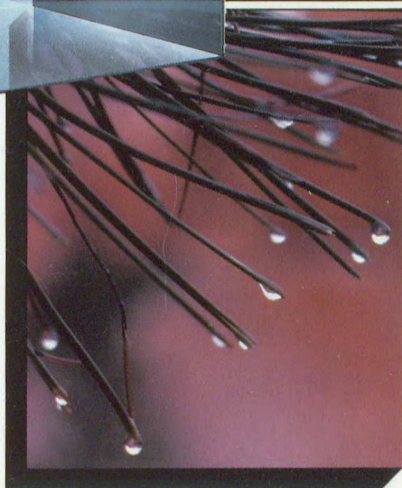
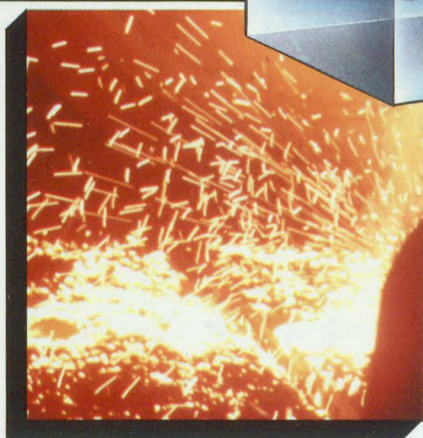
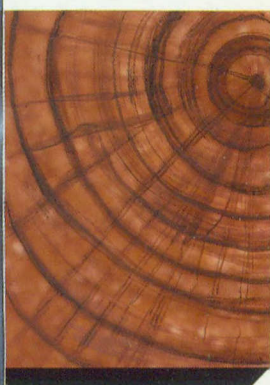
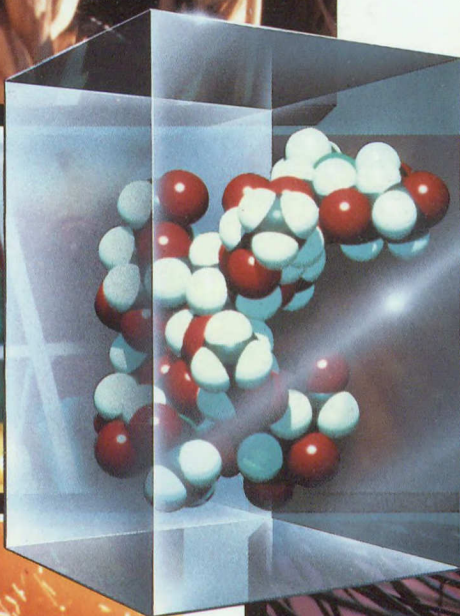


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# Canadian Biotech '89: *On the Threshold*



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A survey of business and financial issues

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## Cover

Biotechnology is revolutionizing industry around the world. This revolution is based on the discovery of powerful new techniques for manipulating genetic material. These advances are important to future economic development since, as our cover illustration depicts, biotechnology will have very broad applications to the various industrial sectors including human health care, agriculture, forestry, the environment and mining.

The central molecule in the illustration is a model of the polysaccharide antigen from the bacterial cell wall surface of salmonella. At the National Research Council of Canada's Division of Biological Sciences in Ottawa, the Carbohydrate Laboratory specializes in interpreting the antigen-antibody interaction underlying the immune response in terms of its biochemical properties and molecular structures. Cell surface carbohydrate antigens, like the one depicted, have been modified to produce a new generation of vaccines to diseases such as meningitis, gonorrhea, and enteric diseases caused by salmonella and *E.coli*.

Photos: Industry, Science and Technology Canada

Molecular model: The National Research Council of Canada

# Canadian Biotech '89: *On the Threshold*

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A survey of business and financial issues

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# Preface

In the past, information on the challenges and successes of industrial biotechnology in Canada has been mostly anecdotal. No single source of consolidated and current information on biotechnology existed.

Through a collaborative effort among five players, Ernst & Young's High Technology Group, Winter House Scientific Publications Inc., Industry, Science and Technology Canada, the National Research Council of Canada, and, most importantly, the industry itself, a detailed study was undertaken in November of 1988. The objective: to gather qualitative and quantitative data on the Canadian biotechnology industry that could serve as a useful baseline of information against which the future performance of the industry could be measured.

The outcome, *Canadian Biotech '89: On the Threshold*, presents a dynamic picture of an industry, active in almost all parts of the economy, emerging as a force to be reckoned with in international markets. It is our hope that the results presented in this publication will be of value to policy makers, the financial community and the industry itself, both in Canada and abroad, in their deliberations.

Many individuals were responsible for collecting, analyzing and publishing the results. A first effort is always infinitely more onerous than could possibly be imagined at the outset. All those who participated in this venture are to be congratulated. Statistics Canada deserves special thanks for assistance in the evaluation of financial data.

I look forward to reconvening the entire team in the future to measure the progress of this exciting sector once again as it moves beyond the threshold.

**Peter Winter,**  
**Winter House Scientific Publications Inc.**  
**December, 1989**

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# Executive Summary

**B**iotechnology in Canada is in a dynamic state of investment in new technology, new manufacturing facilities and new markets. Optimism pervades the sector. Challenges abound. With strategies based on innovation and partnership, Canada's biotechnology companies are poised to take their place among the pioneers in international markets.

Biotechnology is breaking even in Canada. Total sales hit \$660 million last year, R&D accounted for aggregate spending of \$275 million, and the net loss after taxes for the entire industry was only \$3 million, with half of the companies reporting profits.

Canadian biotechnology firms are on the threshold of a period of rapid growth. With an average of six products in production and another six in development, companies plan to spend almost \$7 million each on new manufacturing facilities by 1992. The industry expects to hire 5000 new employees by 1992, almost doubling the present workforce, and forecasts sales that total \$5 billion industry-wide by the same year, for an annual growth rate of 46 per cent.

These are somewhat modest plans as viewed from a North American perspective: U.S. firms plan to spend \$51 million each on manufacturing facilities, eight times as much as Canadian firms; U.S. firms expect to grow to 321 employees each by 1992 while Canadian firms grow to 53; and U.S. firms forecast an increase by a factor of 4.9 in their revenues by 1992 to total \$72 billion on an industry-wide basis.

The products and processes invented and sold by Canadian biotechnology companies involve nearly every industrial sector. They include cloned varieties of ornamental plants, bioleaching in the mining of uranium and gold, quick tip-of-the-tongue tests to measure blood alcohol, anaerobic digestion systems for the treatment of pulp mill effluents, the world's first conjugate vaccine, cattle improvement through nuclear transplantation and embryo cloning, monoclonal antibodies for blood typing, soil microbes to improve plant growth, diagnostic kits for AIDS, the brewing of beer, biological pesticides, and mass production of biological reagents from eggs and plants. This list just scratches the

surface. The common theme is that all involve the harnessing of living systems to carry out specialized tasks or to manufacture tailor-made products.

Canada's traditional strength in the natural resource-based industries has had a significant impact on the way biotechnology has developed here. A much higher proportion of Canada's biotechnology companies is involved in activities such as mining, forestry, fishing, agriculture and environmental industries than in the U.S., the U.K. or Japan. Many of Canada's largest biotechnology companies are well-established members of these conservative industrial sectors. Founded in the early part of this century, these companies have been attracted to biotechnology in recent years in part as a result of strong government incentives for collaboration among industry players, university scientists and government laboratories. These firms make up a significant fraction of the large biotechnology companies in Canada. They continue to be quite conservative.

In what is the first survey of its type conducted in Canada, some extremely valuable insights were gained into the current status and future directions of Canada's emerging biotechnology industry.

Taken as a group, Canada's biotechnology companies are ambitious. The challenges for the future, if these ambitions are to be realized, will be to find the capital to finance the building boom of new manufacturing facilities; to educate and attract the people needed to fill the 5000 new jobs in industrial biotechnology; to create and maintain the linkages with scientists who can ensure a continuing stream of innovative products; and to cement the commercial partnerships that will permit Canadian companies to compete effectively in international markets.

## *The Survey*

Eighty-four companies, representing 38 per cent of the 220 companies known to be involved in biotechnology in Canada, were selected so as to reflect the geographical, sectoral and size distribution of the industry.

The survey addressed an extensive range of business and financial topics which included human resource requirements, intellectual

property issues, regulations, liability concerns, manufacturing capabilities, partnering strategies, availability of capital, obstacles in commercialization, approaches to marketing, sources of revenue and future plans.

Results were analyzed by size of company and by sector of activity. Company size was determined based on the total number of employees: very small, 1-10; small, 11-50; mid-size, 51-135; and large, over 135. Companies were placed into ten groups to permit sectoral analysis: diagnostics, therapeutics, agriculture, suppliers, environmental, aquaculture, food and beverage, forestry, mining, and consulting and contract research firms.

The key findings of this survey of industrial biotechnology undertaken in Canada between November of 1988 and February of 1989 follow.

## Key Findings

### *Commercialization*

- ☐ **Over 10,000 products of biotechnology:**  
The 84 surveyed companies collectively have 4078 products at all stages of product development. If this is extrapolated to the entire industry, this leads to an estimate of 10,600 products of biotechnology in the roughly 220 biotechnology companies in Canada.
- ☐ **Most products are in development:**  
These products include 2542 (62%) at the stage of research and development, 617 in testing (15%) and the remainder, 919 (23%) at the stage of production.
- ☐ **Seed companies account for 76 per cent of all products:**  
Seed companies surveyed account for a disproportionate number of these products - a full 76 per cent of the aggregate 4078 products, or 3089 products in all. Of these, 2200 are at the stage of research and development, 437 are at the stage of testing and 452 are in production.
- ☐ **Health care companies have strength "in the pipeline":**  
The remaining 989 products (24%), distributed across all of the other sectors surveyed, included 342 at the stage of research and development, 180 in testing and 467 in production. Diagnostics companies have the highest number of products "in the pipeline", with an average of 9.2 each in R&D or testing. Therapeutics firms are a close second with an average of 8.7 each.
- ☐ **Small companies lead in number of products:**  
When seed companies are excluded, the average number of products in production per company decreases

with increasing company size. Small companies with 11-50 employees have an average of eight products in production while companies with greater than 150 employees have an average of only three.

- ❑ **More than half of the companies surveyed have manufacturing facilities:** Fifty-six per cent of the companies surveyed already have in-house manufacturing facilities. Fifty per cent expected to build new facilities within the next two years.
- ❑ **Over \$1 billion will be invested in new Canadian manufacturing facilities by 1992:** Companies surveyed expect to invest a total of \$546 million in manufacturing facilities between 1988 and 1992. If this is extrapolated to the 220 biotechnology firms doing business in Canada, this leads to an estimate of \$1.4 billion for the entire industry. According to those surveyed, 76 per cent of this investment will be for domestic facilities with the remainder targetted for investment abroad.
- ❑ **Small companies have ambitious plans for growth:** Between 1988 and 1992 they expect to commit an average of \$4 million per company on domestic manufacturing facilities. Large companies report plans to spend just over double this amount in the same period.
- ❑ **Direct sales figure prominently:** The companies surveyed indicated a range of different approaches for distributing their products. The most frequently cited technique for both the domestic market and Japan was direct sales. On the other hand, wholesalers were cited most often for the United States, and distributors for Europe.

- ❑ **Companies predict their sales will quadruple in five years:** Canadian biotechnology companies expect their annual sales figures to more than quadruple between 1988 and 1992 from an average of \$4.6 million per company to \$21.1 million. This leads to an estimate of \$4.6 billion revenue from the products of biotechnology for the entire industry in 1992.
- ❑ **Exports to grow faster than domestic sales:** At the time of the survey, the ratio of domestic to foreign sales of Canadian biotechnology companies was roughly 50:50. However, these companies predict that their export sales will increase so that by 1992 their domestic to foreign sales ratio will be 35:65.
- ❑ **Research cited as top competitive factor:** The companies surveyed rated research expertise, management expertise and products as the top three determinants of their competitive advantage.

## *Combining Forces*

- ❑ **Alliances are a common feature of Canadian biotechnology companies:** Eighty-seven per cent of companies surveyed have alliances with other firms and organizations, with an average of 8.3 per company.
- ❑ **Half of the alliances are foreign:** Alliances with other companies are distributed as follows: 47 per cent in Canada, 33 per cent in the United States, 13 per cent in Europe, 3 per cent in Japan, and 4 per cent elsewhere.

- ☐ **Universities are the most frequent partners:**  
The top three categories of alliances in terms of frequencies were those with universities (22%), government laboratories (14%) and other biotechnology companies (13%).

- ☐ **Companies look for credibility when choosing partners:**  
Credibility, access to technology and research capability were the top three factors involved in selecting a domestic alliance partner. For foreign alliances the top factors were credibility, marketing expertise, and access to technology.

- ☐ **Acquisitions are expected to be high:**  
The firms surveyed expect 60 per cent of Canadian biotechnology companies to be acquired within the next ten years. Only 17 per cent expect to be among those to be acquired and 29 per cent expect to acquire a company.

## *The Human Dimension*

- ☐ **Industry-wide requirement for 5000 new employees over five years:**  
The 84 companies surveyed expected their aggregate total of employees to grow from 2510 in 1988 to 4476 in 1992. This increment of almost 2000, when extrapolated to the whole industry, reveals a requirement for over 5000 new employees for Canada's biotechnology industry during this five-year period. Approximately 1500 of these will be bioscientists, 400 will be engineers and 700 will be in sales and marketing.
- ☐ **Highly qualified personnel are hard to find:**  
Companies report that bioscientists and

engineers, especially those with multidisciplinary capabilities and industrial experience, are hardest to find.

- ☐ **Government is seen as a competitor for staff:**  
Industry views its top three competitors for highly qualified personnel as other biotechnology firms, government and educational institutions.

- ☐ **Best technical advice is not from scientific advisory boards:**  
Only 44 per cent of the companies surveyed have scientific advisory boards. When asked to rank their three most valuable sources of advice about technology, companies identified universities (63%), in-house expertise (62%) and the federal government (44%).

- ☐ **Boards of Directors feature prominently in financial decisions:**  
Eighty-three per cent of the companies surveyed have Boards of Directors. They rank their three most valuable sources of advice about financing as their own Board of Directors (55%), the federal government (47%) and in-house personnel (46%).

- ☐ **Consultants provide advice in many areas:**  
In-house personnel, consultants and trade associations were ranked as the three most valued sources of advice on manufacturing and marketing. The survey found that over 45 per cent of companies hire consultants to obtain advice on marketing, 40 per cent for advice about technology, and 30 per cent for advice about financing and manufacturing.



## ***Financial Indications***

- ☐ **Half have positive net incomes:**  
Over half of the companies surveyed reported positive net incomes after tax in each of the two most recent fiscal years.
- ☐ **Only the therapeutics sector had average net incomes which were positive:**  
Average net income after taxes was negative for all size categories except the large companies and for all sectors except therapeutics.
- ☐ **R&D spending almost doubled:**  
Average expenditure on R&D per company per year was found to be \$1,250,000 in the most recent fiscal year, representing a growth rate of 89 per cent over the previous one.
- ☐ **Diagnostics firms increased their R&D by a factor of 12:**  
R&D growth rates from 1986 to 1987 were highest for mid-size firms and for diagnostics companies.
- ☐ **Strong growth in revenues reported:**  
Total revenue per company grew by 28 per cent from \$2,590,000 in 1986 to \$3,322,000 in 1987.
- ☐ **Mid-sized companies showed highest revenue growth rate:**  
The average revenue per company in 1987 increased with size of company from \$267,000 for very small companies to \$19,365,000 for large companies. Annual growth rates between 1986 and 1987 were 40 per cent for very small companies, 33 per cent for small, 72 per cent for mid-size, and 24 per cent for large.
- ☐ **Over \$70,000 revenue per employee:**  
Revenue from sales of biotechnology products per employee devoted to biotechnology also increased with company size in 1987 from \$10,089 for very small companies to \$113,246 per employee in large companies, with an overall average of \$72,530 per employee.
- ☐ **Contract research important to small firms:**  
Small companies derive most of their revenue from contract research (66%) and large ones derive essentially all of their revenue from sales. Revenue from royalties is important only in very small and small firms.
- ☐ **Liquidity ratio is high:**  
The overall average per company for current assets in 1987 was \$2,835,000, and for current liabilities, \$1,100,000, yielding a median liquidity ratio of 2.3. This was up from 2.0 in 1986. These values are at the high end of the range defined by other industrial sectors.
- ☐ **Mid-sized firms displayed the highest liquidity ratios:**  
The liquidity ratio was highest in mid-sized firms and in the therapeutics sector with median values of 6.5 and 2.6 respectively.
- ☐ **Debt-to-equity ratios are low:**  
The average debt per company in 1987 was \$2,434,000 and the average equity was \$5,418,000 with a median debt-to-equity ratio of 0.47. This was down from 0.68 in 1986. These values are much lower than other Canadian industrial sectors in the same year.



## ***Legal and Tax Environment***

- ☐ **Companies believe in patenting:**  
Seventy-five per cent of the companies surveyed believe that patenting is worthwhile. At the same time, half of the companies do not believe they can defend their patents.
- ☐ **Relatively few patent disputes:**  
Only 20 per cent of the companies surveyed had ever been involved in patent disputes. Only four companies have actually been involved in litigation in connection with a dispute.
- ☐ **Many companies patent abroad:**  
More than half of the companies reported first-hand experience with patenting products in Europe, the United Kingdom and the United States. Forty-three per cent of the companies have experience with patenting in Japan.
- ☐ **Most file first in the United States:**  
The majority of companies file their patent applications in the United States first, to obtain a one-year protection during which they file in Canada, Europe, Japan and elsewhere.
- ☐ **Suppliers and therapeutics firms concerned about liability issues:**  
Over 80 per cent of the companies in the survey reported no liability concerns. Supplier firms and therapeutics manufacturers showed the highest level of involvement with this issue. All sectors expect liability concerns to increase, with 38 per cent of those surveyed believing their ability to commercialize products in the future will be impaired by product liability.
- ☐ **Regulatory approval takes on average 15 months:**  
Eighty-two per cent of the companies surveyed have products which require regulatory approval by one or more agencies. Of those surveyed, 49 have products regulated by Health and Welfare Canada, 30 by Agriculture Canada, 20 by Environment Canada, and 20 by other agencies. Regulatory approval takes on average 15 months, ranging from eight months for diagnostics firms to 22 months for therapeutics firms.
- ☐ **Awareness of CEPA regulations was low:**  
Only 29 of the 84 companies surveyed were familiar with the Canadian Environmental Protection Act (CEPA) and its implications for industrial biotechnology. All but six of these had serious concerns about the proposed regulations as drafted at the time of the survey, (November 1988 to February 1989).
- ☐ **Research tax credit system drew criticism:**  
The Scientific Research and Experimental Development (R&D) Tax Credit was criticized by many respondents for having too narrow a definition of research, for being cumbersome to apply for, and for taking too long to receive.
- ☐ **Research tax refunds are arriving sooner:**  
The streamlined system for R&D tax credits introduced in the spring of 1988 has shortened the waiting period for cash refunds from an average of 20.9 months to 5.2 months. Approximately equal numbers of respondents fall into each of these two categories as might be expected since the survey took place in late 1988 and early 1989.

