separate reporting, list the names of other companies included in this report and indicate whether they are engaged in biotechnology activities by writing YES or NO in the second column.

Name of company	Biotechnology activities YES or NO	Indicate type of affiliation with reporting company (i.e. parent, subsidiary or other)
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	

Biotechnologies used by your firm

2. Please review the following list of biotechnologies, and check the applicable circle for each technology.

Biotechnologies	Currently Used in Operations?	IF "YES" ▶ Principal Use (check one only)			IF "NO" Do you PLAN TO USE within 3 years?
		Products/ Processes Development	Clinical/ Field Trials	Current Production	
DNA Based					
Genetic Engineering	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Gene Probes	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Bio-informatics / Genomics / Pharmacogenetics	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
DNA Sequencing / Synthesis / Amplification	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Gene Therapy	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Biochemistry / Immunochemistry Based					
Vaccines / Immune Stimulants / Drug Design & Delivery / Combinatorial Chemistry	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Diagnostic Tests / Antibodies	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Peptide / Protein Sequencing or Synthesis	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Cell Receptors / Cell Signalling / Pheromones / Three Dimensional Molecular Modelling / Structural Biology	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Biosensors	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Biomaterials	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Microbiology / Virology / Microbial Ecology	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Bioprocessing Based					
Cell / Tissue / Embryo Culture & Manipulation	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Fermentation / Bioprocessing / Biotransformation / Bioleaching / Biopulping / Biobleaching / Bidesulphurization	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Extraction / Purification / Separation	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Bioremediation / Phytoremediation / Biofiltration / Bioindicators	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Natural Products Chemistry	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
Others (Please specify)					
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No
	1 <input type="radio"/> Yes 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	1 <input type="radio"/> Yes 2 <input type="radio"/> No

If your company does not presently use or plan to use any of the biotechnologies listed above, please stop here. Sign and return questionnaire. Thank you for your cooperation.

BIO-INDUSTRY SECTOR

3. a) Please indicate the top 3 bio-industry sectors, where applicable, in numbered order, that best describe your firm's biotechnology activities, (use 1 for the Most important and 3 for the least important). Please also indicate the number of products based on genetic engineering (rDNA) your company has in each of the relevant development stages:

Human Health - Bio

- 1) **Diagnostics** (e.g. immunodiagnostics, gene probes, biosensors)
- 2) **Therapeutics** (e.g. vaccines, immune stimulants, biopharmaceuticals, rational drug design, drug delivery, combinatorial chemistry)
- 3) **Gene Therapy** (e.g. gene identification, gene constructs, gene delivery)

Bio-Informatics

- 4) **Genomics and Molecular Modelling** (e.g. DNA/RNA/protein sequencing & databases for humans, plants, animals and microorganisms)

Ag - Bio

- 5) **Plant Biotechnology** (e.g. tissue culture, embryogenesis, genetic markers, genetic engineering)
- 6) **Animal Biotechnology** (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)
- 7) **Biofertilizers/Biopesticides/Bioherbicides/Biological Feed Additives/Microbial pest control** (e.g. bacteria, fungi, yeasts)
- 8) **Non-Food Applications of Agricultural Products** (e.g. fuels, lubricants, commodity and fine chemical feedstocks, cosmetics)

Food Processing

- 9) **Bioprocessing** (e.g. using enzymes and bacteria culture)
- 10) **Functional Foods/Nutraceuticals** (e.g. probiotics, unsaturated fatty acids)

Aquaculture

- 11) **Fish health** (e.g. diagnostics, therapeutics)
- 12) **Broodstock genetics** (e.g. tracking superior traits, genetic modification / engineering)
- 13) **Bioextraction** (e.g. karageenan from seaweed, antifreeze proteins from fish, flavours)

Mining/Energy/Petroleum/Chemicals

- 14) **Microbiologically enhanced petroleum/mineral recovery**
- 15) **(Cleaner) Industrial Bioprocessing** (e.g. biodesulphurization, bio-cracking, bio-recovery)

Forest Products

- 16) **Silviculture** (e.g. ectomycorrhizae, tissue culture, somatic embryogenesis, genetic markers, genetic engineering)
- 17) **(Cleaner) Industrial Bioprocessing** (e.g. biopulping, biobleaching, biological prevention of sapstain)

Environment

- 18) **Biofiltration** (e.g. treatment of organic emissions to air/water)
- 19) **Bioremediation and Phytoremediation** (e.g. cleanup of toxic waste sites using microorganisms)
- 20) **Diagnostics** (e.g. detection of toxic substances using bioindicators, biosensors, immunodiagnostics)

Other

- 21) **Custom synthesis- chemical or biological** (e.g. peptides, proteins, nucleotides, hormones, growth factors, biochemicals)
- 22) **Other** (please specify)

--

Top Bio-sectors (1 to 3 by importance) Please write number and sub-headings from above list	Number of products by development stages		
	Approved/ On Market <small>(number)</small>	Clinical/Field Trial stage <small>(number)</small>	Under development <small>(number)</small>
1			
2			
3			

b) Did you implement a new or significantly improved **PROCESS** in the last 3 years that required the development of biotechnologies?

- 1 Yes ➤ How many?
 2 No

Number

c) Do you **PLAN** to implement in the NEXT 3 years a new or significantly improved **PROCESS** that requires the development of biotechnologies?

- 1 Yes ➤ How many?
 2 No

Number

Financial Information

4. Total Business Activity (All activities including Biotech)

- a) Is your firm a public company? ¹ Yes
² No

- b) Please report data for 1997 or the latest fiscal year available.
 Do not include sales and operations of your **subsidiaries** located outside Canada.

Fiscal year (if different from 1997)

Balance Sheet	1997	Revenue	1997	Expenses	1997
Cash & securities	000\$	Product sales	000\$	R&D	000\$
Total Assets	000\$	Contract Research	000\$	All other expenses	000\$
Total liabilities	000\$	Other revenue	000\$		
Shareholders Equity	000\$				

TOTAL Exports (as % of product sales)	%	Total exports to the United States (as % of product sales)	%
Biotechnology Related Exports (as % of product sales)	%	Total exports to Europe (as % of product sales)	%
		Total exports to Asia (as % of product sales)	%
		Total exports to South/Latin America (as % of product sales)	%
		Total exports to other countries (as % of product sales)	%

Total number of employees (average for the year):

What percentage of your product sales are based on biotechnology? % OR bio product sales 000\$

What percentage of your R&D expenses are based on biotechnology? % OR bio R&D 000\$

R&D

5. a) Did your firm have biotech R&D expenditures in any of the years 1995-1997?
¹ Yes
² No

- b) In the past 5 years, did your company apply for the tax benefit under the R&D (SR&ED) tax programme?
¹ Yes ➤ What was the most recent year?
² No ➤ Why did your company not apply? (check most important only)
¹ complexity of the application process
² uncertainty of eligibility
³ did not meet eligibility requirements
⁴ other (specify)

Strategic Partnerships

6. Does your firm currently have any strategic alliances with other organizations *{a strategic alliance is a formal agreement with another firm to do business activities without merging}*

Strategic Alliance for:		Canadian Partner	Foreign Partner, (Please identify country of partner)				
			USA	E-U	Asia	South/ Latin America	Other
Marketing/Distribution	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Manufacturing	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Regulatory Affairs	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Finance	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Other	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
R&D Partnership:							
Biotech Company	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Other company	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
University	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Hospital	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Research Institute	1 <input type="radio"/> Yes ► 2 <input type="radio"/> No	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>	6 <input type="radio"/>
Federal Lab (Canadian)	1 <input type="radio"/> Yes 2 <input type="radio"/> No						
Provincial Lab (Canadian)	1 <input type="radio"/> Yes 2 <input type="radio"/> No						
Network of Centres of Excellence (Canadian)	1 <input type="radio"/> Yes 2 <input type="radio"/> No						

Human Resources engaged in Biotechnology Activities

7. a) In your current biotechnology activities, please give the number of employees on staff in the listed positions (include contract personnel and use fractions of a person-year if individuals are filling more than one role).

Position	Number Now Employed	Positions Unfilled Now	Estimated Number Employed in year 2001
R&D			
Clinical Affairs/Quality Assurance			
Regulatory/Legal/Government Affairs			
Manufacturing			
Marketing & Sales			
Business Development/Finance			
Administration/Human Resources			

Human Resources engaged in Biotechnology Activities (continued)

7. b) Does your firm have a formal employee development program (continuing education and training program)?

- 1 Yes ➤ If yes, estimate your firm's total expenditures on formal education and training in 1997? OR
- 2 No (\$000) or as a percentage of product sales OR

c) Does your firm employ co-op program students from universities?

- 1 Yes
- 2 No

d) Do you have a full time person solely responsible for Human Resources in your organization?

- 1 Yes
- 2 No

e) What is your approximate professional staff turnover rate (persons leaving as a % of total staff) for the biotechnology activity in 1997?

%

f) Are you experiencing problems in recruiting Business Operations staff?

- 1 Yes ➤ If YES. In which specialties? 1 Finance
- 2 No 2 Marketing
- 3 Regulatory, Legal
- 4 Clinical Affairs

g) Are you experiencing problems in recruiting Technical / Production / Scientific / R&D staff?

- 1 Yes ➤ If YES. In which specialties? 1 Scientist
- 2 No 2 Engineering
- 3 Technicians

h) Have you tried to hire personnel from outside Canada in 1997?

- 1 Yes 2 No



If Yes, From which areas?

- 1 US
- 2 EU
- 3 Asia
- 4 South/Latin America
- 5 Other



If Yes, were you successful?

- 1 Yes

2 No ➤ If No, Was the problem related to the following issues?

- 1 Personal income taxes
- 2 Immigration Rules
- 3 Advancement opportunities
- 4 Other

Intellectual property (IP) instruments

8. a) Have you ever had to abandon an important biotech project because further work was blocked by IP rights held by another organization?

1 Yes

2 No

Was this an issue of scope of patent in Canada as compared to other countries?

1 Yes

2 No

b) Has your firm been involved in litigation related to patent infringement in the past year?

1 Yes

2 No

How many different cases?

c) During the last three years has your firm assigned the right to use intellectual property **TO**:
(check where applicable)

In Canada

Outside Canada

Another firm

1

2

Government lab

3

4

University

5

6

Hospital

7

8

d) During the last three years has your firm acquired the right to use intellectual property **FROM**:
(check where applicable)

In Canada

Outside Canada

Another firm

1

2

Government lab

3

4

University

5

6

Hospital

7

8

Problems for Biotechnology Commercialization in Canada

9. Select **the three** issues that you consider are the most important problems to successfully commercialize your biotechnology products/processes:

01 Access to capital

02 Access to smart capital
(money plus management expertise)

03 Access to technology

04 Skilled human resources

05 Consumer acceptance

06 Lack of information about markets

Regulations: 07 Labeling

08 Limited international harmonization

09 IP protection

10 Cost for gaining regulatory approval

11 Time required to gain regulatory approval

12 Other (please specify)

Financing

10. a) Did you raise capital in 1997 for biotechnology?

1 Yes ➤ How Much? 000\$

2 No

For what purposes?
(check most important)

- 1 R&D
 2 Regulatory approvals
 3 Process Scaleup
 4 Other

Sources?
(check most important)

- 1 Friends / "Angel Investors"
 2 Venture Capital / Labour Sponsored Funds
 3 Private Placement
 4 IPO (Initial Public Offering)
 5 Secondary Public Offering
 6 Strategic Alliance Partner
 7 Other

b) Are you planning to raise capital in 1998?

1 Yes ➤ How Much? 000\$

2 No

For what purposes?
(check most important)

- 1 R&D
 2 Regulatory approvals
 3 Process Scaleup
 4 Other

Sources?
(check most important)

- 1 Friends / "Angel Investors"
 2 Venture Capital / Labour Sponsored Funds
 3 Private Placement
 4 IPO (Initial Public Offering)
 5 Secondary Public Offering
 6 Strategic Alliance Partner
 7 Other

Strategic Decisions

The following question should be answered by the CEO of your company.

11. As the CEO, what were the most important decisions you made over last year (1997)? For this year (1998)?
(check up to three for each year)

	1997	1998		1997	1998
Refocused current product development	01 <input type="radio"/>	02 <input type="radio"/>	Licensed out technology	19 <input type="radio"/>	20 <input type="radio"/>
Downsized the organization	03 <input type="radio"/>	04 <input type="radio"/>	Alliances with academia	21 <input type="radio"/>	22 <input type="radio"/>
Increased the size of the organization	05 <input type="radio"/>	06 <input type="radio"/>	Alliances with government	23 <input type="radio"/>	24 <input type="radio"/>
Entered product trials	07 <input type="radio"/>	08 <input type="radio"/>	Alliances with companies	25 <input type="radio"/>	26 <input type="radio"/>
Launched new product	09 <input type="radio"/>	10 <input type="radio"/>	Raised private capital	27 <input type="radio"/>	28 <input type="radio"/>
Acquired a company	11 <input type="radio"/>	12 <input type="radio"/>	Raised public capital	29 <input type="radio"/>	30 <input type="radio"/>
Acquired by a company	13 <input type="radio"/>	14 <input type="radio"/>	Raised \$ from alliance	31 <input type="radio"/>	32 <input type="radio"/>
Outsourced to others	15 <input type="radio"/>	16 <input type="radio"/>	Raised \$ from sales	33 <input type="radio"/>	34 <input type="radio"/>
Licensed in technology	17 <input type="radio"/>	18 <input type="radio"/>	Borrowed \$	35 <input type="radio"/>	36 <input type="radio"/>
			Other (please specify)	37 <input type="radio"/>	38 <input type="radio"/>

Comments

Thank you for your cooperation !

Appendix 2: Biotechnology Use and Development Survey – 1999



Biotechnology Use and Development Survey - 1999

Confidential when completed

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, c. S-19. Completion of the questionnaire is a legal requirement under the Statistics Act.

Si vous préférez ce questionnaire en français, veuillez cocher



Survey Purpose

Statistics Canada is undertaking this survey in support of the Canadian Biotechnology Strategy. The purpose is to produce information about firms engaged in biotechnology activities by addressing the following question. What are the characteristics and activities of firms that use or develop biotechnology as an important part of their firm's activity?

Biotechnology is a dynamic emerging sector of the Canadian economy and its impact has the potential to be felt through all parts of Canadian society. An accurate understanding of biotechnology requires comprehensive data. Information from this survey may be used by businesses for economic or market analysis, by trade associations to study industry performance, government departments and agencies to assist policy formation, and the academic community for research purposes. Statistics Canada will create a database combining survey responses with existing Statistics Canada data records. **An executive summary of the results will be sent to all respondents.**

Please report on Canadian biotechnology activities of your firm. Complete a separate questionnaire for each firm engaged in biotechnology activity in Canada.

Authority

Collected under the authority of the Statistics Act, Revised Statutes of Canada, Chapter S19. Completion of this questionnaire is a legal requirement under the Statistics Act.

Confidentiality

Statistics Canada is prohibited from publishing or releasing any statistics that would divulge information obtained from this survey that relates to any identifiable firm without the previous written consent of that firm. The data reported in this questionnaire will be treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the Statistics Act are not affected by either the Access to Information Act or any other Legislation.

If you require assistance in the completion of the questionnaire or have any questions regarding the survey, please contact:

Claire Racine-Lebel
Science, Innovation and Electronic Information Division
Statistics Canada
Tunney's Pasture
Ottawa, Ontario
K1A 0T6

Phone: (613) 951-6309 (please call collect) - Fax: (613) 951-9920
e-mail: Claire.Racine-Lebel@statcan.ca

Please indicate the name of the person completing this form so we know who to contact should we have questions about this report.