## *International Perspective*

- ❑ **Product sales per employee are higher in Canada than in the U.S.:** Canadian firms reported sales of biotechnology products per employee of \$33,000 for small companies and \$113,000 for large companies. U.S. firms reported \$30,000 for small companies and \$70,000 for large ones.
- ❑ **R&D as a percentage of sales is like that in the U.S.:** Canadian companies spend, on average, 42 per cent of their sales revenue on research and development. Their U.S. counterparts spend 43 per cent.
- ❑ **Canada's biotechnology companies are older than their U.S. counterparts:** Forty-nine per cent of the firms now engaged in biotechnology in Canada were founded before 1980. These include many established natural resource-based firms that have only recently taken up biotechnology activities. Only 31 per cent of U.S. biotechnology firms and 17 per cent of U.K. firms were founded before 1980.
- ❑ **U.S. companies will invest eight times as much in manufacturing facilities:** Between 1988 and 1992, Canadian companies plan to spend an average of \$6.6 million each to build new manufacturing facilities. During the same timeframe, U.S. firms will spend an average of \$51 million each.
- ❑ **Canadian and U.S. firms forecast similar growth rates in revenue from sales:** Between 1988 and 1992, Canadian firms expect their sales revenues to grow by a factor of 4.6 to reach an industry-wide aggregate revenue of \$4.6 billion in 1992. Over the same interval, U.S. firms forecast growth by a factor of 4.9 to reach aggregate industry revenue of \$70 billion.
- ❑ **U.S. companies have more patents than Canadian firms:** Canadian firms hold an average of 2.4 patents per company and have another 2 patents pending. U.S. firms hold an average of 6 patents per company and have an additional 21 pending.
- ❑ **Canadian firms rely more on export sales than do U.S. firms:** In 1988, the sales of Canadian biotechnology companies went 52 per cent to foreign markets. This is expected to increase to 62 per cent by 1992. U.S. firms, on the other hand, sold only 17 per cent of their products to foreign markets in 1988 and expect this to increase to 30 per cent by 1992.

This survey provides a baseline for industrial biotechnology in Canada against which future performance may be measured. It also provides a wealth of information to help investors, policy makers, scientists and the industry itself understand the sector in more depth.





# On the Threshold

**B**iotechnology is one of the oldest technologies on Earth. Knowledge about how living systems grow permitted early civilizations to harness wild yeasts to make fermented drinks and leavened bread. Knowledge about how characteristics are passed on from one generation to another enabled our ancestors to breed cattle to create portable milk factories.

Today's scientists harness this same knowledge to create domestic breeds of fungi, bacteria and viruses to manufacture biological products or to perform highly specific chemical reactions. They also manipulate the genetic material of plants and animals to improve nutritional value, increase productivity, increase shelf life, introduce disease resistance, and increase tolerance to environmental stress.

The big difference today is that, by virtue of scientific breakthroughs made during the 1970's, these goals can be reached much more quickly than in the past. Techniques have been developed for moving genes from one organism to another; for rearranging and editing genetic elements to optimize their expression; for growing large quantities of cells from a wide variety of plant, animal and microbial sources; and for purifying the products manufactured in these miniature factories.

All of these techniques, both old and new, for harnessing our knowledge about biological systems to develop tailor-made products and processes, make up the activity known as biotechnology.

## *Worldwide impact of biotechnology*

Research scientists working in the area of health care were quick to recognize the potential of genetic engineering. In 1983, just one decade after scientists discovered how to move genes from one organism to another, the human gene for insulin had been moved into a bacterial cell, grown in large quantities, and the product, "humulin", placed on the market. This success was followed in 1985 by the production of human growth hormone, an essential medicine for the

treatment of dwarfism. Previous preparations of growth hormone came from the pituitary glands of cadavers and carried the risk of being contaminated with viruses causing the serious central nervous system disease, Creutzfeldt-Jakob disease. The biotechnology product proved to be safer and more plentiful, two characteristics that helped establish recombinant DNA as the technology of choice for human biologicals.

A steady stream of new biopharmaceuticals are on their way to market. These include blood factors for treating hemophiliacs, cell growth factors for boosting the immune system, magic bullets for finding and attacking cancer cells, special factors for inducing regeneration of damaged tissue, and potent recombinant vaccines to protect against disease, and in some cases, perhaps even cure it.

Diagnostic medicine has also been an early and avid player in the realm of industrial biotechnology. The key technology here is the ability to produce a practically infinite range of different monoclonal antibodies (Mabs), each of which can recognize one, and only one, substance. Once a particular Mab is found to be useful, it can be produced in large quantities in immortal mouse cells called hybridomas. Mabs are the basis of a whole range of highly sensitive, rapid, accurate diagnostic tests that take minutes instead of days to perform. Early applications include pregnancy tests, diagnosis of venereal diseases, diagnosis and localization of cancer, and tip-of-the-tongue blood alcohol measurement.

Today, just over six years after the birth of industrial biotechnology, sales of its products have reached \$6 billion worldwide. By the turn of the century, worldwide sales for all biotechnology products are expected to be over \$100 billion.

Why are these advances so important to our future economic development? The answer is simple. Biotechnology has important applications to essentially all traditional industrial sectors, all the way from human health care to mining. The core technology that was so rapidly adopted by the health sector holds within it the seeds of endless innovations of importance to agriculture, aquaculture, forestry, food and beverage production, chemicals, energy, mining and environmental industries.

For example, the application of biotechnology to agriculture permits the development of plants and animals with higher

nutritional value and greater resistance to disease. Treatments are being found for seeds, soil and crops to enhance growth, inhibit weeds, ward off pests and induce tolerance to environmental stress, all using specifically targetted biological agents and reducing requirements for chemical pesticides, fertilizers and herbicides.

When these benefits are added to the prospects for using biotechnology to recover precious metals from low grade ore, to manufacture complex chemicals without producing hazardous waste, to develop faster growing trees and fish, to convert waste materials to energy, and to find solutions to some of our most difficult environmental problems, it becomes obvious that the commercial and cultural impact of biotechnology will be enormous.

## ***Biotechnology in Canada***

Canada has gained a reputation over the years for its application of traditional biotechnology to develop products such as hardy winter wheat, highly productive dairy cattle and pediatric vaccines. However, when the discoveries of genetic engineering and Mabs came along in the 1970's, Canada was slow to recognize their importance. While individual scientists and a few companies became involved, largely through international contacts, it was 1983 before the government developed a strategy for the promotion of this area of activity. Despite this late start, Canadian industry has responded to the opportunities biotechnology has to offer and has made significant progress.

In contrast to countries such as the United States, Great Britain and Japan, where biotechnology is focussed overwhelmingly upon health, agriculture and food, the Canadian biotechnology industry is typified by its diversity. Almost half of its biotechnology firms are in resource-based industries, a reflection of its traditional strength in forestry, mining, agriculture, fishing and chemicals.

Canada is recognized internationally for its health care system, has a strong tradition in research relating to human and animal health care, and is among the ten largest pharmaceutical consuming nations in the world. Consequently, the development of a Canadian biotechnology-based health care industry is considered as a priority by both government and industry. Of the biotechnology firms active in Canada, almost one-third have primary interests and activities in the health care sector.



Agricultural applications of biotechnology in Canada include crop improvement using anther and embryo culture; cell cloning; sexual and somatic hybridization; and gene transfer between different plant species. Specific goals of these programs include frost-resistant plants, genetically improved oilseeds, novel ornamentals, biofertilizers, bioherbicides and biopesticides. Canadian companies and research institutions have also taken a leading role in the genetic improvement of animals.

Canada has over 220 biotechnology firms, over half of which have been founded since 1980. Many of those founded prior to 1980 are established corporations in traditional industrial sectors which have recently established biotechnology research and development departments. A majority of the companies are privately owned and have fewer than 50 employees. Many have brought modest products to market and use the income from these sales, supplemented by contract research and private equity, to finance research and development of highly innovative products.

Canada has an excellent reputation for the quality of its basic research. A significant number of the biotechnology companies in Canada began as start-up firms to commercialize promising university research. The federal government has reinforced these linkages between industry and the research community by providing financial assistance for pre-commercial alliances which bring industry, universities and government together to work on common goals (see Appendix VIII and Appendix IX).

Technical support for the biotechnology industry is supplied through the services of the National Research Council facilities at the Biotechnology Research Institute in Montreal, the Plant Biotechnology Institute in Saskatoon and the Division of Biological Sciences in Ottawa, as well as a network of Agriculture Canada and Forestry Canada research stations across the country. In addition, collaboration between industry and other science-based departments is increasing.

The federal government has helped to establish national R&D networks across the country in seven priority areas: aquaculture; forestry; human and animal health care; plant strain development; nitrogen fixation; waste treatment; and mineral leaching and mining. These networks link the performers and users of research.

Industrial Research Chairs in Biotechnology and networks of centres of excellence linking researchers and industry are further examples of government commitment to the promotion of biotechnology.

## *Investing in biotechnology*

Transforming scientific discoveries into commercially viable products takes time, money and talent. For example, Connaught Laboratories estimates that it took ten years and \$20 million to bring ProHIBiT™, the world's first conjugate vaccine to market. Financial backers with the fortitude to see projects of this kind through to the end are hard to find.

Prospective investors in biotechnology must be prepared to embark upon due diligence exercises in two areas: financial and technological.

Key questions which need to be answered in exploring investment opportunities include:

- Is the technology leading-edge within the world context?
- Can the technology be protected?
- Is there a market for the product?
- Does the company have a competitive advantage which will permit it to capture a significant market share?
- Does the company have the in-house talent and external alliances that will ensure that a high quality product can be accelerated to market, avoiding the re-inventing of wheels?
- What is the company's strategy for second, third and fourth generation products?
- Is the available financing adequate to ensure completion of the pre-commercial phase, based on the projections for R&D expenditures?

Finally, and perhaps most importantly, a management team capable of coping with rapid growth is critical for a biotechnology company's success. Having a great product is simply not enough. Strength in management, strategic planning and marketing is an essential ingredient. The challenge for management is to harness the talents of the company's scientists and business people to develop the kind of well-balanced, aggressive strategies that will permit them to compete in international markets.

## *An industry in transition*

The growth and rapid worldwide development of biotechnology have placed many challenges before Canada. Can it mount a serious challenge and become a force to be reckoned with in this fiercely competitive world marketplace?

Canadian biotechnology companies are on the threshold of commercial development. There are many products in the pipeline. Companies are optimistic about the future. For example, over the next five years the Canadian industry expects to invest \$1.4 billion in manufacturing facilities and forecasts annual sales revenues of \$5 billion by 1992.

This anticipated growth will be accompanied by a requirement for 5000 new employees. Canadian firms are already experiencing difficulty in recruiting molecular biologists, protein chemists, synthetic carbohydrate chemists, immunologists, as well as scientific information specialists, and chemical and biochemical engineers with experience in biotechnological processes. Government and educational establishments compete for the same people, making the task even more challenging. The stiffest competition of all will probably come from the U.S. which forecasts a demand for 164,000 new employees between 1988 and 1992. This increasing demand places pressure on educational institutions to design multidisciplinary biotechnology programs capable of turning out graduates with skills ranging from basic research to fermentation engineering and business management.

A second challenge is in the area of regulations. Products of biotechnology represent such a departure from the past that government regulatory bodies around the world are still some distance from reaching a consensus on the best approach. In Canada, many products of biotechnology are regulated by Health and Welfare or Agriculture Canada. Others will fall under the Canadian Environmental Protection Act whose draft regulations have been the subject of so much discussion. The challenge for Canada is to emerge from this period of transition with regulations which are reliable; predictable; user-friendly; in reasonable harmony with those of the U.S. and Europe; not unnecessarily burdensome to industry; and which ensure the health and safety of Canadians and the quality of our products.

The third and perhaps most vital challenge for the industry as a whole will be to develop creative financial strategies to

sustain ambitious growth plans. Information about the financial successes of biotechnology will play an integral part in attracting investors. But this is not enough. The financial community must also gain a better appreciation of the special needs and unique characteristics of biotechnology firms to enable them to recognize those which represent good investment opportunities. At the same time, biotechnology companies need to explore a wider variety of options for growth and development. In the midst of a strong world-wide trend toward consolidation, strategic partnerships may represent one of the few viable alternatives, and could prove to be a good model for Canadian independents.

The technologies which biotechnology embraces are complex and remain a mystery to a majority of the lay public. This fact lies at the root of the fourth challenge: the environmental, ethical and social concerns which are shaping our attitudes about biotechnology. This dialogue will have a major impact upon success of biotechnology innovations in the market place. Industry must be a participant.

The industry stands poised for significant activity and expansion. Careful management of this growth is essential. It will test the resourcefulness of the business executive and government decision-maker alike. Progress lies in being able to forge strategic alliances that build upon the all-important creative and entrepreneurial spirit that is the essential ingredient for business success. □



# Survey Design and Analysis

## *Overview*

**T**his is the first broadly-based survey of the biotechnology industry to be carried out in Canada. It provides aggregate data on the opinions, experience and expectations of over one-third of the companies engaged in biotechnology in Canada.

The primary goal was to arrive at a reasonably accurate description of the state of development of industrial biotechnology in Canada to assist the investment community, policy makers and industry in their interactions with this increasingly pervasive industrial tool. Secondary goals included establishing a baseline against which future performance could be measured; and collecting the kind of information that would permit direct comparison with other countries.

Topics covered in the survey include human resource requirements, intellectual property issues, regulation, liability concerns, manufacturing capabilities, partnering strategies, availability of capital, obstacles to commercialization, approaches to marketing, sources of revenue and future plans.

Eighty-four companies were surveyed between November of 1988 and February of 1989. They were selected to represent, as closely as possible, the actual distribution of biotechnology companies in Canada with respect to geographical location, industrial sector of activity and size of company.

## *Questionnaire design and delivery*

The survey questionnaire was designed in consultation with the Ernst & Young High Technology Group (formerly the Arthur Young High Technology Group) to ensure that the results could be compared directly with its U.S. survey entitled *Biotech 89: Commercialization*. Some subject areas were dropped, such as the entire section of questions relating to the after-effects of the October 1987 stock market crash. Others with special relevance to Canada, such as those focussed on patent law reform and Canadian regulations for biotechnology, were added. A detailed description of the survey is provided in Appendix I.

The survey was carried out in the form of a series of interviews of about two hours in duration with representatives of top management of each firm. All answers were held in confidence and used only in aggregate form. Of the 97 companies approached, 84 were willing to participate in the survey using this approach.

A few highly sensitive questions referring to actual revenues, taxes, assets and liabilities in previous years were segregated in Part B of the survey. Firms were asked to provide these data directly to Statistics Canada where they were analyzed and provided to the Editors in the form of aggregate data to ensure confidentiality of all participants.

Sixty-four of the 84 participants in the survey forwarded Part B to Statistics Canada. However, because 25 of these only provided partial information, they had to be excluded from this part of the analysis. The Editors are grateful to the 39 companies which provided complete information; and to Statistics Canada for receiving and compiling the data, and for ensuring confidentiality.

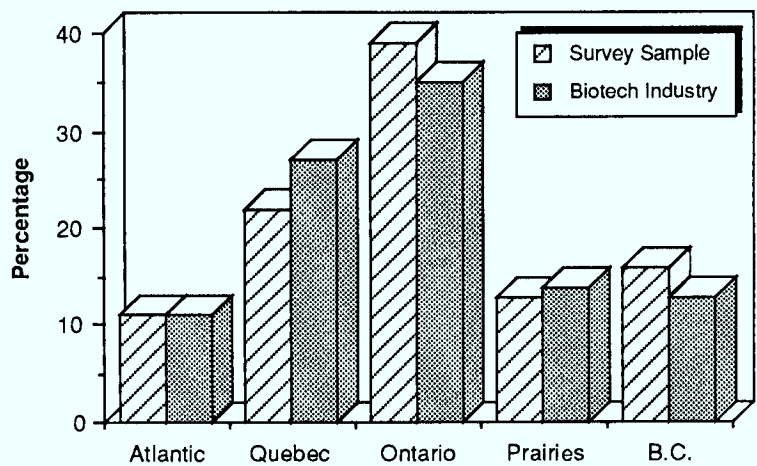
## *Selection of participants*

The most recent available inventory of companies involved in biotechnology in Canada is the 1988 *Canadian Biotechnology Industry Sourcebook*, published by the Ministry of State for Science and Technology (MOSST) in September of 1988, based on a survey completed in the Spring of 1988. This list



of 220 firms was the primary source for selection of participants in our survey. Companies were not selected at random from this list, however. A selection of 97 was drawn up which reflected, as closely as possible, the geographical distribution of firms across Canada, the industrial sectors of activity, and the distribution of company sizes based on number of employees. Because only 84 of the 97 chose to participate, the proportions deviated slightly from the industry total as shown below.

**Chart 2-1: Geographical distribution of Canadian biotechnology companies in 1988.**



**Geographical distribution:** Biotechnology companies are distributed coast-to-coast in Canada in a way that closely follows the population distribution itself (see inside back cover). Chart 2-1 shows the distribution for the industry total and for the sample of 84 companies surveyed. As can be seen, the surveyed sample did not deviate from the industry total distribution by more than 5 per cent in any region of the country.

**Sectoral distribution:** As in the case of the United States, Europe and Japan, the most active sector in biotechnology in Canada is health care. Unlike these competitors, however, Canada has a significant proportion, in fact 47 per cent, of its biotechnology companies in the natural resource-based sectors: agriculture, aquaculture, forestry, mining and environment.

**Chart 2-2: Sectoral distribution of Canadian biotechnology companies in 1988.**

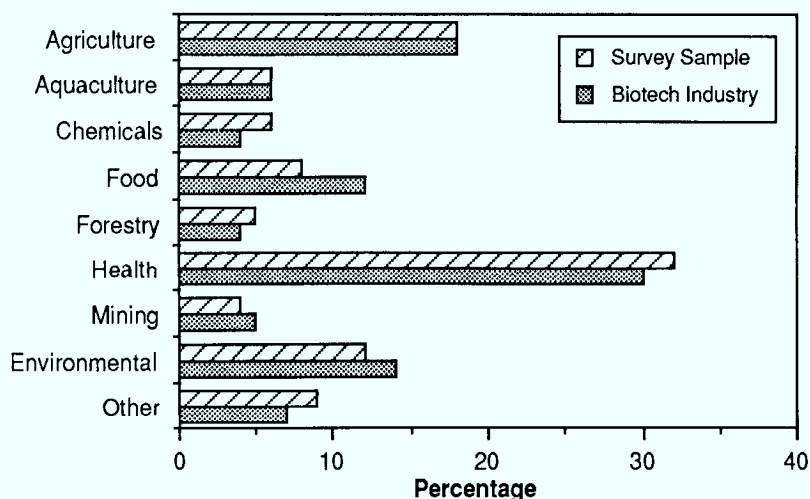
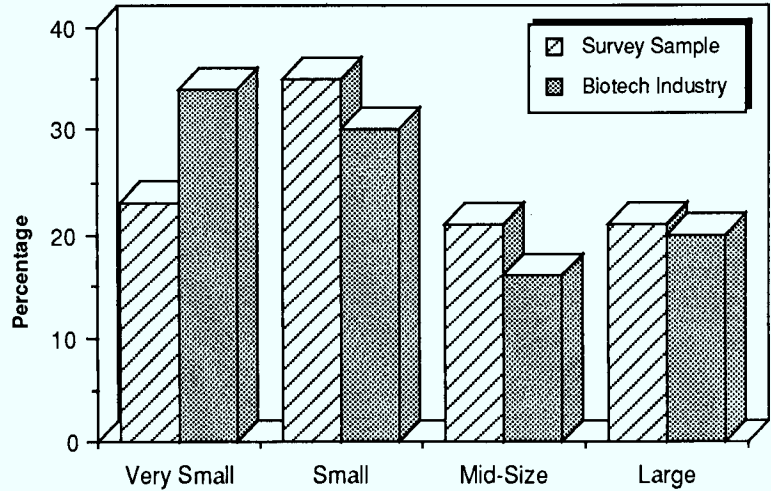


Chart 2-2 illustrates the sectoral distribution of Canadian biotechnology companies and those which participated in the survey. As can be seen, health care companies were somewhat over-represented and environmental companies were under-represented in the survey sample. On the whole, however, the sample is a faithful reflection of the sectoral distribution of the entire industry.