Name	Title
Telephone Number <input type="text"/> - <input type="text"/> - <input type="text"/>	Email
Fax Number <input type="text"/> - <input type="text"/> - <input type="text"/>	

1 Biotechnologies

1. Please review the following list of biotechnologies and check the applicable circle or circles.

Biotechnologies	Currently Used in Operations 0	If currently using, do you use them for			Number of Years in Use 4	If No ↓ Do you plan to use within 3 years 5
		Product/Process Research & Development 1	Current Production 2	Environmental Purposes 3		
DNA Based						
1110 Gene Probes/DNA Markers	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1120 Bio-Informatics	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1130 Genomics/Pharmacogenetics	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1140 Genetic Engineering/DNA Sequencing/Synthesis/Amplification	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Biochemistry/Immunochemistry						
1150 Vaccines/Immune Stimulants	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1160 Drug Design & Delivery	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1170 Diagnostic Tests/Antibodies	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1180 Peptide/Protein Sequencing/Synthesis	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1190 Cell Receptors/Signalling/Pheromones/Structural Biology	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1200 Combinatorial Chemistry/3D Molecular Modelling	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1210 Biomaterials	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1220 Microbiology/Virology/Microbial Ecology	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Bioprocessing Based						
1230 Cell/Tissue/Embryo Culture Manipulation	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1240 Extraction/Purification/Separation	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1250 Fermentation/Bioprocessing/Biotransformation/Natural Products Chemistry	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Environment						
1260 Biobleaching/Biopulping/Biobleaching/Biodesulphurization	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1270 Bioremediation/Biofiltration/Phytoremediation	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Other (please specify)						
1280	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1290	<input type="radio"/> Yes → <input type="radio"/> No →	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No

→ If you use at least one of the biotechnologies in Question 1 go to Question 3.

→ If you don't use any of the biotechnologies listed in Question 1 go to Question 2.

2 Barriers to Using Biotechnologies

2. Rate the following factors' influence on your firm's decision **not** to use biotechnology. Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

		Importance					Not Applicable
		Low				High	
		1	2	3	4	5	0
		—————→					
Lack of Financial Justification							
2100	Small market size	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2110	High cost of equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2120	High cost to implement/integrate biotechnology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2130	Cost of capital	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Human Resources							
2140	Shortage of skilled or trained staff	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2150	Worker resistance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2160	Increased labour costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External							
2170	Government regulations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2180	Public acceptance/perception of biotechnology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technology							
2190	Biotechnology not sufficiently developed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2200	Lack of external technical expertise/support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)							
2210		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you are not using any biotechnology, please stop here.

Please return the questionnaire in the return prepaid envelope.

Thank you for your co-operation

Information Sources on Biotechnology

3. Rate the importance of the following sources of information on biotechnology as used by your firm. Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

Sources of Information on Biotechnology	Importance					Not Applicable 0
	Low 1	2	3	4	High 5	
3100 Internal resources/staff or parent/subsidiary firm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3110 Academic journals/trade publications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3120 Universities/colleges/private training institutes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3130 Federal government department/agency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3140 Personal contact with others (tacit knowledge)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3150 Other companies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3160 Provincial government department/agency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3170 Professional/industry associations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3180 Library/literature search	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3190 Database retrieval services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3200 Conferences/workshops/trade shows	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3210 Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Benefits from Using Biotechnology

4. a) Does your firm use biotechnology in its production or processing operations?

4100 No → Go to Question 5.

Yes



- b) Rate the benefits from using biotechnologies in your firm's production or processing operations. Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

Benefit of Using Biotechnology	Importance					Not Applicable 0
	Low 1	2	3	4	High 5	
Productivity Improvement						
4110 Lower labour costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4120 Lower capital costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4130 Lower energy costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Product Improvement						
4140 Develop new products or processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4150 Extend product range	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4160 Improvement in product quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Plant Organization						
4170 Increase production flexibility	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4180 Lower maintenance expenses	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4190 Cleaner production/pollution reduction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market Performance						
4200 Improve market position	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4210 Increase sales	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4220 Reduced time to market/Faster delivery time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)						
4230	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5 Human Resources

For the purposes of this survey Employees are defined as those workers for whom you completed a Revenue Canada T4-Statement of Remuneration Paid Form for the 1999 tax year. Include working owner(s). Do not include students.

5. a) How many employees does your firm currently employ? 5100

b) How many employees have biotechnology-related responsibilities? 5110

c) In the table below provide the number of biotechnology employees. Class the employee by their primary area of responsibility. For example, a person working 60% of their time on biotechnology research would be counted once as mainly working in scientific/research direction.

Position	Number Currently Employed		
	Working full-time on biotechnology (more than 50% of time) 1	Working part time on biotechnology (less than 50% of time) 2	Estimated number to be employed in biotechnology in 2002 3
Biotechnology R&D Activities			
5120 Scientific/Research Direction			
5130 Technicians/Engineering			
5140 Regulatory/Clinical Affairs			
Biotechnology Administration & Production			
5150 Production			
5160 Finance/Marketing			
5170 Management/Licensing/Administration			

d) Does your firm currently have unfilled full time biotechnology-related positions?

- 5180 No → Go to Question 5 e)
 Yes
↓

Position	If Yes, was the reason due to			
	Number of Unfilled Full-Time Positions 1	Lack of qualified candidates 2	Compensation required by qualified candidates too high 3	Other 4
Biotechnology R&D Activities				
5190 Scientific/Research Direction		<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3
5200 Technicians/Engineering		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5210 Regulatory/Clinical Affairs		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Biotechnology Administration & Production				
5220 Production		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5230 Finance/Marketing		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5240 Management/Licensing/Administration		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

e) Does your firm employ (either paid or unpaid) post-secondary students in biotechnology-related activities? Include co-op placements, part-time, and full-time positions.

5250 No → Go to Question 5 f)

Yes → What level of education? → 1 Technical/Trade/College
 2 Undergraduate level
 3 Graduate level

f) Does your firm contract out any of the following biotechnology-related activities?

Biotechnology Activity	No 0	Yes	If yes, what is the value (in \$000) of contracts in 1999? If more than one what is the total value? 1
5260 Research & Development	<input type="radio"/>	<input type="radio"/> →	\$ _____,000
5270 Regulatory/Clinical Affairs	<input type="radio"/>	<input type="radio"/> →	\$ _____,000
5280 Marketing/Distribution	<input type="radio"/>	<input type="radio"/> →	\$ _____,000
5290 Management/Licensing/Administration	<input type="radio"/>	<input type="radio"/> →	\$ _____,000

6 Recruiting Practices

6. Check any of the following methods used to fill biotechnology-related positions.

- 6000
- | | |
|---|--|
| 1 <input type="radio"/> Internet resources | 7 <input type="radio"/> Use over-qualified staff |
| 2 <input type="radio"/> University recruitment | 8 <input type="radio"/> Networking |
| 3 <input type="radio"/> Use under-qualified staff | 9 <input type="radio"/> Newspaper/journal ads |
| 4 <input type="radio"/> Temporary/contract staff | 10 <input type="radio"/> Professional associations |
| 5 <input type="radio"/> Employment agencies | 11 <input type="radio"/> Other (<i>please specify</i>) |
| 6 <input type="radio"/> In-house training | _____ |
| | _____ |

7. a) Did you attempt to hire biotechnology staff from outside Canada in 1999?

6100 No → Go to Question 7 c)

Yes → From where? → 1 USA 4 Latin America
 2 Europe 5 Other
 3 Asia

b) Were you successful in hiring biotechnology staff from outside Canada?

6120 No

Yes → How many biotechnology staff did you hire from outside Canada in 1999? 1

c) Did biotechnology personnel leave your firm in 1999?

6130 No

Yes → How many? 1

7 Product/Process Development

8. a) Is your firm currently **developing product** that **requires** the use of biotechnologies?

7000 Yes

No

8. b) Is your firm currently **developing** processes that **requires** the use of biotechnologies?

7110 Yes

No

c) Does your firm consider biotechnology central to its activities?

7120 Yes

No

Did you answer "Yes" to any part of Question 8?