**Size distribution:** Industrial biotechnology in Canada is characterized by the relatively large number of very small firms. In fact, only 20 per cent of the firms engaged in biotechnology have over 135 employees while 34 per cent have ten or fewer. Small companies defined as those with 11 to 50 employees represent 30 per cent of the companies, and mid-size companies defined as those with 51 to 135 employees, make up 16 per cent of the total.

As shown in Chart 2-3, the small and mid-size companies were each over-represented in the survey by five per cent, the large companies were over-represented by one per cent and the very small companies were under-represented by 9 per cent.

**Chart 2-3: Size distribution of Canadian biotechnology companies in 1988.**



### ***Analysis of survey results***

The survey results were analyzed both by company size and by industrial sector. The categories were chosen to facilitate comparison with previous studies undertaken by the Ernst & Young High Technology Group in the United States and the United Kingdom (see Chapter 8 for summaries of these studies).

**Company size categories:** The size categories adopted for this report are based on the total number of people employed by each firm. This is a more practical way of subdividing this industry at this time than the more conventional approach of dividing companies into categories based on gross revenue. This is a result of the fact that industrial biotechnology is truly "on the threshold" in Canada and, even in mid-size companies, revenue has often just begun to trickle in. A subdivision based on revenue would group some exceedingly small companies with some very large ones.

A second consideration in selecting size categories was the desire to compare results directly with those obtained in the United States and the United Kingdom. For this reason, we


adopted the three size categories used by the Ernst & Young High Technology Group in *Biotech 89: Commercialization*: small, 1-50; mid-size, 51-135; and large, over 135. This was modified slightly by the splitting of the "small" category into two: very small, 1-10; and small 11-50. In this way, the start-up companies which form such a significant proportion of activities in Canada could be examined much more closely. At the same time, for the purposes of comparison with the United States and the United Kingdom, the two categories could easily be recombined.

In summary, the data in this survey were analyzed by size of companies using the following size categories:

<b>very small</b>	1-10 employees
<b>small</b>	11-50 employees
<b>mid-size</b>	51-135 employees
<b>large</b>	over 135 employees

**Industrial sectors analyzed:** As noted above, half of the firms involved in industrial biotechnology in Canada are in sectors other than health and agri-food. For this reason, while the sectoral divisions used in the U.S. study provided a good starting point, they had to be supplemented to highlight some important activities in the natural resource-based industries in Canada. In particular, the categories used in the U.S. study were diagnostics, therapeutics, agriculture, suppliers and "other". For the purposes of our analysis, environmental companies were split out of the "other" category, and only recombined when direct comparisons to the U.S. were to be made.

**Table 2-1: Sectoral distribution of companies surveyed in 1988**

Diagnostics	13		<b>Aquaculture</b>	<b>5</b>
Therapeutics	14		<b>Food and Beverage</b>	<b>6</b>
Agriculture	15		<b>Forestry</b>	<b>4</b>
Suppliers	10		<b>Mining</b>	<b>3</b>
Environmental	8		<b>Consulting/Contract Research</b>	<b>6</b>
Other	24			

**Table 2-1** shows the distribution of companies surveyed within these six industrial sector categories.

In summary, the industrial sector categories used throughout the analysis of this survey were as follows:

<b>Diagnostics</b>	(human and/or animal health)
<b>Therapeutics</b>	(human and/or animal health)
<b>Agriculture</b>	(plant genetics, microbial crop protectants, animal improvement)
<b>Suppliers</b>	(instruments, cell culture, lab supplies, biotechnology reagents and biological cultures)
<b>Environmental</b>	(waste treatment, biomass conversion, remediation)
<b>Aquaculture</b>	(fish farming, marine products)
<b>Food and Beverage</b>	
<b>Forestry</b>	
<b>Mining</b>	
<b>Consultants</b>	(contract research, consulting services)

*Diagnostics:* In general, diagnostics companies develop sensitive and rapid tests to detect the presence of molecules or substances. The tools most often used are monoclonal antibodies. Valuable applications have been made for the diagnosis of many viral and bacterial diseases, cancer, certain metabolic disorders and pregnancy in both humans and animals. Increasingly the same technology is being applied to other sectors to detect and identify a wide variety of micro-organisms.

*Therapeutics:* Human and animal medicines and therapeutic treatments make up this category of products. As the field of genetic engineering progresses, more and more of the "biologicals" of the pharmaceutical industry will be "designer" drugs, tailor-made by clever manipulation of genetic material. A number of break-through treatments for life-threatening conditions require relatively large quantities of substances which can only be found in tiny amounts in animal or human tissue. Using genetic engineering, the relevant gene can be moved into a bacterium or fungus so that its product can be produced in large quantities by fermentation.

*Agriculture:* These companies deal with plant genetics, cloning, tissue culture and micro-propagation to improve the nutritional or growth characteristics of crops and domestic animals. They are also involved in the development of microbial pesticides, herbicides and fertilizers. While the major impact of these activities is in agriculture, their application in forestry is on the increase.

*Suppliers:* These companies have a distinctive role to play in biotechnology in providing the specialized laboratory instruments, biological reagents and production equipment needed by the biotechnology industry.

*Environmental:* Activities in this sector are focussed on the design of systems which harness microbial agents to bring about the degradation of industrial and municipal wastes, the conversion of biomass to energy, the detoxification and recovery of useful materials from industrial by-products, and remediation. A significant number of engineering consultants specializing in biodegradation place themselves in this market.

*Other:* This category includes all other industrial biotechnology activities. In particular, the numbers of companies that made up the 24 in this category in the survey were: aquaculture, 5; food and beverage, 6; forestry, 4; mining, 3; and contract research and other biotechnology consulting services, 6.

## ***Extrapolation of survey results***

Eighty-four firms out of a total of 220 firms (as documented in the 1988 Sourcebook published by MOSST) were interviewed for this survey. This represents thirty-nine per cent of the companies known by the Editors to be involved in biotechnology at the time of the survey.

A sample was selected which reflected as closely as possible the geographical, sectoral and size distributions of Canadian biotechnology firms as described above.

Since the companies could not be chosen entirely at random, it is not possible to draw conclusions about the aggregate of industrial biotechnology in Canada with a high degree of statistical significance from the present survey. It is intended instead to provide a sound base for understanding the opinions, trends, opportunities and difficulties of this emerging sector.

Occasionally the Editors have taken the liberty of extrapolating from the survey results to the total industry. It was felt that providing estimates for total requirements for trained scientists over the next five years, or total capital expected to be invested in new production facilities, would be useful and would be unlikely to be very far wrong for the total industry based on the responses of 84 of its companies. □





# Commercialization

**I**ndustrial biotechnology is in a period of dynamic growth in Canada, judging by the product pipeline and plans for expansion uncovered in the portion of the survey focussing upon commercialization. As described in this chapter, Canadian biotechnology firms are optimistic when they speak of their opportunities, challenges and projections in the areas of product development, manufacturing capabilities, approaches to distribution, sales expectations, market capture and competition.

For the purpose of this discussion, the word "products" is used to signify all products and processes developed by the surveyed firms.

## *Key findings*

*The number of products decreases as company size increases...*

- The 84 surveyed companies collectively have 4,078 products at all stages of product development. If this is extrapolated to the entire industry, this leads to an estimate of 10,600 products of biotechnology in the roughly 220 biotechnology companies in Canada.
- These products include 2542 (62%) at the stage of research and development, 617 in testing (15%) and the remainder, 919 (23%) at the stage of production.
- Seed companies surveyed account for a disproportionate number of these products - a full 76% of the aggregate 4078 products, or 3089 products in all. Of these, 2,200 are at the stage of research and development, 437 are at the stage of testing and 452 are in production.
- The remaining 989 products (24%), distributed across all of the other sectors surveyed, included 342 at the stage of research and development, 180 in testing and 467 in production.
- When seed companies are excluded, the average number of products in production per company decreases with increasing company size. Small companies with 11-50 employees have an average of eight products in production while companies with greater than 150 employees have an average of only three.

*Ambitious plans  
for investment  
in manufacturing  
facilities...*

- Companies surveyed expect to invest a total of \$546 million in manufacturing facilities between 1988 and 1992. If this is extrapolated to the 220 biotechnology firms doing business in Canada, this leads to an estimate of \$1.4 billion for the entire industry. According to those surveyed, 76% of this investment will be for domestic facilities with the remainder targeted for investment abroad.

- Small companies have ambitious plans for growth. Between 1988 and 1992 they expect to commit an average of \$4 million per company on domestic manufacturing facilities. Large companies report plans to spend just over double this amount in the same period.

*Distribution  
strategies...*

- The companies surveyed indicated a range of different approaches for distributing their products. The most frequently cited technique for both the domestic market and Japan was direct sales. On the other hand, wholesalers were cited most often for the United States, and distributors for Europe.

*Optimistic sales  
projections...*

- Canadian biotechnology companies expect their annual sales figures to more than quadruple between 1988 and 1992 from an average of \$4.6 million per company to \$21.1 million. This leads to an estimate of \$4.6 billion revenue from products of biotechnology for the entire industry in 1992.

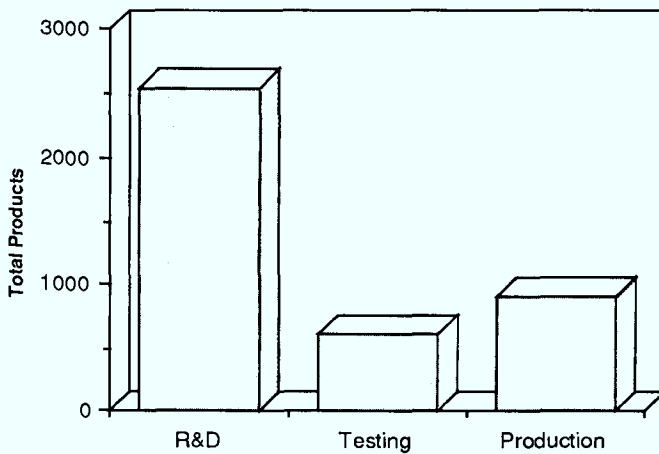
- At the time of the survey, sales of Canadian biotechnology companies were marketed in a ratio of 50:50 to domestic and foreign clients. The relative importance of exports is expected to increase to reach a ratio of 35:65 by the year 1992.

- The companies surveyed rate research expertise, management expertise and products as the top three determinants of their competitive advantage.

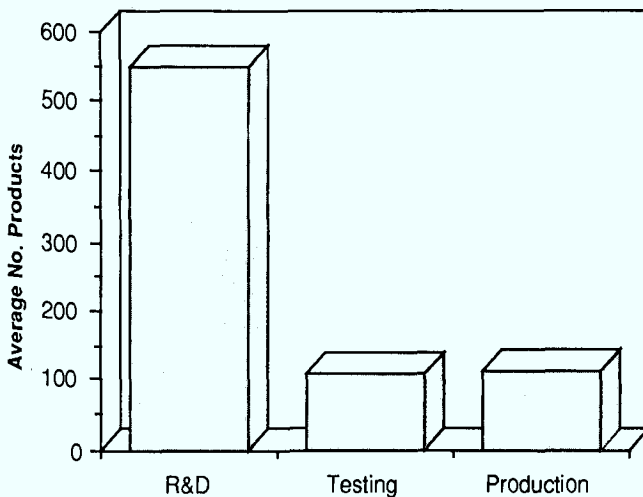
## Product development

The survey determined the number of products at the research and development stage; clinical or field testing/scale-up stage ("testing"); and production stage. Chart 3-1 shows that, in aggregate, the 84 companies surveyed have 2542 products in R&D, 617 undergoing testing and 919 in production for a grand total of 4078 products. Extrapolating this to the 220 firms engaged in biotechnology in Canada leads to an estimate of 10,600 products of biotechnology at various stages of development, testing or production.

**Chart 3-1: Stage of development of biotechnology products of 84 companies surveyed in 1988.**



**Chart 3-2: Stage of development of biotechnology products of seed companies surveyed in 1988.**



Agriculture, one of Canada's leading industrial sectors, is accelerating its use of biotechnology to develop environmentally friendly herbicides, pesticides, fertilizers and growth promoters in addition to harnessing modern cell cloning and genetic engineering technology to produce improved seeds and plants.

The seed companies surveyed account for 2200 products in the R&D stage, 437 in testing and 452 actually in production. The average number of biotechnology products at all stages of development for these companies is 772. Due to this overwhelming number in comparison to the other sectors, the data on the seed companies have been separated for independent review. Chart 3-2 indicates the distribution of the products of these seed companies across the three stages of product development.

The other sectors surveyed have many fewer products per company. Table 3-1 shows the average number of products per company in R&D, testing and production for each of the other sectors. Suppliers boast the greatest number of products per company in production (15.7) with diagnostics in second place

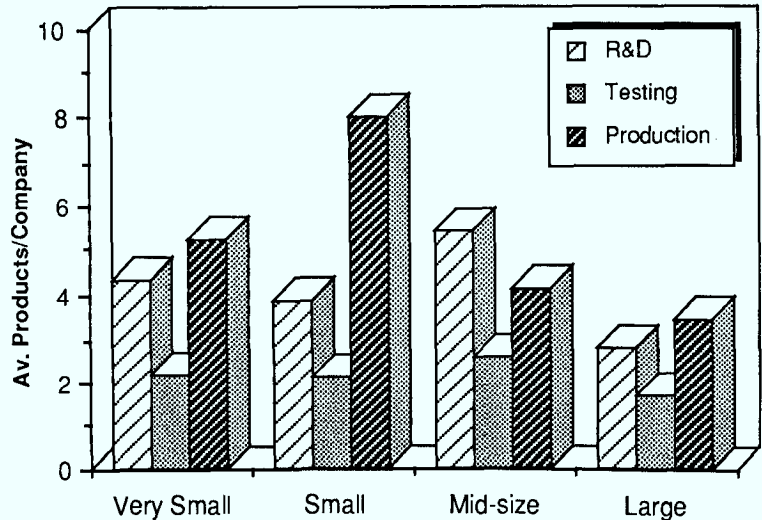
**Table 3-1: Average number of biotechnology products per company as surveyed in 1988: sectoral distribution.**

Market	R&D	Testing	Production
Diagnostics	5.8	3.4	8.8
Therapeutics	6.3	2.4	4.2
Agriculture	4.9	2.4	5.9
Suppliers	4.1	3.3	15.7
Environmental	2.8	1.6	1.5
Aquaculture	1.6	2.0	1.0
Food & Bev	2.8	1.2	4.8
Forestry	2.3	0.5	0.3
Mining	1.7	0.7	0.7
Consulting	3.8	1.5	0.3

(8.8). In terms of products "in the pipeline", diagnostics with a total of 9.2 per company in R&D or testing, is in the lead, with therapeutics at 8.7 per company on average, a close second.

The therapeutics and diagnostics sectors are both highly regulated, requiring that companies working in these fields

**Chart 3-3: Average number of biotechnology products per company in 1988: by company size.**



commit a considerable amount of time and financial resources to testing each product, with the burden being heaviest in the therapeutics sector. The companies in these two sectors averaged about three products each at the stage of testing.

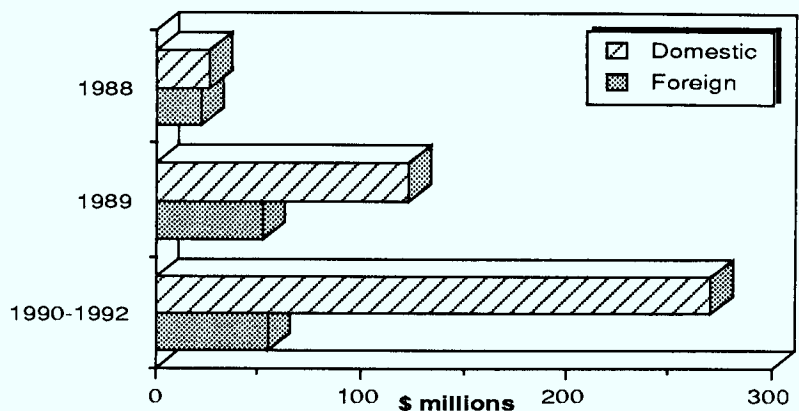
When all companies surveyed except the seed companies are analyzed to determine the average number of products as a function of the size of the company, an interesting result emerges. As shown in **Chart 3-3**, the average number of products actually in production peaks with the small companies and falls to its lowest value with the large companies. The average number of these products reported was five for very small companies, eight for small companies, four for mid-size companies and three for large ones.

The average number of products at the R&D stage is clustered around four for all sizes of companies and the average number in testing is approximately two with only minor variations across the size spectrum, but with large companies being the lowest in both cases.

## *Manufacturing facilities*

The survey revealed considerable strength with respect to existing manufacturing facilities in Canada and ambitious plans for adding to these in the near term. Of the companies surveyed, 56 per cent already have in-house manufacturing

**Chart 3-4:** Aggregate capital requirements for manufacturing facilities in 84 biotechnology companies in 1988 survey.



facilities. Fifty per cent expect to build new facilities within the next two years. The 18 per cent which have no manufacturing facilities now and do not intend to build any include consultants and other service-oriented companies.

The companies surveyed estimated capital expenditures for domestic manufacturing facilities that total \$27 million for 1988. As a group, they expected to spend \$123 million in 1989 and an additional \$270 million over the 1990-1992 three-year period (see Chart 3-4). This amounts to \$420 million investment in domestic manufacturing facilities over the full five-year period.

In the international arena, the companies estimated a total of \$23 million spending on foreign manufacturing facilities in 1988, \$52 million in 1989 and \$55.4 million over the 1990-1992 three-year period, for a total of \$130 million in the five-year period.

Extrapolated to the Canadian biotechnology industry as a whole, these estimates reveal intentions to invest approximately \$1.4 billion in both domestic and foreign manufacturing facilities during the five-year period 1988-1992. This represents an average of \$6.6 million per company.

A striking feature of this analysis is the apparent optimism of the smaller firms concerning the rate at which they will be able to build new facilities.

**Table 3-2: Average expenditure plans per company for manufacturing facilities as estimated by a survey of 84 companies in 1988: analysis by size of company.**

	1988	1989	1990-92	Total	% Domestic
Very Small	52,000	266,000	700,000	1,000,000	<b>100</b>
Small	173,000	1,700,000	3,300,000	5,200,000	<b>79</b>
Mid-size	597,000	3,400,000	3,400,000	7,400,000	<b>89</b>
Large	1,800,000	3,400,000	8,400,000	13,600,000	<b>64</b>

All amounts are expressed in Canadian dollars

When these data are analysed by company size, it can be seen that large companies plan to spend, on average, almost 14 times as much as very small companies on manufacturing facilities over the five year period (Table 3-2) with large companies spending \$13.6 million each and very small companies spending \$1 million each. Small and mid-sized companies are in between, where plans are to spend, on average, \$5.2 million and \$7.4 million each respectively.

Not surprisingly, expenditures for manufacturing facilities for very small companies will be entirely within Canada while 36 per cent of large companies' expenditures will be outside Canada.