7130 Yes → Go to Question 9

No → Please stop here. Return the questionnaire in the prepaid return envelope. Thank you for your cooperation.

8 Biotechnology Products

9. Please provide the **number** of biotechnology products or processes your firm has at each stage of development.

Biotechnology Sector	Number of biotechnology products/processes by development stage			
	Research & Development 0	Pre-clinical trials/ Confined field trials 1	Regulatory phase/ Unconfined release assessment 2	Approved/ On market/In production 3
Human Health				
8110 Diagnostics (e.g. biosensors, immunodiagnostics, gene probes)				
8120 Therapeutics (e.g. vaccines, immune stimulants, biopharmaceuticals, rational drug design, drug delivery, combinatorial chemistry)				
Agriculture Biotechnology				
8130 Plant Biotechnology (e.g. tissue culture, embryo-genesis, genetic markers, genetic engineering)				
8140 Animal Biotechnology (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)				
8150 Non-food Agriculture (e.g. fuels, lubricants, commodity and fine chemical feedstocks, cosmetics)				
Natural Resources				
8160 Energy (e.g. microbiologically enhanced petroleum recovery, industrial bioprocessing, biodesulphurization)				
8170 Mining (e.g. microbiologically enhanced mineral recovery, industrial bioprocessing, biodesulphurization)				
8180 Forest Products (e.g. biopulping, biobleaching, biopesticides, tree biotechnology, industrial bioprocessing)				
Environment				
8190 Air (e.g. bioremediation, diagnostics, phytoremediation, biofiltration)				
8200 Water (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
8210 Soil (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				

Biotechnology Products

Biotechnology Sector	Number of biotechnology products/processes by development stage			
	Research & Development 0	Pre-clinical trials/ Confined field trials 1	Regulatory phase/ Unconfined release assessment 2	Approved/ On market/In production 3
Aquaculture				
8220 Fish health, broodstock genetics, bioextraction				
Bioinformatics				
8230 Genomics & molecular modelling (e.g. DNA/RNA/protein synthesising & databases for humans, plants, animals, and micro-organisms)				
8240 Gene therapy (e.g. gene identification, gene constructs, gene delivery)				
Food Processing				
8250 Bioprocessing (e.g. using enzymes and bacteria culture)				
8260 Functional Foods/Nutraceuticals (e.g. probiotics, unsaturated fatty acids)				
Other (please specify)				
8270				
8280				

9 Cooperative/Collaborative Arrangements

10. Was your firm involved in biotechnology-related **cooperative/collaborative arrangements** with other companies or organizations in 1999?

Cooperative and collaborative arrangements involve the active participation in projects by your company and other companies or organizations in order to develop and/or continue work on new or significantly improved biotechnology processes, products and/or services. Pure contracting-out is not regarded as collaboration.

- 9100 No → Go to question 13
- Yes → How many? → 1

11. Please indicate for which purposes. Check any that are applicable.

Arrangement Purpose	
9110 To conduct research & development (R&D)/ Access to specialized inputs	<input type="checkbox"/>
9120 Regulatory affairs	<input type="checkbox"/>
9130 To access knowledge/skills/critical expertise	<input type="checkbox"/>
9140 Prototype development/production/manufacturing	<input type="checkbox"/>
9150 Access markets/distribution channels	<input type="checkbox"/>
9160 Access to capital	<input type="checkbox"/>
9170 Intellectual Property Protection	<input type="checkbox"/>
9180 Other (please specify)	<input type="checkbox"/>

12. Check collaboration/co-operation arrangements by each type and their geographic location.

Partner Category	Canada	USA	Europe	Latin America	Asia
	0	1	2	3	4
9190 A firm of smaller or equal size	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9200 A larger firm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9210 Government department/agency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9220 University/Hospital/Research network	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9230 Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. Would you describe your firm as a 'spin-off'?

A Spin-off is defined as a new firm created to transfer and commercialize inventions and technology developed in universities, firms or laboratories.

9240 No → Go to Question 14

Yes → Was your firm a spin-off from; →

- ¹ University/hospital
- ² Another company
- ³ Government agency/lab
- ⁴ Other (please specify) _____

10 Obstacles to Biotechnology Commercialization

14. Rate the following **obstacles to advancement of biotechnology commercialization** activities in your firm. Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

	Importance					Not Applicable 0
	Low 1	2	3	4	High 5	
Inputs						
10100 Access to capital	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10110 Access to technology/information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10120 Access to human resources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Markets						
10130 Domestic market too small	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10140 Lack of access to international markets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10150 Transportation regulations on biotechnology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10160 Lack of distribution & marketing channels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Constraints						
10170 Public perception/acceptance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10180 Regulatory requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10190 Time/cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10200 Patent rights held by others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10210 Lack of patent protection for plants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10220 Lack of patent protection for animals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10230 Lack of patent protection for human components (e.g., organs, tissues)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10240 Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11 Patents

15. a) How many patents and/or pending patents does your firm currently have in each region. (Indicate '0' if none).

		Geographic Location					
		None 5	Canada 0	USA 1	Europe 2	Latin America 3	Asia 4
11100	Existing patents						
11110	Pending patents						

b) Please indicate the number of **patent applications** your company submitted to the following Patent Offices. (Indicate '0' if none)

11120	Patent Office/Year	1998 0	1999 1
11130	Canadian Intellectual Property Office (CIPO)		
11140	United States Patent & Trademark Office (USPTO)		
11150	European Patent Office (EPO)		
11160	Other (please specify)		

c) Please indicate the number of applications for **plant breeders' rights** your company submitted. (Indicate '0' if none)

	Patent Office/Year	1998 0	1999 1
11170	Canadian Plant Breeders' Rights Office		
11180	Plant Variety Protection Office, USDA		
11190	Community Plant Variety Office, EU		
11120	Other (please specify)		

12 Intellectual Property

16. During the last two years, 1998-1999 did your firm **grant the right to use intellectual property** to another firm or did your firm **acquire the right to use intellectual property** from another firm?

12100 No → Go to Question 17

Yes → Please indicate the type and direction of such intellectual property transfer.

Intellectual Property	Granted Rights to Canadian Firms 0		Granted Rights to Foreign Firms 1		Acquired Rights from Canadian Firms 2		Acquired Rights from Foreign Firms 3	
	Yes	No	Yes	No	Yes	No	Yes	No
12110 Trade Secrets/Licensing Agreements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12120 Patents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12130 Plant breeders' rights	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13 Revenues, Expenditures & Trade

17. Please provide financial details in the following table. Please report for fiscal years and in thousands of dollars (\$,000's). Indicate "0" if none

	Please provide details in \$,000's for the years		What is your forecast for 2002
	1998	1999	2002
	0	1	2
13100 Total Firm Sales/Revenue	\$,000	\$,000	\$,000
13110 % of Total Sales/Revenue From Biotechnology	%	%	%
13120 Total R&D Spending	\$,000	\$,000	\$,000
13130 % of R&D Spending on Biotechnology R&D	%	%	%
13140 Total Exports (including licensing agreements)	\$,000	\$,000	\$,000
13150 % of Exports from Biotechnology	%	%	%
13160 Total Imports	\$,000	\$,000	\$,000
13170 % of Imports from Biotechnology	%	%	%

18. If your firm **exported** biotechnologies, what percentage (%) of biotechnology **exports** went to the following geographic locations in 1999? Include licensing agreements. What is your forecasted distribution for 2002?

Year	Geographic Location				
	Canada	USA	Europe	Latin America	Asia
	0	1	2	3	4
13180 1999					
13190 Forecast for 2002					

19. If your firm **imported** biotechnologies, what percentage (%) of biotechnology **imports** came from the following geographic locations in 1999? Include licensing agreements. What is your forecasted distribution for 2002?

Year	Geographic Location				
	Canada	USA	Europe	Latin America	Asia
	0	1	2	3	4
13200 1999					
13210 Forecast for 2002					

20. a) Did your firm attempt to raise capital for biotechnology in fiscal year 1999?