**Table 3-3: Sectoral analysis of biotechnology company spending plans for manufacturing facilities as estimated by a survey of 84 firms in 1988.**

	1988	1989	1990-92	Total	% Domestic
Diagnostics	125,000	515,000	1,700,000	2,400,000	100
Therapeutics	1,700,000	6,900,000	11,500,000	20,100,000	71
Agriculture	563,000	749,000	2,600,000	3,900,000	100
Suppliers	145,000	2,400,000	3,900,000	6,400,000	94
Environmental	0	3,200,000	3,500,000	6,700,000	61
Aquaculture	0	1,500,000	2,200,000	3,700,000	100
Food & Bev	417,000	833,000	1,100,000	2,300,000	83
Forestry	0	0	2,500,000	2,500,000	100
Mining	300,000	867,000	2,700,000	3,900,000	90
Consulting	91,000	114,000	319,000	500,000	80

All amounts are expressed in Canadian dollars

When the forecasts for new facilities are viewed within the context of individual sectors, therapeutics clearly dominates (see Table 3-3). These companies expect to spend on average just over \$20 million each in the timeframe 1988-1992 on manufacturing facilities in Canada and abroad. Although therapeutics companies have comparatively few products in the pipeline, 6.3 in R&D and 2.4 in testing (Table 3-1), these aggressive plans for investing in manufacturing facilities in the near term are indicative of their expectations that these products and those already in production (4.2) will rapidly achieve success.

Suppliers and environmental biotechnology companies are next in line with plans to spend \$6.4 million, on average, each over the five years on manufacturing facilities. The low estimate for consultants and contract research companies reflects the small amount of manufacturing conducted by these companies.

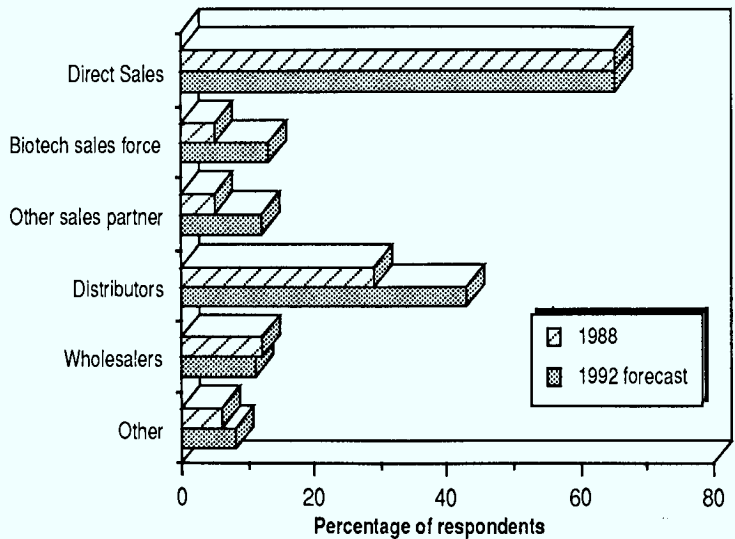


## Distribution

The process of building and maintaining a sales force is often considered to be too costly for biotechnology companies. A more practical route to market frequently involves an alliance with a non-competing company which already has an established distribution mechanism in the target market.

Companies surveyed were asked to identify mechanisms employed for product distribution and to indicate whether their future plans include any distinct changes in marketing philosophy. The survey did not request information on the proportion of sales handled by each of the routes to market.

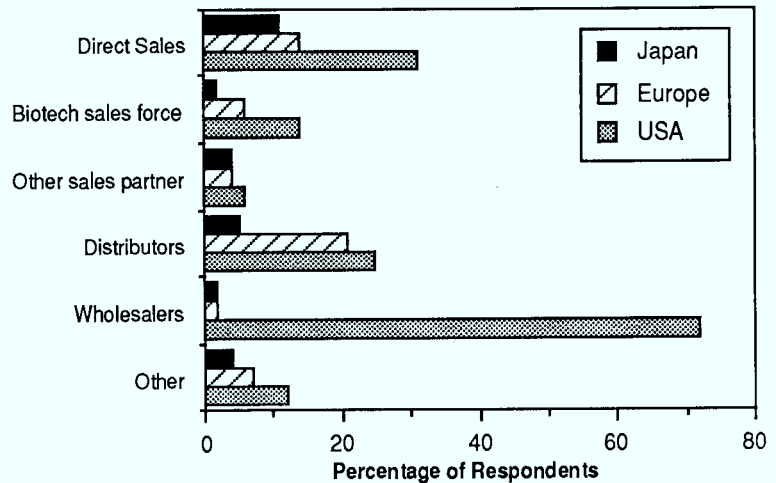
**Chart 3-5: Distribution mechanisms used for domestic sales by Canadian biotechnology companies as estimated by a survey of 84 firms in 1988.**



In the domestic market, 63 per cent of the companies surveyed reported that they use direct sales as part of their marketing strategy (Chart 3-5).

The use of distributors was the second most cited route for getting products to market in Canada. Almost 30% of respondents include this mechanism in their domestic sales strategy. This is expected to increase to 43% by 1992. A significant increase in the use of other biotechnology companies and other sales partners for product distribution is also expected in this timeframe.

**Chart 3-6: Distribution mechanisms used for foreign sales by Canadian biotechnology firms as estimated by a survey of 84 companies in 1988.**



The survey also explored mechanisms used by Canadian biotechnology companies in distributing their products abroad. Not surprisingly, the foreign market in which the largest number of Canadian firms is active is the United States. Over 70 per cent of all firms surveyed indicated that they use wholesalers to reach at least part of their U.S. market (Chart 3-6). The second and third most often cited mechanisms for distribution in this market were direct sales (30%) and distributors (25%).

In selling products to Europe, 20 per cent of the companies surveyed cited distributors and 14 per cent cited direct sales as their route to market (Chart 3-6). Even fewer of those surveyed are selling into Japanese markets. The most cited mechanism for distribution in this case was direct sales (11%), with distributors and other sales partners being cited much less frequently (5% and 4%, respectively).

Obstacles to getting products distributed in foreign markets, as identified by those surveyed, included shortage of business contacts, difficulty in finding a competent distributor and lack of the time and money needed to establish a foreign sales force.

## Sales

Aggregate figures show that by 1992 the Canadian biotechnology companies surveyed expect to more than quadruple their 1988 sales performance, revealing another dimension of the optimistic outlook of this industrial sector. This optimism parallels that reported in the United States where biotechnology companies expect a five-fold increase in sales during the same five-year period.

In particular, the 84 companies surveyed estimated aggregate sales revenues for 1988 at \$390 million and indicated an expectation that these revenues would rise to \$1.8 billion in 1992. This would represent an average revenue per company in 1988 of \$4.6 million and an expected revenue in 1992 of over \$20 million.

**Table 3-4: Average forecast revenue per company from biotechnology product sales based on a survey of 84 firms in 1988.**

	1988	1992	Growth Factor (1988-1992) <sup>1</sup>	Annual Growth (Percentage) <sup>2</sup>
<b>Analysis by company size:</b>				
Very Small	1,100,000	7,900,000	7.2	64
Small	1,600,000	14,800,000	9.3	75
Mid-size	2,300,000	23,900,000	10.4	80
Large	15,500,000	42,400,000	2.7	28
<b>Overall Average</b>	<b>4,600,000</b>	<b>21,100,000</b>	<b>4.6</b>	<b>47</b>
<b>Analysis by industrial sector:</b>				
Diagnostics	761,000	13,100,000	17.0	104
Therapeutics	15,300,000	63,900,000	4.2	43
Agriculture	2,900,000	16,800,000	5.8	55
Suppliers	7,100,000	25,100,000	3.5	37
Environmental	3,000,000	16,700,000	5.3	52
Aquaculture	868,000	4,800,000	5.5	53
Food & Bev.	530,000	2,500,000	4.7	47
Forestry	3,000,000	3,100,000	1.0	-
Mining	1,800,000	5,300,000	2.9	30
Consulting	341,000	2,000,000	6.1	57

<sup>1</sup> Ratio of 1992 projected revenues to 1988 revenues.

<sup>2</sup> Percentage growth year over year between 1988 and 1992.

All amounts are expressed in Canadian dollars

Extrapolation to the full industry of 220 companies leads to an estimate of \$1 billion revenue in 1988 and a forecast of \$4.6 billion in 1992.

This dramatic growth is expected to be most pronounced in the small and mid-sized companies and in the diagnostics sector as summarized in Table 3-4. As shown, small and mid-sized companies forecast that their sales revenues from biotechnology will rise between 1988 and 1992 by factors of 9 and 10, respectively. Diagnostics firms expect their revenues from the sale of biotechnology products to rise by a factor of 17 over the same interval.

These results become a little less surprising when it is realized that 32 per cent of the companies surveyed were founded during the five years preceding the survey (1982 to 1987). Others, founded prior to that time, have only recently begun biotechnology activities. At early stages, the growth factor is highly sensitive to rather minor fluctuations in present revenue. For example, if a company projects \$10 million revenue five years from now, this will represent a growth factor of 50 if this year's revenue is \$200,000 or a factor of 20 if it is \$500,000 - a change of only \$300,000 in current year revenue.

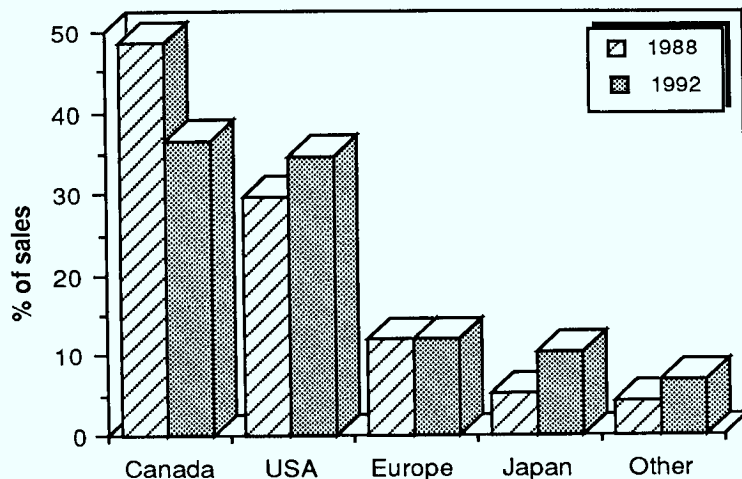
## *Markets*

The development of the products of biotechnology require such large financial investments that, as a general rule of thumb, a company's strategy must include capture of international markets if it hopes to make a significant return on investment. While international sales and marketing will figure prominently in the long term goals of biotechnology companies, strong product acceptance in domestic markets can often act as a springboard in this process. In the survey, participants were asked what percentage of the Canadian market they believe they have captured with their products of biotechnology, and what their level of activity is in foreign markets.

Sixteen per cent of the companies surveyed estimated that they had captured more than 50 per cent of the domestic market for their primary product. Over half of the companies believed they had only captured ten per cent or less. Two-thirds were not satisfied with this performance, and most of these believed that a stronger domestic market base would facilitate their entry into foreign markets.

Among factors identified as obstacles to domestic sales of biotechnology products were the complexity of Canadian regulations, the difficulty in obtaining patents, the tendency of government tenders to be too large for small company participation, the lack of strong commitment to research in Canada, and the lack of an established reputation of many companies.

**Chart 3-7: Relative distribution of sales of biotechnology products to domestic and foreign markets as estimated from a survey of 84 companies in 1988.**



At the time of the survey, the split between domestic and foreign markets for Canada's products of biotechnology was approximately 50:50. During the course of the rapid growth in sales forecast for the next five years, companies expected proportionately more sales to foreign markets. This would lead to a balance of about 35 per cent domestic and 65 per cent foreign by the year 1992. The expected trends for percentage of sales to Canada, the U.S., Europe and Japan are shown in Chart 3-7. Among the most frequently cited other foreign destinations for Canadian biotechnology products were Asia, Australia and the Middle East.

This transition to increased exports will not be without difficulties. Fifty-seven per cent of companies surveyed believe that complex regulatory issues and non-tariff barriers present major obstacles to foreign trade. Others cited intense international competition, lack of capital, foreign exchange rates, lack of reliable transportation for biologics, perception that foreign markets entail unacceptable capital risk, and

lack of an established Canadian reputation in the area of biotechnology. It is interesting to note that language and cultural differences were not identified as obstacles to trade by those surveyed.

## *Competition*

The strategy adopted by a biotechnology company is usually based, at least in part, on what it perceives as its competitive advantage vis-a-vis the international context in general, and its major competitors in particular. Survey participants were asked to identify their competitors and their own competitive advantages.

The top three competitors identified by the biotechnology companies surveyed were, in descending order:

- other biotechnology companies
- government
- pharmaceutical companies.

The government was mainly cited as a competitor for contract research and analysis. Since many small Canadian biotechnology companies rely on contract research revenue for cash flow, this is a common concern. Consultants tend to see both the government and universities as competitors for research and analysis. Suppliers noted the practice of in-house manufacturing as a source of significant competition for their products.

In terms of maintaining their own competitive edge, biotechnology companies rated the following as the top five factors, again listed in descending order of importance:

- research expertise
- management expertise
- products
- financial resources
- foreign markets

Other competitive advantages noted with some frequency in the survey were flexibility, ability to respond quickly, uniqueness and quality of product, reliability of supply and availability of post-sales service. □



# Combining Forces

**I**ndustry in the western world is undergoing an unprecedented phase of acquisition and consolidation. Independent companies are being swallowed up by multinationals and mergers between multinationals are giving rise to transnationals. The marketing power of these giants is formidable. On the other hand, these huge organizations suffer from a problem common to all large bureaucracies: they are slow to respond to new opportunities.

Highly innovative companies such as those engaged in biotechnology often pursue a different pathway to growth which preserves their flexibility and keeps them close to sources of knowledge. Strategic partnerships are becoming the way of the future for these firms. Alliances of all kinds with universities, government laboratories, manufacturers, distributors, and other companies, both domestic and foreign, are permitting biotechnology companies around the world to obtain access to leading-edge technology, expand their product lines, and increase access to markets while remaining in control of their own companies.

In this chapter, the results from the portion of the survey relating to both alliances and acquisitions are summarized. It is important to note that, for the purposes of the survey, respondents were asked to provide information on all alliances, including contracts, with other organizations.

## *Key findings*

- Eighty-seven per cent of companies surveyed have alliances with other firms and organizations, with an average of 8.3 each.
- Alliances with other companies are distributed as follows: 47 per cent in Canada, 33 per cent in the United States, 13 per cent in Europe, 3 per cent in Japan, and 3 per cent elsewhere.
- The top three categories of alliances in terms of frequencies were those with universities (22%), government laboratories (14%) and other biotechnology companies (13%).



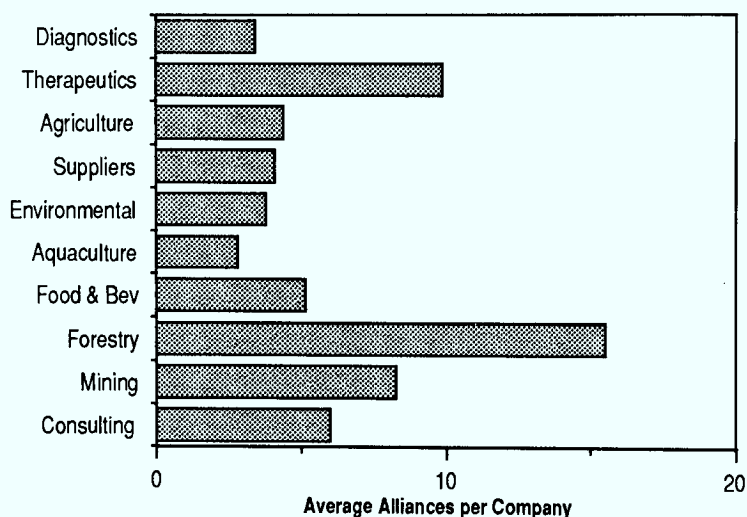
- Credibility, access to technology and research capability were the top three factors involved in selecting a domestic alliance partner. For foreign alliances the top factors were credibility, marketing expertise, and access to technology.
- The firms surveyed expect 60 per cent of Canadian biotechnology companies to be acquired within the next ten years. Only 17 per cent expect to be among those to be acquired and 29 per cent expect to acquire another company.

## Alliances

Companies were asked to provide information on all alliances, whether domestic or foreign, including contracts with other firms and organizations.

Alliances figure strongly in the strategies of Canadian biotechnology companies. Eighty-seven per cent of the companies surveyed reported that they have at least one alliance, with an overall average of 8.3 per company.

**Chart 4-1: Average number of alliances per biotechnology company based on a survey of 84 companies in 1988: sectoral analysis.**



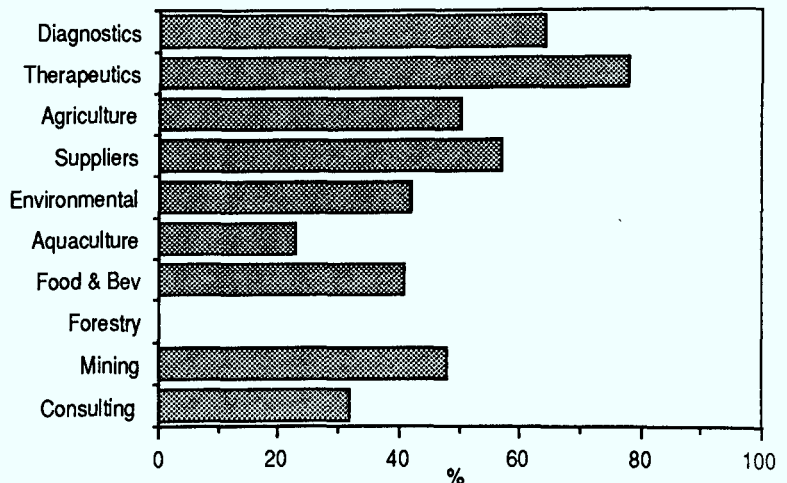
When analyzed by sector, forestry had the highest number of alliances, with an average of 15.5 per company (Chart 4-1). The forestry industry in Canada has for some time ap-

proached the need for research through establishment of not-for-profit corporations that undertake generic research for the industry and function in alliance with all the member companies. This is in part responsible for the high number of alliances reported by representatives of this sector.

Therapeutics and mining companies ranked second and third behind forestry companies in terms of numbers of alliances, with averages of 9.9 and 8.3 per company, respectively. In the case of therapeutics firms, about one-third of these alliances are with universities and another third are divided between pharmaceutical companies and distributors. A full two-thirds of mining sector alliances are with other mining companies. The sector with the lowest number of alliances is aquaculture with an average of 2.8 per company.

A total of 605 alliances were reported by those surveyed. Of these, 47 per cent are domestic alliances and 53 per cent are foreign: 33 per cent with organizations in the United States, 13 per cent with Europe, and 3 per cent each with Japan and other regions.

**Chart 4-2: Percentage of foreign alliances among Canadian biotechnology companies as estimated from a survey of 84 companies: sectoral analysis.**



Therapeutics firms reported the highest percentage of alliances with foreign partners (78%) with diagnostics companies and suppliers not far behind (64% and 57%, respectively). As shown in Chart 4-2, foreign partnerships

do not exist in the forestry sector, which reported 100 per cent domestic alliances. Aquaculture firms and consultants also have a predominance of domestic alliances with 77 per cent and 68 per cent, respectively.

*What factors are important in choosing a partner?* Credibility is the major common denominator when companies consider either a domestic or foreign alliance. Companies chose it as their top criterion for selection. For domestic alliances, factors which ranked second and third in importance behind credibility were access to technology and research capability. In the case of foreign alliances, marketing expertise and access to technology were ranked second and third.

Interestingly, factors which companies tended to rate as not very important in selecting a domestic alliance partner included regulatory expertise, manufacturing capability, management experience and availability of capital. The same four factors came out as of least importance in identifying a foreign alliance partner, but in each case the importance rating was a little higher than in the case of domestic firms. When an alliance is with another company, many of those surveyed prefer to select partners with similar size and philosophy.

*Alliances with whom?* When the distribution of alliances among all types of organizations is analyzed, several interesting features emerge. The top three categories were universities (22%), government laboratories (14%) and other biotechnology companies (13%). Other significant categories

**Table 4-1: Sectoral analysis of biotechnology company alliances based on a survey of 84 companies in 1988: top three most frequent types.<sup>1</sup>**

<b>Diagnostics</b>	University (20%) <sup>2</sup>	Distributor	Venture Capital Co.
<b>Therapeutics</b>	University (31%)	Pharmaceutical Co	Distributor
<b>Agriculture</b>	University (26%)	Food Co.	Government
<b>Suppliers</b>	Distributor (24%)	Chemical Co.	University
<b>Environmental</b>	Engineering (17%)	Licensee	Biotechnology Co. Government
<b>Aquaculture</b>	Government (36%)	University	-
<b>Food &amp; Beverage</b>	Food Co. (26%)	University	Government
<b>Forestry</b>	Forestry Co. (81%)	University	Government
<b>Mining</b>	Mining Co. (64%)	University	Government
<b>Consultants</b>	Government (53%)	University	Biotechnology Co.

<sup>1</sup> Includes contract relationships.

<sup>2</sup> Percentage of total alliances in this sector.

were pharmaceutical companies (8%), distributors (8%) and food companies (6.4%). Suppliers and venture capital firms each represented three per cent of alliances.

The importance placed by biotechnology companies on university scientists is demonstrated in the analysis by sector presented in Table 4-1. Universities ranked in the top three most frequent alliances for all sectors except environmental. Government was the most frequent associate for aquaculture and consultants and ranked third for food and beverage, forestry, mining, agriculture and environmental. The overall pattern reinforces the conclusion that companies place high priority on access to technology and the development of research expertise. In the natural resource-based sectors, alliances most frequently involve companies in the same sector. In these cases, biotechnology firms develop processes and products which replace traditional approaches in these sectors. Conversion of these typically conservative industries to the new technology is one of the major challenges.

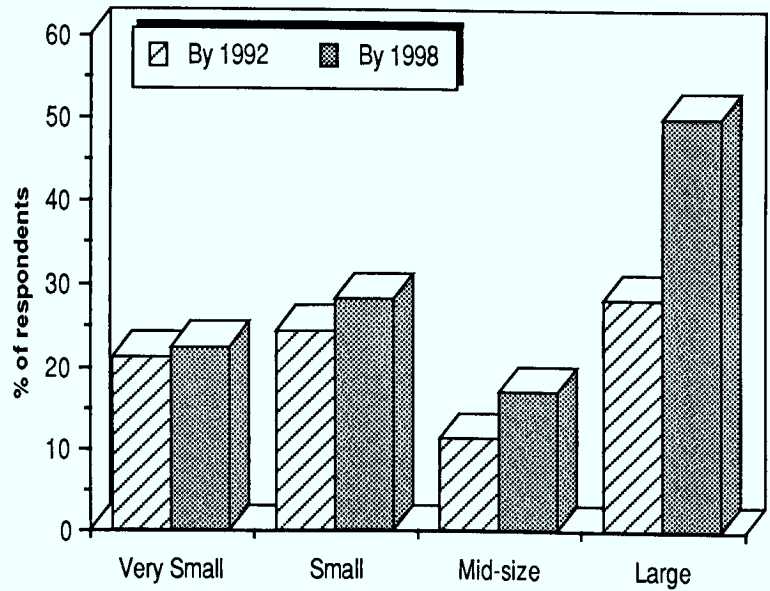
## *Mergers and acquisitions*

Many factors contribute to the growing international trend toward merger and acquisition. In relation to Canadian biotechnology firms, these would include the fact that it is usually less expensive to purchase technology than to develop it; Canada has a reasonable number of small research-intensive firms with leading-edge technology; many of these firms lack the capital required to get their products to market; and the Canada-U.S. Trade Agreement has made it more attractive for non-North American companies to locate in Canada to serve the entire North American market.

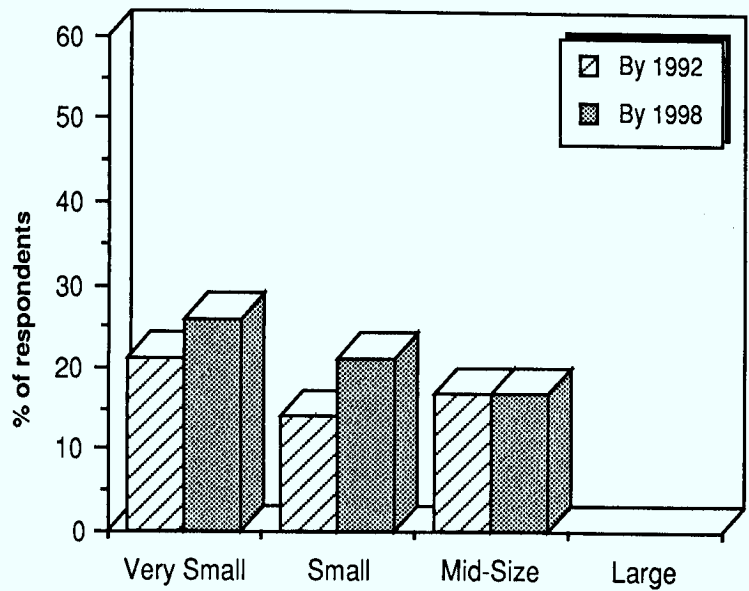
The survey probed the attitudes of Canadian biotechnology companies on the subject of the likelihood of acquisition activity in this sector in Canada. The firms surveyed expect 40 per cent of Canadian biotechnology companies to be acquired by 1992 and a further 20 per cent to be acquired in the five years following that - a grand total of 60 per cent of all existing Canadian biotechnology companies being acquired between 1988 and 1998.

When these attitudes were analyzed by size of company, a significant difference was noted between the responses of large companies and the other size categories. While very small, small, and mid-size companies predicted that anywhere from 40 to 50 per cent of existing Canadian biotech-

**Chart 4-3: Biotechnology companies expecting to acquire another biotechnology firm as indicated in a survey of 84 firms in 1988.**



**Chart 4-4: Biotechnology companies expecting to be acquired as indicated in a survey of 84 firms in 1988.**



nology companies will have been acquired by 1992, large companies predicted that only one-quarter will be acquired by then.

As noted above, the biotechnology companies surveyed have acquisition aspirations themselves. Twenty-one per cent predicted they would acquire another biotechnology company some time before 1992. A further eight per cent believe they will have acquired another biotechnology company by the year 1998.

A surprising feature of this result is that very small and small companies have acquisition plans almost equal in magnitude to those of the larger firms over the years 1988 to 1992, with over 20 per cent of such companies planning to make an acquisition. Mid-size companies have more modest plans with about 11 per cent planning acquisitions of other biotechnology firms (Chart 4-3).

Despite the belief on the part of the companies surveyed that 60 per cent of the current Canadian biotechnology firms will be acquired within the next ten years, only 17 per cent of the firms believe they themselves are candidates for acquisition (Chart 4-4). None of the large companies interviewed expects to be acquired.

Among those expecting to be acquired, multinational pharmaceutical firms were identified as the most likely purchasers, with multinational agricultural chemical or seed companies in second place, and foreign biotechnology supply companies in third.

**Management of acquired companies:** The companies surveyed were evenly split when asked how they believe an acquired company should be managed. Half said acquired companies should be integrated with the parent and the other half said they should not. Analysis on the basis of company size revealed that 60 per cent of large companies favoured integration with the parent while under 45 per cent of mid-size companies were of this opinion. However, many respondents pointed out that the answer would be highly dependent upon the exact circumstances. □



# The Human Dimension

**A**s described in Chapter 3, the biotechnology companies surveyed rate scientific and management expertise as their most important assets for maintaining a competitive edge. They also forecast ambitious plans for growth. During the period 1988 to 1992, as Canada's biotechnology firms go through this growth phase, it will be crucial to their continued success that they attract talented people with the right kind of training and experience.

In this chapter, the requirements of Canadian biotechnology companies for highly qualified personnel are explored. Results are also presented which indicate where these companies find their most highly valued advice.

## *Key findings*

- The 84 companies surveyed expected their aggregate total of employees to grow from 2510 in 1988 to 4476 in 1992. This increment of almost 2000, when extrapolated to the whole industry, reveals a requirement for over 5000 new employees for Canada's biotechnology industry during this five-year period. Approximately 1500 of these will be bioscientists, 400 will be engineers and 700 will be in sales and marketing.
- Companies reported that bioscientists and engineers, especially those with multidisciplinary capabilities and industrial experience, are hardest to find.
- Industry views its top three competitors for highly qualified personnel as other biotechnology firms, government and educational institutions.
- Only 44 per cent of the companies surveyed had scientific advisory boards. When asked to rank their three most valuable sources of advice about technology, companies identified universities (63%), in-house expertise (62%) and the federal government (44%).
- Eighty-three per cent of the companies surveyed had Boards of Directors. They rank their three most valuable sources of advice about financing as their own Board of



Directors (55%), the federal government (47%) and in-house personnel (46%).

- In-house personnel, consultants and trade associations were ranked as the three most valued sources of advice on manufacturing and marketing.

## *Staffing the industry*

Companies were asked to describe their present complement of staff and to forecast their human resources needs for 1992. Companies reported an aggregate total, for the 84 companies surveyed, of 2510 employees in 1988 with an expectation that this number would grow to 4476 by 1992. When these numbers are adjusted to reflect the 220 companies active in biotechnology in Canada, an estimate of 6525 employees in 1988 growing to 11,638 in 1992 is obtained. In other words, between 1988 and 1992 Canadian biotechnology companies expect to hire more than 5000 people.

**Table 5-1: Average number of employees per company devoted to biotechnology based on a survey of 84 companies in 1988**

	1988	1992 Forecast	Growth Factor <sup>1</sup>
Very Small	7.4	23.3	3.1
Small	21.4	48.8	2.3
Mid-Size	40.2	65.2	1.6
Large	56.5	80.0	1.4
<b>Overall Average</b>	<b>29.9</b>	<b>53.3</b>	<b>1.8</b>

<sup>1</sup> Ratio of 1992 forecast to 1988 data

The rate of growth of personnel devoted to biotechnology will be highest in very small companies and lowest in large companies as shown in Table 5-1, with an overall growth factor of 1.8 in the companies surveyed. During the 1988 to 1992 period, very small firms expect to grow by a factor of 3.1 from an average of 7.4 employees to 23.3 per company. At the same time, large firms forecast that their biotechnology personnel will grow by a factor of 1.4 from 56.5 to 80 employees each. By the end of the five year period, each size class of companies will have overtaken the next in terms of number of employees. It is interesting to note that during the course of this average 1.8-fold growth in employees devoted to biotechnology, companies expect their revenues to grow by a factor of 4.6 (see Chapter 3).

**Table 5-2: Sectoral analysis of Increase In employees devoted to biotechnology based on a survey of 84 companies In 1988.**

	<b>Av. Total Employees/Co 1988</b>	<b>Employees devoted to biotechnology 1988</b>	<b>Growth Factor: 1988 to 1992<sup>2</sup></b>
Diagnostics	30	19.5 (65%) <sup>1</sup>	1.9
Therapeutics	358	119.3 (33%)	1.6
Agriculture	468	18.8 ( 4%)	2.0
Suppliers	447	14.7 ( 3%)	2.9
Environmental	94	7.6 ( 8%)	1.9
Aquaculture	36	7.2 (20%)	2.1
Food & Beverage	1005	9.7 ( 1%)	1.5
Forestry	4036	21.3 (0.5%)	1.3
Mining	577	27.7 ( 5%)	1.7
Consultants	52	10.0 (19%)	1.5

<sup>1</sup> Biotechnology employees as a per cent of total employees.

<sup>2</sup> Ratio of 1992 forecast to 1988 data for average number of employees/company in each sector

Increase in staff devoted to biotechnology is expected to be relatively constant across the different industrial sectors studied, ranging from a low of 1.3 for forestry to a high of 2.9 for suppliers (see Table 5-2). This narrow range of variation is surprising since the proportion of total staff devoted to biotechnology varies widely from one sector to the other. For example, biotechnology employees represent only 0.5 per cent of the forestry companies surveyed, one per cent of the food and beverage companies and three per cent of the suppliers. At the other end of the spectrum, diagnostics and therapeutics firms have staffs which are 65 per cent and 33 per cent, respectively, devoted to biotechnology.

The highest relative growth in staff will be in the areas of sales and marketing and production as might be predicted based on the projections for the building of new manufacturing facilities and increases in sales revenue described in Chapter 3. As shown in Table 5-3, while overall growth in biotechnology employment in the companies surveyed increases by a factor of 1.8, sales and marketing staff will increase by a factor of 2.4 and production by a factor of 2.2. Research and development staff, management and administration will all grow by a factor of 1.5 to 1.6.

These aggregate results somewhat obscure the fact that R&D and production are expected to grow disproportionately in very small companies, and that production, sales and mar-

**Table 5-3: Activity profile of employees devoted to biotechnology based on a survey of 84 companies in 1988.**

	1988	1992 Forecast	Growth Factor <sup>3</sup>
Sales & Marketing	191 <sup>1</sup> ( 7.6%) <sup>2</sup>	466 (10.4%)	2.4
Production	779 (31.0%)	1686 (37.6%)	2.2
R&D	1054 (42.0%)	1525 (34.1%)	1.5
Administration	295 (11.7%)	469 (10.5%)	1.6
Management	174 ( 6.9%)	269 ( 6.0%)	1.6
Other	17	61	
<b>Total</b>	<b>2510</b>	<b>4476</b>	<b>1.8</b>

<sup>1</sup> Aggregate total reported by the 84 companies surveyed.

<sup>2</sup> Percentage of total employees of survey of companies.

<sup>3</sup> Ratio of 1992 forecast to 1988 data

**Table 5-4: Educational backgrounds of employees devoted to biotechnology based on a survey of 84 companies in 1988: 1988 data and 1992 forecasts.**

	Survey		Entire Industry <sup>3</sup>		Demand <sup>4</sup>
	1988	1992 <sup>2</sup>	1988	1992	1988-1992
Biosciences	988 <sup>1</sup>	1550	2569	4030	1461
Chemistry	227	366	590	952	362
Physics	12	18	31	47	16
Computer Science	31	74	81	193	112
Engineering	139	292	361	759	398
Management	149	279	387	725	338
Sales & Marketing	183	442	476	1149	673
Unskilled	282	498	733	1295	562
Other	499	957	1297	2488	1191
<b>Total</b>	<b>2510</b>	<b>4476</b>	<b>6525</b>	<b>11,638</b>	<b>5113</b>

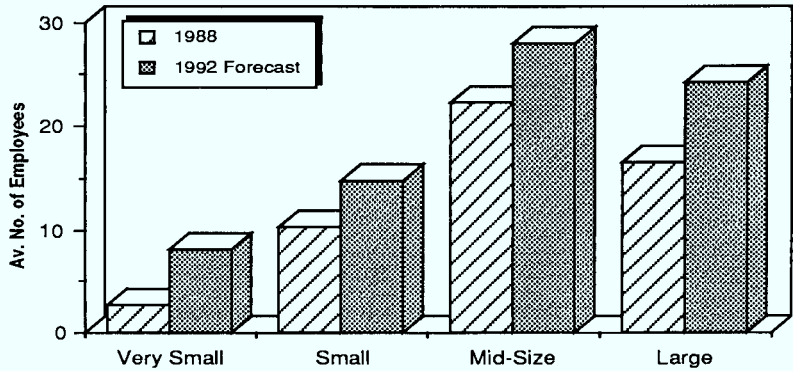
<sup>1</sup> Numbers shown are aggregate totals for the 84 companies surveyed.

<sup>2</sup> Survey respondents were asked to estimate their 1992 requirements.

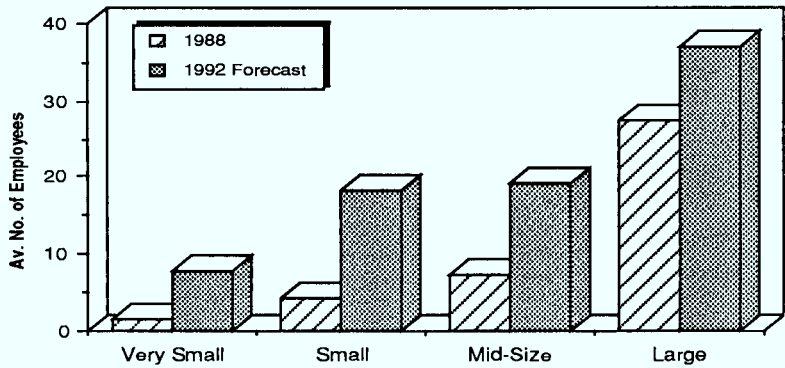
<sup>3</sup> Estimates for the entire industry were calculated by extrapolating from 84 companies to 220.

<sup>4</sup> The "demand" is the difference between the number required in 1992 and the number employed in 1988 for the entire industry.

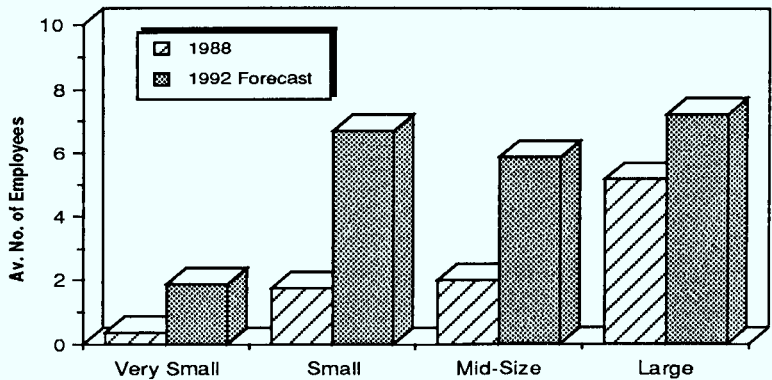
**Chart 5-1: Expected increase of R&D employees per company devoted to biotechnology in the 84 companies surveyed in 1988.**



**Chart 5-2: Expected increase of production employees per company devoted to biotechnology in the 84 companies surveyed in 1988.**



**Chart 5-3: Expected increase of sales and marketing employees per company devoted to biotechnology in the 84 companies surveyed in 1988.**



keting are expected to grow very rapidly in small companies and to a lesser extent in mid-sized companies (Charts 5-1, 5-2 and 5-3).

Most of the companies surveyed consider that it will be a significant challenge to find high quality personnel with the right education and experience to satisfy the needs of the growing company. Table 5-4 presents a summary of estimates of the number of people in each area of capability that will be needed between 1988 and 1992. For example, 1461 additional bioscientists, 362 chemists and 398 engineers will be required if plans for growth proceed as forecast.

These estimates are based only upon the 220 biotechnology companies known by the Editors to be active in Canada at the time of the survey. Since 32 per cent of the companies in the survey were founded in the five years preceding the survey, it is reasonable to expect a significant number of firms to be founded in the interval 1988 to 1992. This could increase demand for skilled workers in the biosciences above the estimates listed in Table 5-4.

Survey participants itemized a vast array of areas of specialization where they have encountered difficulty finding the

**Table 5-5: Skilled people identified as "hard to find" In a 1988 survey of biotechnology companies.**

protein chemists	geneticists	plant molecular biologists
protein engineers	microbiologists	cell cloning specialists
carbohydrate chemists	virologists	tissue culture specialists
organic chemists	immunologists	horticultural biochemists
analytical chemists	molecular biologists	agricultural sciences
lipid biochemists	bioengineers	fish culture specialists
industrial chemists	chemical engineers	fish pathologists
biophysicists	metallurgists	pharmaceutical specialists
biochemists	fermentation engineers	mining specialists
senior executives	responsible management	marketing specialists
product developers	regulatory affairs experts	

right staff. The common elements were biochemists, molecular biologists, bioengineers, chemical engineers, and senior management. Respondents repeatedly stressed the need for multiple talents, industrial experience and, in the cases of management and marketing, the need for international "head office" experience. The full range of skills mentioned by those surveyed as difficult to find is presented in Table 5-5 to illustrate the great variety of activities which are the core of Canadian industrial biotechnology.