- 13220 No → Go to Question 20 c)
 Yes
↓

b) Were you successful in raising capital?

- 13230 No → Go to Question 20 c)
 Yes → How much did you raise? → \$,000
(in thousands)

Indicate the sources of capital and the percentage (%) of total capital that source provided in 1999.

Source	% of Total Capital
13240 Angel investors/family/friends	
13250 Government loans/grants/incentives	
13260 Venture Capital funds	
13270 Conventional sources (i.e. banks)	
13280 Initial Public Offering (IPO)	
13290 Collaborative alliance	
13300 Other (please specify)	
TOTAL	100%

20. c) Does your firm plan to raise capital in 2002?

13310 No → Go to Question 21

Yes → How much do you plan to raise in 2002? →
1 Less than \$500,000
2 \$500,000 to \$5,000,000
3 More than \$5,000,000

21. In the past 5 years did your firm apply for the tax benefit for biotechnology related activities under the R&D (SRED) tax program?

13320 No → Why? →
1 Complexity of application process
2 Uncertainty of eligibility
3 Did not meet eligibility requirements
4 Other (please specify) _____
 Yes

22. Does your firm use the Internet?

13330 No → Go to Question 23

Yes → Indicate for what purposes your firm uses the Internet.
(Select any that are applicable.)

- 1 Sharing research & development
- 2 Marketing/selling
- 3 Purchasing goods and services
- 4 Accessing databases/information sources
- 5 E-commerce
- 6 Human resource search
- 7 Public relations
- 8 General communication
- 9 Other (please specify) _____

23. Which of the following strategies did your firm use in 1999?
(Select any that are applicable)

- 13400 1 Refocused product development
- 2 Downsized
- 3 Increased size
- 4 Entered product trials
- 5 Launched new product
- 6 Acquired a company
- 7 Out-source production
- 8 Licensed in technology
- 9 Licensed out technology
- 10 Merged with other company
- 11 Formed a joint venture
- 12 Expanded into foreign markets
- 13 No change
- 14 Other (please specify)

Comments

14100

If you have any comments regarding this survey, please provide them in the space below.

Thank you for your co-operation
Please return the questionnaire in the return prepaid envelope.

**Appendix 3: Biotechnology Use and Development Survey – 2001;
First phase questionnaire**



Biotechnology Use and Development Survey - 2001

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, Chapter S19. Completion of this questionnaire is a legal requirement under the Statistics Act.

Version française au verso



Information for the Respondent

Purpose of Survey

Statistics Canada is conducting this survey in order to develop information on biotechnology and related technologies such as functional foods, nutraceutical and bioproducts by identifying industry sectors where these activities take place. Please report on *Canadian activities of your firm in biotechnology, functional foods, nutraceutical or bioproducts*. Your firm may have responded to biotechnology questions in previous surveys, but there is also an increasing demand for information on other technologies and their impact on the Canadian economy.

Authority

Collected under the authority of the *Statistics Act*, Revised Statutes of Canada, 1985, Chapter S19. Completion of this questionnaire is a legal requirement under the *Statistics Act*.

Confidentiality

Statistics Canada is prohibited from publishing any statistics that would divulge information obtained from this survey that relates to any identifiable business, institution or individual. Data is treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the *Statistics Act* are not affected by either the *Access to Information Act* or any other Legislation.

Federal-Provincial Agreement

In order to avoid duplication of enquiry, reduce the cost of collection, and provide consistent statistics, Statistics Canada has entered into an agreement with the Institut de la Statistique du Québec, under Section 11 of the *Statistics Act*. Data collected from Québec firms in this survey will be transmitted to the Institut de la Statistique du Québec. The *Statistics Act* of Quebec includes the same provisions for confidentiality and penalties for disclosure of information as the Federal Statistics Act.

Instruction

A knowledgeable senior person in your firm, such as an R&D manager or production manager, can quickly complete this questionnaire. Please fill in the contact information below, answer all 3 questions and return the completed questionnaire in the accompanying self addressed prepaid envelope to Statistics Canada by March 7, 2002.

Assistance

If you have questions or require assistance please contact:

Claire Racine-Lebel
7th floor, RHCoats Building
Statistics Canada

Telephone: 613-951-6309
Fax: 613-951-9920
E-mail: Sieidinfo@statcan.ca

Please provide the following information:

Name of person completing this form	Telephone number Area code _ _ - _ _ - _ _ _ _
Title	Fax number _ _ _ - _ _ _ _
Web address	E-mail

1. Does your firm currently use or develop biotechnology in its activities?

- Yes
 No

Examples of biotechnologies:

DNA genomics, pharmaco-genetics gene probes, DNA sequencing/synthesis/amplification, genetic engineering. Protein/peptide sequencing/synthesis, lipid/protein engineering, proteomics, hormones and growth factors, cell receptors/signalling/pheromones, cell/tissue culture, tissue engineering, hybridisation, cellular fusion, vaccine/immune stimulants, embryo manipulation, bioreactors, fermentation, bioprocessing, bioleaching, bio-pulping, bio-bleaching, biodesulphurization, bioremediation, biofiltration, gene therapy, viral vectors, bioinformatics, other.

2. Does your firm currently make or develop functional foods or nutraceutical products?

- Yes
 No

Functional food

is a conventional food, beverage, or ingredient enriched with functional components beneficial in disease prevention or disease-risk management, beyond basic nutritional functions. A food, beverage or ingredient may be made functional through a variety of means, such as the addition of components, extraction, fractionation, processing, plant or livestock breeding, livestock feeding techniques, genetic modification, other.

Nutraceutical

is a product isolated or purified from foods (includes herbs and botanicals) that is generally sold in medicinal forms not usually associated with food. A nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic disease.

3. Does your firm currently make or develop a bioproduct?

- Yes
 No

Bioproduct

a commercial or industrial product (other than food and feed) made with biological or renewable domestic agricultural (plant, animal), marine or forestry materials, such as, bio-energy (heating and electricity), bio-fuels (ethanol and bio-diesel), biochemicals, fiberboard, textiles and bio-plastics, other.

Thank you for your cooperation

Please return the completed questionnaire
in the accompanying self addressed prepaid envelope

**Appendix 4: Biotechnology Use and Development Survey – 2001;
Second phase questionnaire**



Biotechnology Use and Development Survey - 2001

Confidential when completed

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, c. S-19. Completion of the questionnaire is a legal requirement under the Statistics Act.

Si vous préférez ce questionnaire en français, veuillez cocher



Information for the Respondent

Survey Purpose

Statistics Canada is undertaking this survey to produce a profile of firms engaged in biotechnology activities in Canada. The survey focuses on the characteristics and activities of firms that use or develop biotechnology as part of their company's activity.

Biotechnology is an emerging sector of the Canadian economy and its impact has the potential to be felt through all parts of Canada's society. An accurate understanding of biotechnology requires comprehensive data. Information from this survey may be used by businesses for economic or market analysis, by trade associations to study industry performance, government departments and agencies to assist policy formation, and by the academic community for research purposes. Statistics Canada may create a database by combining survey data with existing Statistics Canada data records.

Please report 2001 on Canadian biotechnology activities of your firm unless a specific question indicates otherwise. Complete a separate questionnaire for each company engaged in biotechnology activities in Canada.

Confidentiality

Statistics Canada is prohibited from publishing any statistics that would divulge information obtained from this survey that relates to any identifiable business, institution or individual. Data is treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the *Statistics Act* are not affected by either the Access to Information Act or any other Legislation.

Federal-Provincial Agreement

In order to avoid duplication of enquiry, reduce the cost of collection and provide consistent statistics, Statistics Canada has entered into an agreement with the Institut de la Statistique du Québec. Under Section 11 of the Statistics Act data collected from Quebec firms in this survey will be transmitted to the Institut de la Statistique du Québec. The Statistics Act of Quebec includes the same provisions for confidentiality and penalties for disclosure of information as the Federal Statistics Act.

Who Should Complete This Questionnaire?