## *Competition for personnel*

Companies were asked to identify their most serious competitors for highly qualified personnel. The top three responses were: other biotechnology companies, the government and educational establishments.

In addition to potential competitors, the survey asked companies to list the factors which they felt reduced their chances of attracting qualified personnel. The critical considerations reported were: compensation, location, in-house expertise and equipment and facilities.

To increase the attractiveness of positions being offered and to retain existing key staff members, over 50 per cent of the companies surveyed offer employee stock options or other similar incentives.

## *Sources of advice*

Companies surveyed were asked to identify the sources of their most valuable advice in the areas of technology, financing, marketing and manufacturing.

In the area of technology, even though 44 per cent of the companies reported that they have scientific advisory boards, the top three most valuable sources of advice about technology cited were universities (63%), in-house (62%) and the federal government (44%).

Where financial advice is concerned, 83 per cent of the companies have Boards of Directors and 55 per cent cite them as the most valuable source of advice. Second and third-rank positions for financial advice go to the federal government (47%) and in-house expertise (46%).

The top three most valuable sources of advice for marketing and manufacturing are identical: in-house expertise, consultants and trade associations.

It is interesting to note the extent to which companies rely on consultants for advice on all matters relating to their business. For example, over 45 per cent hire consultants to obtain advice in the area of marketing, 40 per cent in the area of technology and about 30 per cent in the area of financing and manufacturing. □

# Financial Indications

**T**he process of getting biotechnology products to market is a very costly one. Finding enough capital at the right time to permit a company to be first on the market can be a substantial competitive advantage. To explore strategies used by Canadian biotechnology companies to finance their growth, the survey included questions about the sources of revenue, expenditures on research and development, net income before and after taxes, current assets and liabilities, and total assets and liabilities.

Companies were asked to provide figures for their two most recent completed fiscal years. The average ends of these fiscal years for the companies surveyed correspond to November of 1986 and November of 1987. The data were sent directly to Statistics Canada to ensure confidentiality during the analysis phase. Aggregate results were supplied to the Editor.

Recognizing that financial data of this kind are considered highly sensitive by most companies which are not publicly traded, it was gratifying to receive responses from 64 of the 84 companies surveyed. Because many of these provided partial data, only 39 could be included in the full analysis leading to the aggregate data presented in this chapter. As a result of the lower sample size, sectoral analysis of all ten sectors treated in other chapters was not possible. Instead, data are provided for the four top sectors - diagnostics, therapeutics, agriculture and suppliers.

## *Key findings*

### *Income*

- Over half of the companies surveyed reported positive net incomes after tax in each of the two most recent fiscal years.
- Average net income after taxes was negative for all size categories except the large companies and for all sectors except therapeutics.

### *R&D Expenditure*

- Average expenditure on R&D per company per year was found to be \$1,250,000 in the most recent fiscal year, representing a growth rate of 89 per cent over the previous one.



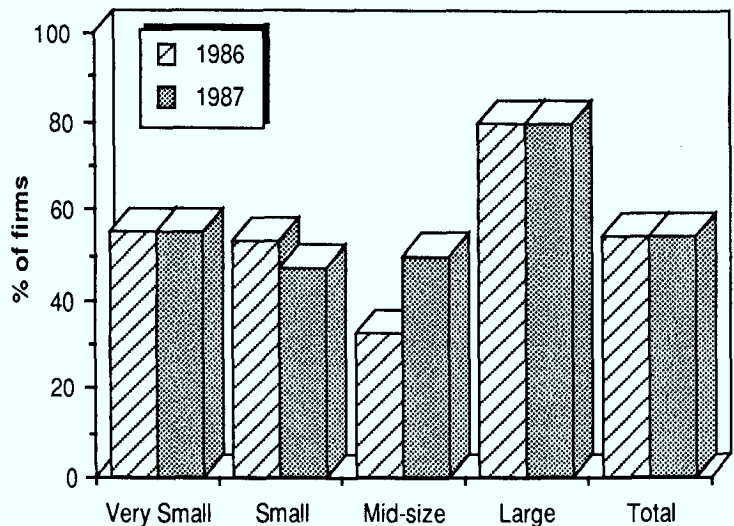
## Revenue

- Mid-size companies recorded the highest R&D growth rate, from 1986 to 1987, at 246 per cent, with the diagnostics sector showing a dramatic 1164 per cent increase.
- Total average revenue per company grew by 28 per cent from \$2,590,000 in 1986 to \$3,322,000 in 1987.
- The average revenue per company in 1987 increased with size of company from \$267,000 for very small companies to \$19,365,000 for large companies.
- Revenue from sales of biotechnology products per employee devoted to biotechnology also increased with company size in 1987 from \$10,089 for very small companies to \$113,246 per employee in large companies.
- Small companies derive most of their revenues from contract research (66%) and large ones derive essentially all of their revenue from sales. Revenue from royalties is important only in very small and small firms.

## Assets and Liabilities

- The overall average per company for current assets in 1987 was \$2,855,000, and for current liabilities, \$1,100,000 yielding a median liquidity ratio of 2.3. This was up from 2.0 in 1986.
- The liquidity ratio was highest in mid-sized firms and in

**Chart 6-1: Percentage of biotechnology firms showing a profit in two previous fiscal years as reported in a 1988 survey of 39 companies**



**Table 6-1: Average income after tax for biotechnology firms in two previous fiscal years as reported in a 1988 survey of 39 companies.**

	Average income (loss) after tax	
	1986	1987
Very small	(110,000)	(82,000)
Small	(66,000)	(440,000)
Mid-size	(512,000)	(16,000)
Large	1,373,000	1,592,000
<b>All companies</b>	<b>38,000</b>	<b>(13,000)</b>

All amounts are expressed in Canadian dollars

the therapeutics sector with median values of 6.5 and 2.6 respectively.

- The average debt per company in 1987 was \$2,434,000 and the average equity was \$5,418,000 with a median debt-to-equity ratio of 0.47. This was down from 0.68 in 1986.

## ***Income***

Biotechnology is an industrial sector which, at this stage in its development worldwide, is noted for the number of its companies which are not yet turning a profit. It is interesting to note in this context that over half (54%) of the 39 companies which provided complete financial data reported a profit in their most recent fiscal year. Over half reported a profit in the previous fiscal year (see Chart 6-1).

The 39 companies providing these data represent 46% of the 84 companies surveyed. At a minimum, therefore, it may be concluded that at least 25% of the firms surveyed have had positive net incomes after taxes in each of the two most recent fiscal years.

Large firms were the only size class in which the average net income after tax per company for the whole class was also positive (see Table 6-1). This indicates that in all other size classes, aggregate losses for the group were greater than aggregate profits.

**Table 6-2: Sectoral analysis of average income after tax for biotechnology firms in two previous fiscal years as reported in a 1988 survey of 39 firms.**

	Average income (loss) after tax	
	1986	1987
Diagnostics	(4000)	(815,000)
Therapeutics	295,000	665,000
Agriculture	(187,000)	(211,000)
Suppliers	80,000	(230,000)
<b>All companies</b>	<b>38,000</b>	<b>(13,000)</b>

All amounts are expressed in Canadian dollars

Analysis of net income after tax by sector reveals that, while therapeutics and agriculture both have more than half of their companies in a profit position (Chart 6-2), only therapeutics yielded a positive average net income per company (Table 6-2).

As far as year-to-year trends are concerned, all size categories of companies except the small ones increased their net income after tax from 1986 to 1987. Small firms, on the other hand, moved from an average loss of \$66,000 in 1986 to an average loss of \$440,000 in 1987, in keeping with the challenge of developing and testing a large number of products (see Chapter 3).

## ***R&D expenditure***

In order to thrive, biotechnology companies need to develop a steady stream of products. A company launched on a single idea is destined for failure if it does not quickly put in place a competent research team to: develop second, third and fourth generation products which improve upon the first product; diversify into new product lines building upon technical strength; and remain alert to opportunities to purchase technology that matches the company's technological and/or market focus.

The average spending on R&D per company grew from \$663,000 in 1986 to \$1,250,000 in 1987, an increase of 89 per cent. As shown in Table 6-3, growth was highest in mid-size companies (246%) and lowest in the very small companies (10%). On a sectoral basis, diagnostic firms recorded a huge increase (1164%) reflecting major activities of some very young firms in several product areas (Table 6-4).

**Table 6-3: Average R&D expenditures per company in the two most recent fiscal years as estimated in a 1988 survey of 39 companies: by company size.**

	1986	1987	Percentage increase
Very small	274,000	302,000	10
Small	624,000	1,038,000	66
Mid-size	833,000	2,879,000	246
Large	1,445,000	2,100,000	45
<b>All companies</b>	<b>663,000</b>	<b>1,250,000</b>	<b>89</b>

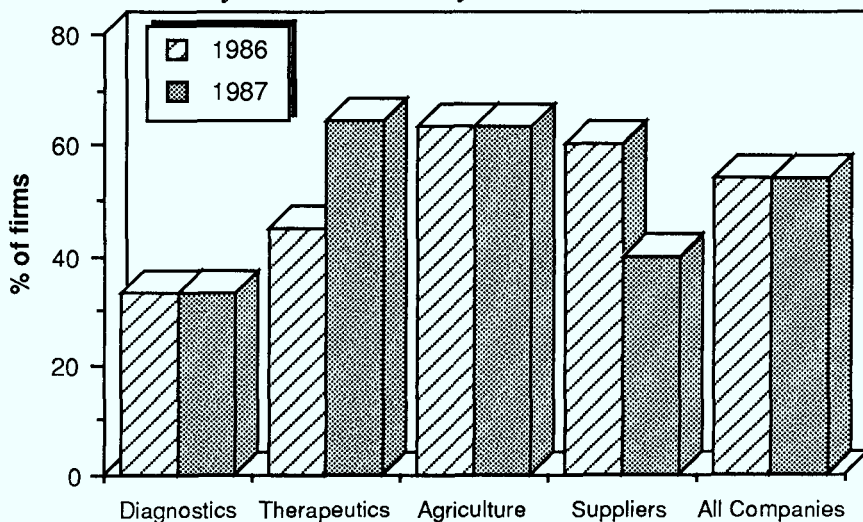
All amounts are expressed in Canadian dollars

**Table 6-4: Average R&D expenditures per company in the two most recent fiscal years as estimated in a 1988 survey of 39 companies: by sector.**

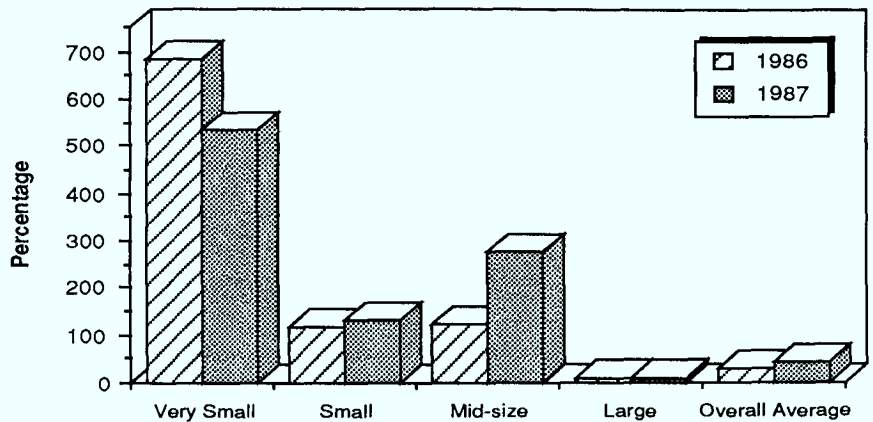
	1986	1987	Percentage increase
Diagnostics	86,000	1,087,000	1164
Therapeutics	1,214,000	2,665,000	119
Agriculture	741,000	905,000	22
Suppliers	459,000	493,000	7

All amounts are expressed in Canadian dollars

**Chart 6-2: Sectoral distribution of biotechnology firms reporting a profit for the two previous fiscal years in a 1988 survey of 39 firms.**

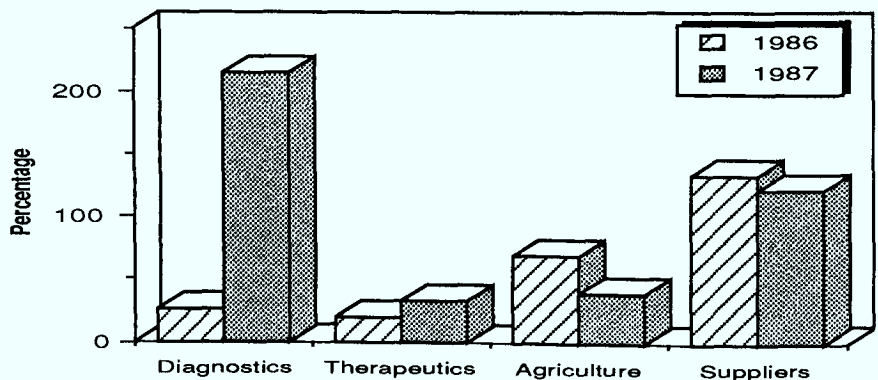


**Chart 6-3: R&D expenditure as a percentage of sales revenue in two previous fiscal years for biotechnology firms of different sizes as measured in a survey of 39 companies in 1988.**



As a biotechnology company matures, it makes a transition from paying for its R&D out of equity to paying for its R&D out of sales revenue. The large companies in the survey have R&D expenditures which are about 10 per cent of revenue from sales (Chart 6-3). By the same measure, very small companies have R&D spending in the range of 500 per cent of sales revenue. Small companies are at about 120 per cent and mid-size companies increased their R&D as a percentage of sales revenue from 120 per cent to 278 per cent between 1986 and 1987. This increase in mid-sized company R&D spending is largely a result of a dramatic increase by diagnostic companies both in absolute terms (Table 6-4) and as a percentage of sales revenues (Chart 6-4).

**Chart 6-4: Sectoral analysis of R&D spending as a percentage of sales revenue for biotechnology firms as measured in a survey of 39 firms in 1988.**



The overall average for R&D activities as a percentage of sales revenue increased from 28 per cent in 1986 to 42 per cent in 1987, an indication that industrial biotechnology in Canada is in a dynamic state of investment in new technology.

## Revenue

**Total revenue :** Total revenue grew on average 28 per cent from \$2,590,000 in 1986 to \$3,322,000 in 1987 for the 39 companies surveyed. It is important to note that even if the 45 companies which did not provide financial data had no revenue during these years, the overall average revenues for each of the 84 firms in the present survey would have been \$1,202,000 in 1986 and \$1,542,000 in 1987. This must be considered as a rock bottom estimate since a significant number of companies reported revenues but could not be included because of incomplete data in other sections of the financial questionnaire.

When total revenues are analyzed by size of company (Table 6-5), not surprisingly, large companies reported the highest revenues. The average total revenues per company

**Table 6-5: Average total revenue per company analyzed by size of company based on a 1988 survey of 39 biotechnology companies.**

	Total actual revenue <sup>1</sup>		Growth	Forecast of revenue <sup>2</sup>		Annual Growth Rate
	1986	1987		1988	1992	
Very small	191,000	267,000	40%	1.1M	7.9M	64%
Small	961,000	1,274,000	33%	1.6M	14.8M	75%
Mid-size	791,000	1,359,000	72%	2.3M	23.9M	80%
Large	15,565,000	19,365,000	24%	15.5M	42.4M	28%
<b>Overall Av.</b>	<b>2,590,000</b>	<b>3,322,000</b>	<b>28%</b>	<b>4.6M</b>	<b>21.1M</b>	<b>47%</b>

<sup>1</sup> Based on data from 39 companies.

<sup>2</sup> Based on data from 84 companies (see Chapter 3)

All amounts are expressed in Canadian dollars; M = million

**Table 6-6: Sectoral analysis of average total revenue per company based on a 1988 survey of 39 biotechnology companies.**

	Actual total revenue		Growth	Forecast of revenue		Annual
	1986	1987		1988	1992	Growth Rate
Diagnostics	352,000	728,000	107%	0.76M	13.1M	104%
Therapeutics	6,756,000	8,761,000	30%	15.3M	63.9M	43%
Agriculture	752,000	1,404,000	87%	2.9M	16.8M	55%
Suppliers	1,133,000	821,000	-28%	7.1M	25.1M	37%

All amounts are expressed in Canadian dollars; M = million

revenues. The average total revenues per company increased in 1987 from \$267,000 for very small companies to over \$19 million for large companies.

Analysis of revenue by sector of activity (Table 6-6) reveals that therapeutics firms reported the highest revenue in 1987, an average of \$8,761,000 per company, while diagnostics firms reported the lowest in that year, \$728,000.

It is interesting to compare these results with the forecasts presented in Chapter 3 for revenue in 1988 and 1992 based on the expectations of all 84 companies surveyed (Table 6-6).

For example, as shown in Table 6-5, the large company forecast of 28 per cent growth per year between 1988 and 1992 is consistent with the actual growth rate of 24 per cent between 1986 and 1987. Likewise the mid-sized company expectation of 80 per cent growth is very much in line with the 72 per cent growth experienced by these firms between 1986 and 1987. In the cases of very small and small firms, predictions outstrip actual growth.

Sectoral analysis yields similar results. As shown in Table 6-6, while diagnostics firms experienced a 107 per cent growth in revenues between 1986 and 1987, they predicted year-over-year growth of 104 per cent for the years 1988 to 1992. In other words, the predictions of all 84 firms concerning future revenues conform reasonably well with the actual revenue growth of 39 of these firms over the past two fiscal years.

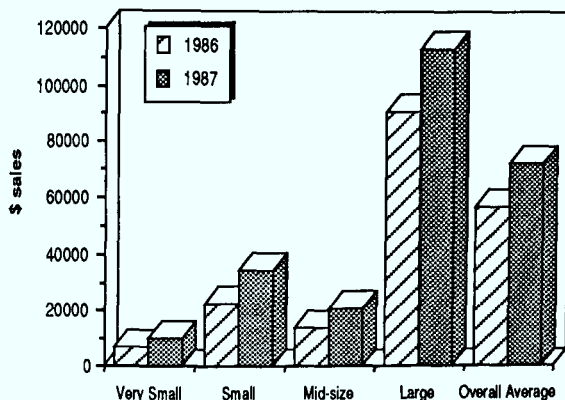
**Categories of revenue:** Respondents were asked to segregate revenues into three categories: product sales, contract research and royalties. The picture which emerges from this



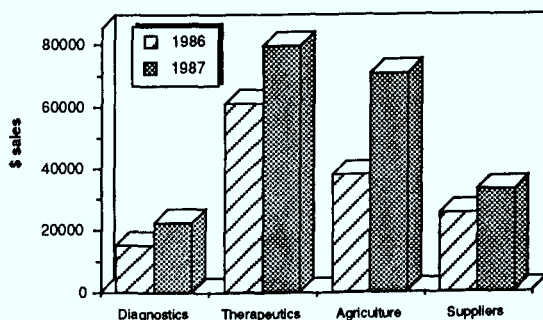
**Table 6-7: Relative Importance of sources of revenue, expressed as a percentage, for biotechnology companies of different sizes as determined by a survey of 39 firms in 1988.**

	Sales		Contract R&D		Royalties	
	1986	1987	1986	1987	1986	1987
Very Small	21	21	78	66	0.5	13.0
Small	55	63	42	32	3.0	4.9
Mid-size	88	76	12	23	0.6	0.4
Large	100	100	-	-	-	-

**Chart 6-5: Average sales revenue per biotechnology employee in 39 companies surveyed in 1988: by company size.**



**Chart 6-6: Average sales revenue per biotechnology employee in 39 companies surveyed in 1988: by sector.**



derived from sales increases steadily from very small companies (21%) to large ones (100%) while contract research and royalty revenues decrease in importance with an increase in size of the company (Table 6-7).