A senior manager, scientist/researcher or production manager should complete this questionnaire.



Assistance

If you have questions or require assistance please contact:

Claire Racine-Lebel
Science, Innovation and Electronic Information Division
Statistics Canada
Tunneys Pasture
Ottawa K1A 0T6
Telephone: 613-951-6309 (Call collect)
Fax: 613-951-9920
E-mail: Sieidinfo@statcan.ca

Please provide the following information:

Name of person completing this form	Telephone number Area code _ _ - _ _ - _ _ _ _
Title	Fax number _ _ _ - _ _ _ _
Web address	E-mail

Section 1 - Biotechnologies in Use

This section measures the use of biotechnologies in your firm.

1. Using the table below, please indicate the use your firm makes of each type of biotechnology listed. Check the applicable circle or circles.

Biotechnologies	Currently Used in Operation 0	If currently using, do you use them for			Number of Years in Use 4	If No ▼ Do you plan to use within 3 years? 5
		Product/Process Development 1	Current Production 2	Environmental Purposes 3		
DNA - the coding						
1000 Genomics/Pharmaco-genetics	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1010 Gene probes	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1020 DNA sequencing synthesis amplification, Genetic Engineering	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Proteins and Molecules - the functional blocks						
1100 Protein/peptide sequencing/synthesis	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1110 Lipid/protein engineering	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1120 Proteomics	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1130 Hormones, growth factors, pheromones	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1140 Cell receptors signalling	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Cell and Tissue Culture, and Engineering						
1200 Cell/ tissue culture, Embryo manipulation	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1210 Tissue engineering	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1220 Hybridization	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1230 Cellular fusion	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1240 Vaccine/immune stimulants	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Process Biotechnologies						
1300 Bioreactors	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1310 Fermentation, Bioprocessing	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No

Biotechnologies	Currently Used in Operation 0	If currently using, do you use them for			Number of Years in Use 4	If No ▼ Do you plan to use within 3 years? 5
		Product/ Process Development 1	Current Production 2	Environmental Purposes 3		
1320 Biobleaching, Bio-pulping, Biobleaching, Biodesulphurization	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1330 Bioremediation, Biofiltration	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Sub-Cellular Organisms						
1400 Gene Therapy	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1410 Viral Vectors	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
Other						
1500 Bioinformatics	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1510 Nanobiotechnologies	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
1520 Other, Please Specify: _____	<input type="radio"/> Yes → <input type="radio"/> No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No

If you use at least one of the biotechnologies listed in Question 1



Go to Section 2

If you do not use any of the biotechnologies listed in Question 1



Please return the questionnaire in the accompanying prepaid return envelope.

Thank you for your assistance.

Section 2 - The Effects of Biotechnology on Your Firm

This section measures the factors influencing the use of biotechnology in your firm and the impact of biotechnology use on your firm's performance.

2. Using the table below, please rate the level of influence of each factor on increasing your use of biotechnology.

		Importance				
		Low				High
		1	2	3	4	5
Inputs		—————→				
2000	Access to capital	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2010	Access to technology/information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2020	Access to human resources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Markets						
2100	Size of Domestic Market	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2110	Access to international markets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2120	Information about markets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2130	Distribution & marketing channels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Constraints						
2200	Public perception/acceptance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2210	Cost of regulatory approval	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2220	Time required for regulatory approval	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2230	Limited international harmonization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2240	Patent rights held by others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2250	Lack of protection for intellectual property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2260	Other, Please specify:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. For each of the performance factors listed below, please rate the level of impacts of biotechnology use on your firm's performance.

		Importance				
		Low				High
		1	2	3	4	5
Increased Productivity		—————→				
3000	Labour costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3010	Capital costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3020	Energy costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved Products						
3100	New products or processes introduced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3110	Product range increased	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3120	Product quality increased	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Knowledge Based						
3200	Developing new areas for R&D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3210	Increase efficiency for R&D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved Market Performance						
3300	Market position improved	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3310	New Market Niche Developed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3320	Sales increased	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3330	Other, Please Specify:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section 3 - Human Resources in Biotechnology

Concerns have been expressed about the availability of skilled biotechnology employees. Your cooperation in careful completion of this section is essential in developing an accurate understanding of human resources in biotechnology. For the purpose of this survey Employees are defined as those workers for whom you completed a Canada Customs and Revenue Agency T-4 statement for the 2001 tax year. Include working owners. Do not include students. Only count employees working in Canada. If '0' (zero) indicate '0'.

Number of Biotechnology Employees

4. a) How many employees does your firm employ in Canada?
Please Report Typical Employment Level for 2001.

b) How many employees have biotechnology-related responsibilities?
Please Report Typical Employment Level for 2001.

c) Full-time Biotechnology Employees

For each group listed below indicate how many are full-time biotechnology employees (50% or more of their time spent on biotech related activities)? If an employee fulfils more than 1 duty, report their primary responsibility. Count each person only once. Please Report Typical Employment Level for 2001.

Position	Number of full-time
Scientific Research & Direction	4100
Technicians	4110
Regulatory/Clinical Affairs	4120
Production	4130
Finance/Marketing	4140
Management	4150
Other, Please Specify:	4160
Total Full-time employees	4170

Part-time Biotechnology Employees

d) For each group listed below indicate how many are Part-time biotechnology employees (less than 50% of their time spent on biotech related activities)? If an employee fulfils more than 1 duty, report their primary responsibility. Count each person only once. Please Report Typical Employment Level for 2001.

Position	Number of part-time
Scientific Research & Direction	4200
Technicians	4210
Regulatory/Clinical Affairs	4220
Production	4230
Finance/Marketing	4240
Management	4250
Other, Please Specify:	4260
Total Part-time employees	4270

e) Total Number of biotechnology employees.

Total full-time and part-time employees with biotechnology-related responsibility (Box 4170 + Box 4270)

This number must equal 4010 above.

Recruiting Practices

5. a) Does your firm have unfilled biotechnology-related positions?

5000 No ► Go to question 5b

Yes ► In the table below indicate the number of unfilled positions by category.

Position	Number of Unfilled Positions
Scientific Research & Direction	5100
Technicians	5110
Regulatory/Clinical Affairs	5120
Production	5130
Finance/Marketing	5140
Management	5150
Other, Please Specify:	5160
Total unfilled positions	5170

b) Did your firm attempt to recruit any biotechnology employees in 2001?

5200 No ► Go to question 8

Yes ► Were you successful?

5300 No ► Go to question 6

Yes ► How many did you hire?

5310

c) What sources were successfully used in recruiting biotechnology staff?

5400 University Recruitment

5450 Other Biotechnology Firms

5410 Temporary/Contract Staff

5460 Pharmaceutical Firms

5420 Employment agencies/Headhunters

5470 Newspaper/Journal

5430 Professional Associations

5480 Student Internship

5440 Own Staff/Incentive program

5490 Internal Training of Staff

6. Please rate the impact of the following factors on your efforts in filling biotechnology-related vacancies.

Factors	Importance				
	Low 1	2	3	4	High 5
Candidate Factors					
6000 Compensation requirements by candidates too high	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6010 Candidates unwilling to relocate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6020 Lack of experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Firm Factors					
6100 Capital/resources insufficient to attract candidates	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External Factors					
6200 Lack of qualified candidates	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6210 Competition for qualified candidates	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6220 Other, Please Specify	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. Did you attempt to hire biotechnology staff from outside of Canada in 2001?

7000 No ► Go to question 8

Yes ► Was your firm successful in hiring from outside of Canada?

7010 No ► Go to question 8.

Yes ► How many staff from outside Canada did you hire?

7020

8. Did any biotechnology personnel leave your firm in 2001?

8000 No ► Go to question 9

Yes ► How many?

8010

Section 4 - Biotechnology Products

This section measures the development of new biotechnology products and processes by your firm.

9. a) Do you have biotechnology products/processes on the market?

9000 No ► Go to question 9b)

Yes ► What year was the most significant product first introduced?

9010

b) Is your firm currently developing products that require the use of biotechnology?

9100 No ► Go to question 9c)

Yes ► What year will the most significant of these products reach market?

9110

c) Is your firm currently developing processes that require the use of biotechnology?

9200 No ► Go to question 9d)

Yes ► What year will the most significant of these processes be completed?

9210

d) Do you consider biotechnology central to your firm's activities or strategies?

9300 No

Yes

e) If you answered "Yes" to any Part of Question 9

► Go to Q10

Otherwise

► Please return the questionnaire in the accompanying prepaid return envelope.

Thank you for your assistance.

10. In the table below, for each sector listed please indicate the number of biotechnology products or processes your firm currently has for each stage of development.

Biotechnology Sector	Number of biotechnology products/processes by development stage			
	Research & Development 0	Pre-clinical trials/ Confined field trials 1	Regulatory phase/ Unconfined release assessment 2	Approved/ On market/In production 3
Human Health				
10000 Diagnostics (e.g. biosensors, immunodiagnosics, gene probes)				
10010 Therapeutics (e.g. vaccines, immune stimulants, biopharmaceuticals)				
10020 Drug Delivery				
Agriculture Biotechnology				
10100 Plant Biotechnology (e.g. tissue culture, embryogenesis, genetic markers, genetic engineering)				
10110 Animal Biotechnology (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)				
10120 Non-food Agriculture (e.g. fuels, lubricants, commodity and fine chemical feedstocks, cosmetics)				
Natural Resources				
10200 Energy (e.g. microbiologically enhanced petroleum recovery, industrial bioprocessing, biodesulphurization)				
10210 Mining (e.g. microbiologically enhanced mineral recovery, industrial bioprocessing, biodesulphurization)				
10220 Forest Products (e.g. biopulping, biobleaching, biopesticides, tree biotechnology, industrial bioprocessing)				
Environment				
10300 Air (e.g. bioremediation, diagnostics, phytoremediation, biofiltration)				
10310 Water (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
10320 Soil (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
Aquaculture				
10400 Fish health, broodstock genetics, bioextraction				
Bioinformatics				
10500 Genomics & molecular modelling (e.g. DNA/RNA/protein synthesising & databases for humans, plants, animals, and micro-organisms)				
10510 Gene therapy (e.g. gene identification, gene constructs, gene delivery)				
Food Processing				
10600 Bioprocessing (e.g. using enzymes and bacteria culture)				
10610 Functional Foods/Nutraceuticals (e.g. probiotics, unsaturated fatty acids)				
10620 Other, Please Specify				

11. a) What is the total time required to bring your principal biotechnology product or process from the initial development phase/proof of concept stage to the market? If still in pre-market stages provide an estimate.

Years Months

b) What is the total cost to bring your principal biotechnology product or process from the initial development phase/proof of concept stage to the market? If still in pre-market stages provide an estimate.

\$,000

Section 5 - Business Practices

Contracting Out

12. a) Did your firm contract out biotechnology related activities in 2001?

12000 No Go to question 12d)

Yes For each partner type listed below, please indicate the number and value of contracts for each group listed.

Partner Type	Number of Contracts 0	Total Value of Contract in 2001 for (\$,000)			
		Purpose of Contract			
		R&D 1	Regulatory/ clinical 2	Management/ Production 3	Other 4
12100 Private Entities (C.R.O's / other Firms, etc)		\$,000	\$,000	\$,000	\$,000
12110 Public Entities (Universities / Government Labs.)		\$,000	\$,000	\$,000	\$,000

b) Did you contract out to organizations outside of Canada?

12200 No Go to question 13

Yes For each organization listed below, please indicate the percentage (%) of your firm's total contracting out in 2001.

Organization	% of total contracting out
12300 Private research lab	%
12310 University/Hospital	%
12320 Government lab	%
12330 Other biotechnology firm	%
12340 Other, Please Specify:	%

c) Rate the level of importance of each of the following reasons on your decision to contract out.

Reasons for Contracting Out	Importance				
	Low 1	2	3	4	High 5
12400 Knowledge not available internally	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12410 Access outside scientific expertise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cost Reduction Related to:					
12420 R&D Activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12430 Regulatory/Clinical Affairs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12440 Production	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12450 Precursor to a formal agreement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12460 Reduce risk/exposure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12470 Other, Please Specify:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

d) Does your firm **provide** contract services to other firms or organizations?

12500 No ► Go to question 13

Yes ► For each type of contract services listed below, please indicate the number of contracts entered into in 2001 and the revenues received for each category.

	Contract Services	Number of contracts entered in 2001 0	Revenue received from this source in 2001 1
12600	Routine Lab services		\$,000
12610	Specialized Lab services		\$,000
12620	Production/manufacturing services		\$,000
12630	Other, Please Specify: _____		\$,000
12640	Total		\$,000

Collaborative Arrangements

Cooperative and collaborative arrangements involve the active participation in projects between your company and other companies or organizations in order to develop and/or continue work on new or significantly improved biotechnology processes and/or products. **Pure contracting-out work is not regarded as collaboration.**

13. a) Was your firm involved in biotechnology-related cooperative/collaborative arrangements with other companies or organizations in 2001?

13000 No ► Go to question 14

Yes ► Provide the number of arrangements by purpose and partner type

Arrangement Purpose	Number of Arrangements by Partner Type			
	Biotech Firm 0	Non-biotech Firm 1	Academic Institution/ Hospital 2	Government lab or agency 3
13100 To conduct research & development (R&D)				
13110 Regulatory affairs				
13120 Access others' patents				
13130 Production/manufacturing				
13140 Access markets/distribution channels				
13150 Access capital				
13160 Access to Intellectual property from partner				
13170 Other, Please Specify _____				
13180 Total number				

Intellectual Property

14. a) Did your firm grant biotechnology related intellectual property (IP) rights to another firm?

¹⁴⁰⁰⁰ No ► Go to question 14b)

Yes ► For each type of intellectual property instrument listed below please indicate the number of IP rights granted by country and the total income received from IP licensing in 2001.

Intellectual Property Instrument	Number with Canadian firms 0	Number with USA firms 1	Number with other country firms 2	Revenue from IP licensing in 2001 3
¹⁴¹⁰⁰ Licensing Agreement				\$,000
¹⁴¹¹⁰ Patents				\$,000
¹⁴¹²⁰ Other, Please Specify _____				\$,000

b) Did your firm obtain biotechnology related intellectual property rights from another firm?

¹⁴²⁰⁰ No ► Go to question 15

Yes ► Complete the following table

Intellectual Property Instrument	Number with Canadian firms 0	Number with USA firms 1	Number with other country firms 2	Cost to your firm of obtaining IP in 2001 3
¹⁴³⁰⁰ Licensing Agreement				\$,000
¹⁴³¹⁰ Patents				\$,000
¹⁴³²⁰ Other, Please Specify _____				\$,000

15. a) Does your firm have biotechnology related patents or pending patents?

¹⁵⁰⁰⁰ No ► Go to question 16

Yes ► How many?

Indicate the distribution of biotechnology related patents and pending patents your firm has by Patent Office

	Canadian Intellectual Property Office (CIPO) 0	U.S. Patent & Trademark Office (USPTO) 1	European Patent Office 2	Other 3
¹⁵¹⁰⁰ Existing Patents				
¹⁵¹¹⁰ Pending Patents				

b) Provide the number of unique patent applications your company submitted in

Number

¹⁵²⁰⁰ 2000	
¹⁵²¹⁰ 2001	

Section 6 - Firm Characteristics and Financial Profile

Revenues and Research and Development (R&D) Expenditures

16. Please complete the following table. If information is not available please provide a carefully considered estimate. Report for fiscal years and in thousands of dollars (\$,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 0	2001 1	2004 Forecast 2
¹⁶⁰⁰⁰ Total Firm Sales/Revenues (all sources)	\$,000	\$,000	\$,000
¹⁶⁰¹⁰ % of revenues from Biotechnology	%	%	%
¹⁶⁰²⁰ Total R&D spending	\$,000	\$,000	\$,000
¹⁶⁰³⁰ Total spending on Biotechnology R&D	\$,000	\$,000	\$,000
¹⁶⁰⁴⁰ % of Biotechnology R&D spending contracted out	%	%	%

17. Does your firm have sales of biotechnology products?

17000 No ► Go to question 18

Yes ► What percentage of your sales of biotechnology products came from.