**Sales revenue per employee:** Every size category of biotechnology firm increased its revenue from the sale of biotechnology products per employee devoted to biotechnology over the two years 1986 to 1987. The same is true of every sector analyzed. As shown in Chart 6-5, sales per employee ranged from \$10,089 for very small companies to \$113,246 for large firms in 1987. The value ranged from a low of \$22,433 in the diagnostics sector to a high of \$79,346 per employee for therapeutics (Chart 6-6).

## Assets and liabilities

**Liquidity ratio:** The ratio of current assets to current liabilities, the liquidity ratio, is a good measure of a company's ability to pay its bills. On the whole, biotechnology companies tend to build up cash reserves to get them



whole, biotechnology companies tend to build up cash reserves to get them through long periods of research in the relative absence of revenues. Canadian biotechnology firms are no exception.

The overall average per company for current assets in 1987 was \$2,855,000, and for current liabilities was \$1,100,000. The median liquidity ratio for this group of 39 firms was 2.3.

As shown in Tables 6-8 and 6-9, the liquidity ratio was highest in mid-sized companies and in the therapeutic sector, with median values of 6.5 and 2.6 respectively. The biggest increase between 1986 and 1987 was seen in mid-sized companies whose median liquidity ratio increased

**Table 6-8: Average current assets, current liabilities and liquidity ratios for biotechnology firms of different sizes based on a survey of 39 companies in 1988.**

	Average Current Assets		Average Current Liabilities		Median Liquidity Ratios	
	1986	1987	1986	1987	1986	1987
Very Small	124,000	127,000	48,000	76,000	1.9	2.0
Small	1,223,000	1,761,000	410,000	776,000	2.3	2.1
Mid-size	4,456,000	4,086,000	923,000	648,000	3.5	6.5
Large	9,783,000	11,100,000	3,866,000	4,994,000	2.2	2.5
<b>Overall Average</b>	<b>2,508,000</b>	<b>2,855,000</b>	<b>830,000</b>	<b>1,100,000</b>	<b>2.0</b>	<b>2.3</b>

All amounts are expressed in Canadian dollars

**Table 6-9: Sectoral analysis of average current assets, current liabilities and liquidity ratios based on a survey of 39 biotechnology firms in 1988.**

	Average Current Assets		Average Current Liabilities		Median Liquidity Ratios	
	1986	1987	1986	1987	1986	1987
Diagnostics	2,242,000	1,819,000	447,000	310,000	1.2	1.5
Therapeutics	5,797,000	6,835,000	1,862,000	2,525,000	3.5	2.6
Agriculture	842,000	1,348,000	520,000	1,025,000	1.7	1.2
Suppliers	965,000	943,000	358,000	456,000	2.1	2.3

All amounts are expressed in Canadian dollars

**Table 6-10: Average total assets, total liabilities and debt-to-equity ratios for biotechnology firms of different sizes based on a survey of 39 firms in 1988.**

	Average Total Assets		Average Total Liabilities		Median Debt- to-Equity Ratios	
	1986	1987	1986	1987	1986	1987
Very small	498,000	616,000	384,000	473,000	0.24	0.41
Small	1,631,000	2,246,000	782,000	1,087,000	0.65	0.32
Mid-size	6,864,000	9,399,000	3,419,000	3,718,000	2.0	1.30
Large	25,177,000	21,991,000	14,366,000	9,785,000	1.0	0.65
<b>Overall Avg</b>	<b>5,136,000</b>	<b>5,418,000</b>	<b>2,817,000</b>	<b>2,434,000</b>	<b>0.68</b>	<b>0.47</b>

All amounts are expressed in Canadian dollars

**Table 6-11: Sectoral analysis of average total assets, total liabilities and debt-to-equity ratios based on a survey of 39 biotechnology firms in 1988.**

	Average Total Assets		Average Total Liabilities		Median Debt- to-Equity Ratios	
	1986	1987	1986	1987	1986	1987
Diagnostics	2,942,000	2,694,000	938,000	758,000	0.28	0.23
Therapeutics	12,704,000	13,534,000	7,331,000	5,772,000	0.12	0.44
Agriculture	1,124,000	1,610,000	559,000	1,059,000	1.20	0.70
Suppliers	2,017,000	2,090,000	861,000	954,000	1.30	1.50

All amounts are expressed in Canadian dollars

from 3.5 to 6.5. Decreases were experienced in the therapeutics sector and the agriculture sector.

**Debt-to-equity ratio:** It is common wisdom that biotechnology firms need to find "patient money" to survive the relatively long development and testing phases that precede marketing. It is also considered to be relatively difficult in Canada to persuade investors and financial institutions to provide substantial debt financing for this phase of business development. As a result, it might be expected that Canadian biotechnology companies would have a relatively low debt-to-equity ratio.

The group of 39 firms surveyed had an average of \$7,852,000 equity in 1987 and debt of \$2,434,000. The median value of the debt-to-equity ratio was 0.47. Furthermore, the trend for all size classes of companies, except the very small ones, from 1986 to 1987 was a decreasing ratio (Table 6-10). When analyzed by sector, the ratios decreased in the cases of diagnostics and agriculture sectors and increased for therapeutics and suppliers sectors (Table 6-11).

Comparison with other industrial sectors indicates the extent to which industrial biotechnology differs from more traditional sectors in these financial indicators. For example, the debt-to-equity ratio ranged from a low of 0.91 for the communications equipment sector to 1.73 for agriculture, forestry and fishing in 1986 while biotechnology had a ratio of 0.68 in that year as measured in the present survey and 0.47 in 1987 (Table 6-12).

Similar results are obtained in the case of the liquidity ratio. In this case other sectors ranged from a low of 1.2 for agriculture, forestry and fisheries to 1.9 for pharmaceuticals. The biotechnology firms had a value of 2.0 in 1986 and 2.3 in 1987.

In summary, Canada's biotechnology firms have a higher liquidity ratio and lower debt-to-equity ratio than other industrial sectors as expected for a sector which is at a stage of development which depends heavily on cash reserves for continued viability. □

**Table 6-12: Comparison of industrial biotechnology liquidity ratio and debt-to-equity ratio with other industrial sectors in Canada<sup>1</sup>**

	Liquidity Ratio		Debt-to-Equity Ratio	
	1986	1987	1986	1987
Biotechnology	<b>2.0</b>	<b>2.3</b>	<b>0.68</b>	<b>0.47</b>
Pharmaceutical	1.9		1.00	
Chemicals/Chemical Products	1.7		1.37	
Communications Equipment	1.6		0.91	
Agriculture, Forestry & Fishing	1.2		1.73	

<sup>1</sup> Most recent data for other industrial sectors was for 1986 (Source: Statistics Canada, 1989).

# Legal and Tax Environment

**T**he success of a biotechnology company depends not only upon the quality of its technology, but also upon the speed at which it is able to commercialize this technology and capture international markets. This process in turn depends heavily upon how well equipped a company is to deal with the increasingly complex legal and tax environment which surrounds the industry both here in Canada and around the world.

## *Key findings*

- Seventy-five per cent of the companies surveyed believe that patenting is worthwhile. At the same time, half of the companies do not believe they can defend their patents.
- Only 20 per cent of the companies surveyed had ever been involved in patent disputes. Only four companies have actually been involved in litigation in connection with a dispute.
- More than half of the companies reported first-hand experience with patenting products in Europe, the United Kingdom and the United States. Forty-three per cent of the companies have had experience with patenting in Japan.
- The majority of companies file their patent applications in the United States first to obtain a one-year protection during which they file in Canada, Europe, Japan and elsewhere.
- Over 80 per cent of the companies in the survey reported no liability concerns. Supplier firms and therapeutics manufacturers showed the highest level of involvement with this issue.
- Only 29 of the 84 companies surveyed were familiar with the Canadian Environmental Protection Act (CEPA) and its implications for industrial biotechnology. All but six of these had serious concerns about the proposed regulations as drafted at the time of the survey, (November 1988 to February 1989).

- The Scientific Research and Experimental Development (R&D) Tax Credit was criticized by many respondents for having too narrow a definition of research, for being cumbersome to apply for, and for taking too long to receive.
- The streamlined system for R&D tax credits introduced in the Spring of 1988 appears to have shortened the waiting period for cash refunds from an average of 20.9 months to 5.2 months.

## *Patents*

*Patent system:* The ability to capture and hold a market position depends heavily upon adequate intellectual property protection either through patents, trade secret, or some other mechanism. In this portion of the survey, participants were asked whether they believe patenting is worthwhile, and whether the Canadian patenting system needs to be changed. In addition, in the light of 1987 Patent Act amendments conferring increased protection upon medicines, respondents were asked if they thought the Canadian system has been improved.

Seventy-five per cent of those surveyed indicated that patenting is worthwhile. This suggests that, for the remainder, patenting may not be critical to their business strategy. This group would include the producers of new crop varieties since, at the time of the survey, Canada had not yet passed its Plant Breeders' Rights legislation (Bill C-15). The Bill passed second reading in the House of Commons on June 27, 1989 and was sent to Committee for study. As of November 1989 and final editing of this book, the Committee had not yet reported back to Parliament.

In addition to plant breeders, the group not finding patenting worthwhile would be expected to include process engineering companies; small companies which may find the process too costly or complex; and firms whose products are based entirely on technology in the public domain. The most frequent reason given by respondents was that they believed they would lose more by the disclosure accompanying patenting than they would gain by holding the patent. Other reasons included that patenting takes too long and is too costly; that it is not possible to patent technology or plants; that it is difficult to defend patents in biotechnology, because of both subject material and cost; that it is too

difficult and is costly to monitor for infringement of a patent; and that it is easier to protect intellectual property through confidentiality agreements than through patents.

There was a considerable diversity of responses to a question concerning the process of patent application in Canada. One quarter of the companies indicated that the process should be changed, 20 per cent believed that it should remain the same, and 50 per cent responded that they did not know, suggesting that they were not sufficiently familiar with the process to indicate a position on the subject.

This finding was reinforced by answers to the questions about 1987 amendments to the Canadian Patent Act (Bill C-22). Over half of the companies did not know if the new Act has increased the attractiveness of patenting in Canada.

The two most frequent responses to a question about how the process of patenting in Canada should be improved were that it should be faster and that it should be expanded to permit patenting of new varieties. Suggestions were also made to provide clearer guidelines on what can and what cannot be patented; to have better informed patent examiners in the area of biotechnology; to reduce duplication of analysis and judgement by screening cases already examined in the United States for exceptions only; to simplify the system for defending patents and move it out of the legal area as much as possible; and to introduce a process for re-examination.

As discussed above, one of the key concerns about the Canadian patent system was that it takes too long. Survey respondents estimated that it takes them, on average, 24.1 months to obtain Canadian patents. Analysis by size of company reveals that very small companies take an average of 32.8 months while small, mid-size and large companies take 22 to 25 months. This suggests that experience and financial resources could play a significant role in determining the time taken to obtain a patent.

**Patent activity:** It would be reasonable to expect that the number of patents held by a company would be roughly equal to the number of products in production and that the number of patents pending would approximate the number of products in development.

This correspondence holds fairly well for large companies where the average number of products in testing or production is 5.1 and the average number of patents held or pend-

**Table 7-1: Comparison of average numbers of patents and products of biotechnology per company as determined by a survey of 84 firms in 1988: analysis by size of company.**

	Patents Held	Patents Pending	Total	Products in Production	Products in Testing	Total
Very small	1.7	1.5	3.2	5.2	2.2	7.4
Small	1.9	1.7	3.6	21.8 (8.6) <sup>1</sup>	5.9 (2.2 )	27.7(10.8)
Mid-size	2.4	3.8	6.2	7.0 (4.6)	20.8 (2.9)	27.8 (7.5)
Large	4.0	1.6	5.6	3.4	1.7	5.1
<b>Overall avg</b>	<b>2.4</b>	<b>2.0</b>	<b>4.4</b>	<b>10.9 (5.8)</b>	<b>7.3(2.3)</b>	<b>18.2(8.1)</b>

<sup>1</sup> Data in parentheses are calculated with seed companies removed.

ing is 5.6 (see Table 7-1). In the case of mid-sized firms, the number of products is 7.5 and the number of patents is 6.2 when seed company data are removed from the calculation.

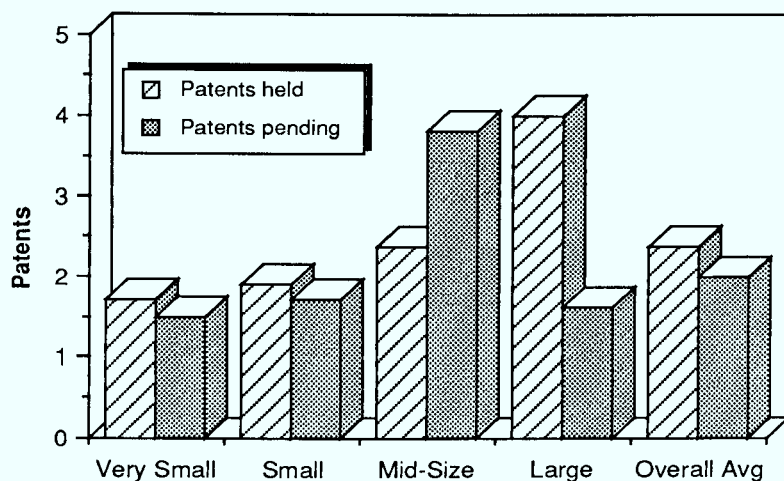
The correspondence breaks down in small and very small companies where the number of patents held or pending is in the range of one-third to one-half the number of products in testing or in production. (As above, these data do not include seed company results.)

When seed company data are included in the calculation, the number of products in small and mid-size companies exceeds the number of patents by factors of 7 and 4, respectively. This is to be expected since plant varieties cannot be patented in Canada.

It is interesting to note the significant potential for product commercialization in mid-size companies - those with 51 to 135 employees - since these companies have an average of more than twice as many patents pending as do companies of other sizes (see Chart 7-1 and Table 7-1).

When the number of patents is compared with the number of products on a sectoral basis, further refinement of this picture emerges (Table 7-2). As expected, very few of the

**Chart 7-1: Average number of patents held or pending per biotechnology firm in 1988 based on a survey of 84 companies.**



**Table 7-2: Comparison of average numbers of patents and products of biotechnology per company as determined by a survey of 84 firms in 1988: sectoral analysis**

	Patents Held	Patents Pending	Products in Total	Products in Production	Products in Testing	Total
Diagnostics	0.8	2.0	2.8	8.8	3.4	12.2
Therapeutics	8.3	5.9	14.2	4.2	2.4	6.6
Agriculture	0.6	2.2	2.8	36.0(5.9) <sup>1</sup>	31.0(2.4)	67.0(8.3)
Suppliers	2.8	1.5	4.3	15.7	3.3	19.0
Environmental	2.4	0.4	2.8	1.5	1.6	3.1
Aquaculture	0.4	0.4	0.8	1.0	2.0	3.0
Food & Bev.	2.3	0.7	3.0	4.8	1.2	6.0
Forestry	1.0	0.5	1.5	0.3	0.5	0.8
Mining	0.3	1.0	1.3	0.7	0.7	1.4
Consultants	0	0.3	0.3	0.3	1.5	1.8

<sup>1</sup> Data in parentheses are calculated with seed companies removed.

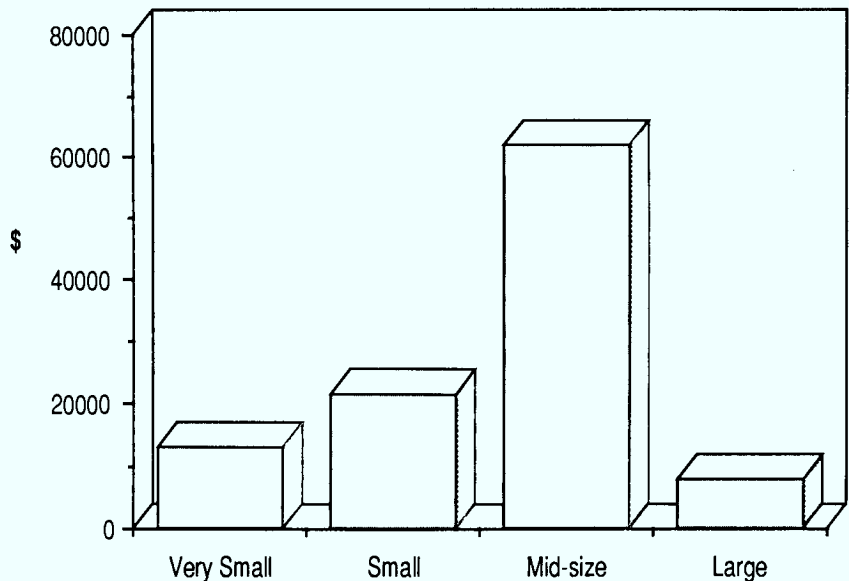


agricultural company products are patented or have patents pending. The average number of products in production or testing in this sector is 67, the highest by far of any sector, while patents held or pending only average 2.8 per company. This picture would be expected to change dramatically if Plant Breeders' Rights legislation is adopted in Canada. If seed company data are not included, the average number of products per agricultural company becomes 8.3, still three times the number of patents per company.

The therapeutics sector, by far the most active in patenting, has more patents than it has products in production or in testing. In particular, it has an average of 14.2 patents per company, either held or pending, and an average of 6.6 products in production or testing (Table 7-2). In this sector, the patenting process often begins well before a product enters the testing and scale-up phases.

In contrast the diagnostics sector appears to protect less than one-quarter of its products with patents. The average number of products per company is 12.2 while the number of patents held or pending is 2.8. Included in this group is a significant number of smaller firms who, for lack of funds or experience or both, tend not to file for patents as early as the larger firms. Furthermore, many diagnostic products rely on a clever combination of non-proprietary materials and can only be protected by trade secret.

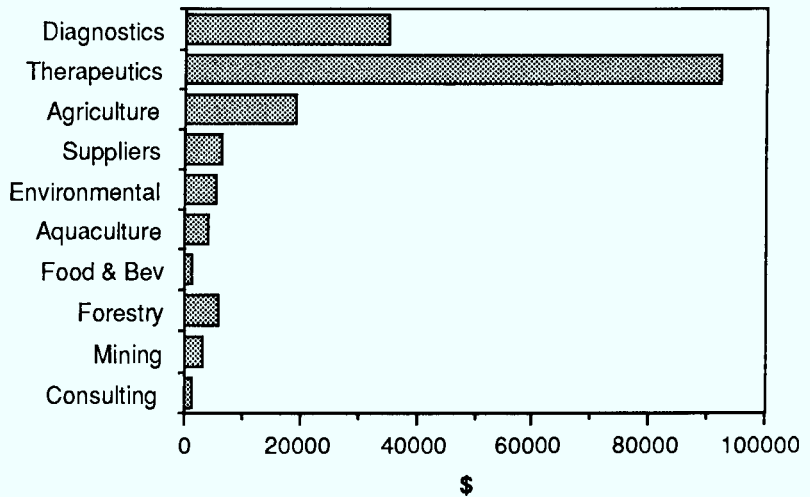
**Chart 7-2: Average annual patenting expenditures per company for 84 biotechnology firms surveyed in 1988: analysis by size of company.**



**Patent costs:** Companies surveyed spent an aggregate of \$2.3 million in 1988 obtaining patents and expect to spend an additional \$8.4 million by 1992. This amounts to an aggregate average of \$2.1 million per year during this four-year period, or an average of \$25,000 per company per year.