	%
Direct sales to consumers or distributors	17100
Products sold to other firms to be used as inputs	17110

Firm History

18. Is your firm a public firm?

18000 No ► Go to question 19

Yes ► What year was the Initial Public Offering (IPO)?

18100

19. What year was your firm or spin-off established?

19000

20. Has your firm merged with another firm? (Include acquisition of another firm or by another firm)

20000 No ► Go to question 21

Yes ► What year did the merge take place?

20100

21. Is your firm a subsidiary of a Multi-National Enterprise (MNE)?

21000 No ► Go to question 22

Yes

22. a) Is your firm a spin-off? A spin-off is defined as a new firm created to transfer and commercialize inventions and technology developed in universities, firms or laboratories.

22000 No ► Go to question 23

Yes ► Was your firm a spin-off from ►

University/hospital	<input type="checkbox"/>	22100
Another Biotech company	<input type="checkbox"/>	22110
Non-biotech firm	<input type="checkbox"/>	22120
Government Agency/lab	<input type="checkbox"/>	22130
Other, Please Specify	<input type="checkbox"/>	22140

Raising Capital

A great deal of attention has focused on the ability of biotechnology firms to raise capital and the challenges of raising capital. Questions in this section are intended to collect information in order to address this critical issue facing the biotechnology sector.

23. a) Did your firm attempt to raise capital for biotechnology related purposes in 2001?

23000 No ► Go to question 23h)

Yes ► Were you successful in raising capital?

23100 No ► Go to question 23c)

Yes ► How much \$,000

b) Did you reach your target?

23200 No ► Go to question 23c)

Yes ► Go to question 23d)

23. c) What reasons did the lender give in limiting or refusing your request for capital?

Check all that apply.

- Biotechnology product/process not sufficiently developed 23300
- Biotechnology product line or portfolio limited in scope 23310
- Insufficient specific management skills/expertise 23320
- Capital not available due to market conditions 23330
- Further product development or proof of concept required 23340
- Lender does not fund development projects 23350
- Other, Please Specify 23360

d) What sources provided funding?

	% of total raised from each source?
Canadian based Venture Capital	23400 %
American based Venture Capital	23410 %
Conventional sources (i.e. banks)	23420 %
Angel Investors/Family	23430 %
Government sources	23440 %
Other, Please Specify	23450 %
_____	%

e) For your most important biotechnology product or process, please indicate the current stage of development.

Stage of Development

- R&D 23500
- Pre-Clinical 23510
- Clinical Trials 23520
- Market Entry 23530

For your most important biotechnology product or process, please indicate total spending since the beginning of development.

	Stage of Development	Total spending up to and including current stage
23600	R&D	\$ _____,000
23610	Pre-Clinical	\$ _____,000
23620	Clinical Trials	\$ _____,000
23630	Market Entry	\$ _____,000

For your most important biotechnology product or process, please estimate the total amount of capital required to complete each stage, as well as the total capital available.

	Stage of Development	Total additional capital required to complete stage <small>1</small>	Total capital available to complete stage (include all committed funds) <small>2</small>
23700	R&D	\$ _____,000	\$ _____,000
23710	Pre-Clinical	\$ _____,000	\$ _____,000
23720	Clinical Trials	\$ _____,000	\$ _____,000
23730	Market Entry	\$ _____,000	\$ _____,000

23. f) How long do you anticipate this capital (committed and on hand) lasting?

Years Months

g) Why did you raise or attempt to raise capital? Indicate each category that applies to your firm

- 23900 R&D purposes/Expand R&D capacity
- 23910 Repay current investors
- 23920 Commercialize current R&D projects
- 23930 Clinical/regulatory expenses
- 23940 Develop production/manufacturing capability
- 23950 Other, Please Specify:

h) Do you plan on raising capital in 2002?

- 24000 No Go to question 24
- Yes How much do you plan to raise? < \$1,000,000 24010
- \$1,000,000-\$5,000,000 24020
- > \$5,000,000 24030

Tax Incentives

24. a) Did your firm have biotechnology R&D expenditures in any of the previous 5 years?

- 24100 No Go to question 26
- Yes In the past 5 years did your firm apply for benefits for biotechnology related activities under the Scientific Research and Experimental Development (SR&ED) tax program?
 - 24200 Yes How much did you apply for in 2001? \$ _____ ,000 Go to question 24b
 - No Why?
 - Complexity of application process 24300
 - Uncertainty of eligibility 24310
 - Did not meet eligibility requirements 24320
 - Other, Please Specify: 24330

b) Have any of your SR&ED credits expired?

- 24400 No
- Yes

25. Did your firm apply for any provincial R&D tax benefit or incentive?

25000 Yes

No ► Why did you not apply?

Complexity of application process 25100

Uncertainty of eligibility 25110

Did not meet eligibility requirements 25120

Other, Please Specify 25130

Imports & Exports

26. Did your firm export biotechnology products?

26000 No ► Go to question 27

Yes ► Please complete the following table. Report for fiscal years and in thousands of dollars (\$,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 0	2001 1	Forecast for 2004 2
26100 Total Exports Revenues (all sources)	\$,000	\$,000	\$,000
26110 % export revenues from Biotechnology	%	%	%

Regional Distribution

26200 % export revenues to US	%	%	%
26210 % export revenues to Europe	%	%	%
26220 % export revenues to Asia	%	%	%
26230 % export revenues to other regions	%	%	%

27. Did your firm import biotechnology products?

27000 No ► Go to question 28

Yes ► Please complete the following table. Report for fiscal years and in thousands of dollars (\$,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 0	2001 1	Forecast for 2004 2
27100 Total Import Expenditures (all sources)	\$,000	\$,000	\$,000
27110 % import expenditures from Biotechnology	%	%	%

Regional Distribution

27200 % import expenditures to US	%	%	%
27210 % import expenditures to Europe	%	%	%
27220 % import expenditures to Asia	%	%	%
27230 % import expenditures to other regions	%	%	%

Strategies Used in 2001

28. In the table below rate the significance of each of the following strategies on your firm's performance in 2001.

Importance

Low					High
1	2	3	4	5	

Knowledge development strategies

28000	Captured and used knowledge obtained from other industry sources such as industry associations, competitors, clients and suppliers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28010	Captured and used knowledge obtained from public research institutions including universities and government laboratories	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28020	Used and updated databases of scientific information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28030	Developed firm policies and practices for knowledge/intellectual property protection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28040	Developed/encouraged staff education/upgrading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28050	Conducted an Intellectual Property Audit to ensure protection of products and processes at all stages of development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Business strategies

28100	Increased firm size through acquisition, merger or joint venture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28110	Downsized operations of the firm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28120	Entered product trials/adapted products or processes for increased market penetration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28130	Began new research & development project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28140	Expanded into foreign markets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28150	Other, Please Specify: _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

29 a) Does your firm develop, produce or sell **Living Modified Organisms (LMO)**?

Living modified organism means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology. A living organism means any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses and viroids.
 Source: Cartagena Protocol on Biosafety

29000 No

Yes ► If yes, how many unique products based on living modified organisms does your firm have at each of the following stages?

Research & Development Stage	_____	29100
Clinical/Regulatory stage	_____	29110
Market stage	_____	29120
Total	_____	29130

b) Did your firm export living modified organisms in 2001?

29200 No

Yes ► If yes, how many unique products based on living modified organisms did you export? _____ 29210

How many unique living modified organisms did you export to

United States	_____	29300
Europe	_____	29310
Other	_____	29320

Comments ³⁰⁰⁰⁰

Thank you for your assistance.

Return the questionnaire in the accompanying self addressed prepaid envelope.