Analysis of patent expenditures by size of company (Chart 7-2) reveals that mid-size companies are far ahead of other sizes of companies in their average spending on patents, with expectations of spending \$62,000 per year each on average from 1988 to 1992. The average annual expenditures for patenting by small, very small and large companies are all expected to be less than \$25,000. Large firms reported the lowest, at about \$8000 per year; very small companies are next at \$13,000; and small companies expect to spend \$21,000 per year. This relatively low spending suggests that these firms have obtained protection for key technology and will be concentrating on scaling up production and launching products over the next five years. Support for this interpretation comes from the plans of these companies for investing in manufacturing facilities (see Chapter 3) and increasing their production and marketing staffs (see Chapter 5).

**Chart 7-3: Average annual patenting expenditures per company for 84 biotechnology firms surveyed in 1988: sectoral analysis.**



Analysis of the expenditures on patents by sector (Chart 7-3) reveals that the therapeutics sector is way out in front with plans to spend more than \$90,000 per year per company on

average. Diagnostics firms expect to spend \$35,000 per year, agricultural firms, \$19,000 per year, and all others expect to be under \$7500 per year. Factors which affect these figures include how many products are now at the stage of R&D; patentability of the product or service; and the number of countries in which patents will be sought.

*Defending patents:* On the international scene, fiercely competitive biotechnology companies involved in the development of powerful new therapeutic agents have created the perception that industrial biotechnology almost always attracts patent infringement suits. One part of the survey was devoted to exploring this situation with Canadian biotechnology companies.

Only 17 of the 84 companies surveyed, just 20 per cent, had ever been involved in patent disputes up to the time of the survey. Only four of these cases actually involved litigation.

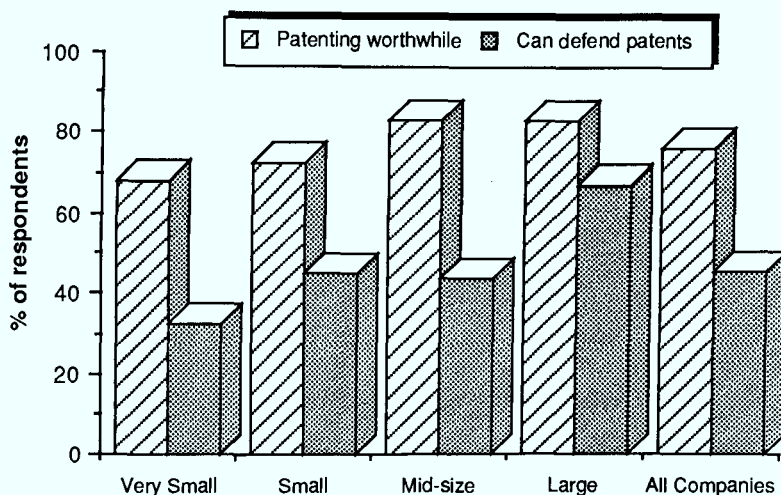
Not surprisingly, patent disputes reported were highest in the therapeutics sector where almost half of the firms had experienced disputes. Diagnostics companies were second, where one-third had been involved in disputes. The technologies in these two human health-related sectors are based upon a narrow pool of fundamental research. Furthermore some patents granted in the early days of the new generation of biotechnology activities, have proven to be very broad, attracting many challenges.

In this "age of litigation" it is surprising to find that the 84 companies surveyed spent, in aggregate, only \$195,000 in 1988 to defend patents. They expect their aggregate spending over the next four years to be \$1.4 million, or an average of \$328,000 per year for all 84 firms. This corresponds to an average of \$3905 per year per company to defend patents.

Although 76 per cent of those surveyed believe it is worthwhile patenting their products, 46 per cent of the respondents do not believe they can afford to defend their patents. An analysis of this question based on the size of company is shown in Chart 7-4. Recognition of the value of patenting increases with company size and so does perceived ability to defend patents.

Sixty-eight per cent of very small companies believe it is worthwhile to patent their products while 83 per cent of large companies believe it is worthwhile. The gap is more dramatic in the area of patent defence. Only 32 per cent of the very small companies estimate that they would be able to

**Chart 7-4: Patent protection considerations by size of company based on a survey of 84 biotechnology firms in 1988**



defend their patents while 67 per cent of the large ones believe they could.

**Foreign Patents:** The extent to which Canadian biotechnology companies apply for patents in foreign countries is an indication of their stage of maturity with respect to international competition.

More than half of the companies surveyed reported that they had obtained first-hand experience with patenting in Europe, the United Kingdom and the United States. Forty-three per cent reported experience with Japan's patenting system.

Based on their experiences, the companies were asked to rate the patent approval process in foreign countries against the Canadian system. Seventy per cent of the respondents rated the Japanese system as worse than Canada's, while 50 per cent rated the systems in the United States and United Kingdom as much better.

The strategy followed by most companies which patent outside Canada is to file for patent first in the United States, thereby obtaining a one-year protection period elsewhere, and then file, before the end of the year, in Canada and Europe and then Japan and perhaps other countries.

## *Product liability*

Product liability does not seem to be a major issue among Canadian biotechnology companies. Over 81 per cent of those surveyed reported no liability concerns of any kind. Only the supplier sector reported product liability as an issue, with 75 per cent of these companies indicating that they had concerns.

Of the companies reporting concerns, specific problems appeared to be in relation to their ability to obtain adequate liability insurance coverage and the need for performance guarantees. Representatives of the environmental sector indicated their inability to purchase coverage at a reasonable price.

Looking to the future, it is likely that the impact of product liability on the industry will increase. The survey shows that 38 per cent believe product liability will impair their ability to commercialize products in the future. This view is consistent across all sectors with the surprising exception of agriculture which reported the least concern with the liability issue.

Among the considerations raised was the tendency of foreign parents of Canadian subsidiaries to insist on avoidance of any product line which itself could be at risk, or any of whose inputs could be at risk. This ultra-conservative approach underscores the degree to which top management of multinational firms is sensitive, from a financial and image perspective, about the damage that may be caused by liability actions.

Other concerns include the fact that while some companies are large enough to self-insure, many smaller firms do not have the resources. As a result, in cases where commercial insurance costs have become prohibitively high or in other cases where insurance organizations are unwilling to insure a product under any circumstances, the biotechnology firm has no real options.

## *Regulations*

Industrial biotechnology is developing new products and services at a breathtaking pace. They touch almost every traditional industrial sector. Regulatory agencies throughout the world are hard pressed to keep up with these developments with regulations that meet health and safety standards while avoiding the introduction of regulatory systems that are so onerous that they inhibit or prevent beneficial industrial development. The challenge for Canadian companies is to stay abreast of the changing regulatory landscape in Canada and relevant foreign markets to remain at least as effective as their competitors in satisfying the regulatory requirements.

Eighty-two per cent of the companies surveyed have products which require regulatory approval.

Many companies deal with more than one agency in the regulation of their products. Of those surveyed, 49 have products which are regulated by Health and Welfare Canada, 30 have products regulated by Agriculture Canada, 20 are regulated by Environment Canada and 20 by other agencies. Other agencies include Fisheries and Oceans and Consumer and Corporate Affairs in Canada and the Food and Drug Administration and Department of Agriculture in the United States.

The time taken to obtain regulatory approval can have an enormous impact upon the ability of a company to capture a significant share of the market. Companies surveyed reported that they take, on average, 15 months to obtain approval, ranging from eight months for diagnostics firms to 22 months for therapeutics firms with the products of agriculture falling in between at 12 months.

Eighty-eight per cent of respondents agreed that it is necessary to regulate products of biotechnology. Industry self-regulation was cited as the preferred regulatory mechanism by less than 10 per cent of respondents while federal regulation was advocated by 85 per cent.

The Canadian Environmental Protection Act (CEPA), passed into law in 1988, is important new legislation which could have a considerable impact on the biotechnology industry. The regulations to this Act which apply to biotechnology were first available in draft form in late 1987 and since that time have been the subject of broad consultation across

Canada among regulators and industry. Only 29 of the 84 companies surveyed were familiar with CEPA. All but six of these had serious concerns about the proposed regulations and most of these (17) have communicated these concerns to Environment Canada.

The most commonly expressed worries were that the 12-month notification period required by the draft regulations would be inordinately long and that the regulations encompass an overly broad mandate as a result of a very broad definition of products of biotechnology. In addition, a number of companies felt that costs of compliance could be prohibitive; that the regulations should be harmonized with other Canadian, U.S and European regulations; and that the draft regulations did not adequately reflect an understanding of the needs of plant biotechnology.

## ***Tax***

In an environment of increasingly liberalized international trade, the tax climate created by a government becomes a significant factor in competitiveness of companies. The survey examined attitudes about the present procedures involved in claiming Scientific Research and Experimental Development (R&D) Tax Credits and about limited partnerships.

***Scientific Research, and Experimental Development (R&D) Tax Credits :*** The Government of Canada provides tax credits to companies carrying out research in Canada. The amount of the credit varies with the size of the company but is 35 per cent of research expenditures for small (as defined by Revenue Canada) companies and 20 per cent for large companies. Privately-held small companies whose net income before tax is negative, as is the case for many start-up biotechnology companies, may claim their tax credits as a cash refund.

Many of the companies surveyed reported dissatisfaction with the R&D tax credit system. The major criticisms were that the procedures for applying for refunds are too cumbersome, that it takes too long to receive the refund, and that the definition of research is too narrow. In particular, a number of companies mentioned the need to include activities such as market research and patenting under the definition of research.



Modifications in the way R&D tax credit applications are processed were introduced in the Spring of 1988. The prime objective of these changes was to speed up the system for small companies so that they could receive their cash refunds within 60 days of filing their claims. It was hoped that the new system would make the timing of refunds more reliable so that companies could include them in their cash flow planning.

Because the survey was carried out from November 1988 to February 1989, the impact of these changes had only been experienced by some of the companies. In particular, while the overall average of the time taken to receive the refund was 13.5 months, this broke down into two distinct and equal classes: one with an average of 20.9 months, and the other, obviously reflecting the new streamlined system, of 5.2 months.

**Limited partnerships:** At the time of the survey, it was possible to use limited partnerships to bring in a wide range of investors to set up research limited partnerships as a source of finance. However, over 75 per cent of the companies surveyed did not feel that such limited partnerships had been of great importance to them in the past.

Limited partnerships have been of considerable importance to one quarter of the biotechnology firms surveyed and also have been used extensively by other high-technology industries, primarily for precommercial research and development stages. This situation changed dramatically in 1988. From that point on, partners in a limited partnership could only claim the costs of their investment if the research was in a field related to their business. The net effect of this change has been to limit further the options for biotechnology companies to finance their R&D efforts.

**Improvements to the tax system:** The survey provided companies the opportunity to suggest improvements in the tax system that they felt would be of benefit to their company. A majority of the companies referred to the need discussed above to broaden the definition of research and development and to introduce a less cumbersome system for obtaining refunds for private companies. A number of companies spoke about the need for public companies to have equal access to cash refunds for their R&D tax credits; and the need for an improvement of tax credits for service industries.



Other suggestions cited by at least several companies included reintroducing limited R&D partnerships; increasing the existing R&D tax credit from 35 per cent to 50 per cent for small companies; introducing flow-through shares for industrial biotechnology; creating a system which provides immediate tax relief for any investors in R&D; permitting faster capital cost depreciation; and making Canada's tax system for high technology firms competitive with the U.S. system.

A final point that emerged specifically from consulting engineering companies was that companies in traditional industrial sectors should be given tax credits for undertaking research on projects designed to resolve environmental problems, not just for purchasing pollution abatement equipment as is the present situation. This change could stimulate contract research aimed at harnessing biotechnology to find novel solutions to industrial pollution. □

# International Perspectives

**B**iotechnology has been identified as a key technology for meeting the global challenges of the twenty-first century. Governments around the world have focussed special attention on the development and acquisition of biotechnology in the belief that it will also be important in ensuring the continued growth of their economies. As part of this increased attention, a variety of studies have been undertaken to measure the stage of development of industrial biotechnology and to forecast its opportunities and needs.

The pioneering effort in this regard was the study published in 1987 by the Arthur Young High Technology Group in the United States entitled *Biotech 86: At the Crossroads*. This was so successful that it was followed up in 1988 with *Biotech 88: Into the Marketplace*; in 1989 by *Biotech 89: Commercialization*; and, just released as we go to press, *Biotech 90: Into the Next Decade*, a publication of the Ernst & Young High Technology Group (formerly Arthur Young).

In early 1989 the United Kingdom published the results of its first survey of the biotechnology industry under the title *UK Biotech 88: Industry in Evolution?*, the product of a collaborative effort between the Arthur Young High Technology Group and the Association for the Advancement of British Biotechnology.

In the case of Japan, it was the Japan Economic Journal, the *Nihon Keizai Shimbun*, which conducted a major bio-industry survey of research and development trends in biotechnology in 1988.

As noted previously, the Canadian survey was carried out between November 1988 and February 1989. This timeframe corresponds to within a few months of the intervals during which data for the U.S. 1989, the U.K. and the Japanese studies were gathered.

In the present chapter, the Canadian results are compared with those of the U.S., the U.K. and Japan to gain insight into the position of Canada's biotechnology activities in relation to these international competitors. In cases where it was desirable to make direct comparisons between specific

results in the Canadian and U.S. studies with reference to results of different size classes of companies, the very small and small companies from the Canadian study were pooled into one group to provide data on all companies with 50 or fewer employees, the strict equivalent of the small size class in the U.S. study.

## *Overall industry and company characteristics*

Participation in industrial biotechnology in Canada is taking off. The 1988 *Canadian Biotechnology Industry Sourcebook* compiled by the Ministry of State for Science and Technology lists 220 commercial organizations involved in biotechnology research, development or manufacturing. This has been updated to reflect a few changes in the industry discovered during the course of the survey (see **Appendix II**).

By comparison with its international competitors, Canada is still a young player in biotechnology. The U.S. dominates, followed by Japan, then the U.K. Canada was a latecomer to biotechnology relative to the U.S., which realized the potential of biotechnology early and gained a significant lead. The Canadian, U.S. and U.K. companies surveyed consisted mostly of small companies employing 1-50 individuals. In Canada 57 per cent of companies surveyed were identified as small, in the U.S. 49 per cent, and the U.K. 73 per cent. In contrast, Japan's biotechnology industry is concentrated almost entirely in large corporations with small start-ups being virtually non-existent.

- Canada has more companies engaged in biotechnology per capita than the U.S. or Japan.

	Total Number of Firms	Ratio of Population to Canada's Firms <sup>1</sup>	Ratio of Firms <sup>1</sup>	Number of Firms Surveyed
Canada	220	1:1	1.0	84
United Kingdom	450	2:1	2.0	78
Japan	400	5:1	1.8	297
United States	1037	10:1	4.7	291

<sup>1</sup> Total number of companies from country in question divided by total number of Canadian firms.

- The percentage of Canada's biotechnology firms which have 50 or fewer employees lies between those of the U.S. and the U.K. as based on the surveyed samples of all three countries. In the Canadian case, the proportion of such firms in the entire industry is 64 per cent (see Chapter 2).

	Canada	U.K.	U.S.
1 to 50 employees	57	73	49
over 50 employees	43	27	51

- Canada has a much greater proportion of its biotechnology activity in the natural resource-based industrial sectors than do the United States, the United Kingdom or Japan. The most active sector in the U.S. is health. In both the U.K. and Japan, suppliers (equipment and chemicals) and the health sector are equally active. In the case of the U.K., the "other" category is composed of equal numbers of environmental and food companies. In Japan, it is composed almost entirely of food companies.

	Canada	U.K.	U.S.	Japan
Health	30%	28%	57%	26%
Agriculture	18%	22%	13%	23%
Suppliers	5%	28%	19%	26%
Other	47%	22%	11%	25%

- Canada's biotechnology companies are older on average than those of either the U.S. or the U.K. This is partly a result of the fact that Canada has a higher proportion of established companies in activities such as forestry, mining and fishing which are engaged in biotechnology.

	Canada	U.K.	U.S.
Founded before 1979	49%	17%	31%
Founded 1980-1984	29%	44%	42%
Founded 1985-1988	22%	39%	27%

- Canada has a lower percentage of biotechnology companies which have gone public than has the U.S. However, it should be noted that 27 per cent of the Canadian firms surveyed indicated that they will go public within the next five years; 47 per cent stated that they would not; 24 per cent were already public; and two per cent were uncertain as to

whether they would go public.

	Canada	U.S.
Public	24%	57%

## *Commercialization of biotechnology*

R&D spending is a key indicator of activity and is fundamental to growth. The annual expenditures on R&D in Canada by the biotechnology industry at the time of the survey amounted to approximately \$286 million. This pales in comparison to annual expenditures in the U.S. of about \$4.6 billion. These levels were estimated from an extrapolation of the Canadian and U.S. survey results of \$1.3 million and \$4.4 million in R&D spending per company per year, on average, to the total industry of 220 companies in Canada and 1037 companies in the U.S.

- *R&D spending:* Canada's small and mid-sized biotechnology firms spend almost as much as their U.S. counterparts on research and development. The large firms in Canada, on the other hand, spend less than a quarter the amount spent by large U.S. firms. This reflects the existence of numerous large therapeutics firms in the U.S. with most or all of their products based on biotechnology while large Canadian biotechnology firms include many established companies from traditional sectors such as brewing, chemicals and forestry which have only recently initiated biotechnology activities.

	Canada	U.S.
Small	\$745,000	\$957,000
Mid-size	\$2,900,000	\$3,300,000
Large	\$2,100,000	\$9,600,000
All companies:	\$1,300,000	\$4,400,000

- *In-house manufacturing facilities:* Fewer Canadian companies have in-house manufacturing facilities than their U.K. and U.S. counterparts. Of the firms surveyed, 56 per cent in Canada had in-house facilities, 71 per cent in the U.K., and 76 per cent in the U.S. The proportions of the surveyed companies planning to add to existing facilities or to build new facilities within the five-year period, 1988-1992, is quite similar: 73 per cent for Canadian companies; 69 per cent for U.S. companies.

- *Building new manufacturing facilities:* Canadian companies have aggressive plans to build new manufacturing facilities in the near term, with an average expected spending per company of \$6.6 million in the 1988-1992 five-year period. However, this is only one-eighth of the \$51 million each U.S. biotechnology company expects to spend on average during the same period. The overall proportion to be spent domestically is remarkably similar for the two countries: 76 per cent for Canadian firms; 75 per cent for U.S. firms.

- *Numbers of patents held:* Canadian companies hold just under half as many biotechnology patents as U.S. firms, with an average of 2.4 per company surveyed as compared with 6 per company in the U.S. There is a much bigger gap when it comes to patents pending. In this case, Canadian biotechnology firms have an average of 2 each while their U.S. counterparts boast an average of 21 each.

Therapeutics companies hold the highest number of patents, with an average of 8.3 each in Canada and 8 each in the U.S. Once again, in the area of patents pending, the U.S. far outstrips Canada. U.S. therapeutics firms have an average of 35 patents pending each while Canadian therapeutics firms reported an average of 5.8 patents pending each.

- *Sales from biotechnology products:* Canadian firms reported average revenue from sales of \$3 million. U.S. firms reported more than triple this amount. At the same time, when looked at by company size, the difference between performance in the two countries is not as great. The Japanese study indicated that 50 per cent of those surveyed reported that they had already commercialized the results of R&D.

	Canada	U.S.
Small	\$552,000	\$762,000
Mid-size	\$1,034,000	\$2,531,000
Large	\$19,365,000	\$28,763,000
All companies	\$3,010,000	\$10,123,000

- *Growth of sales revenue:* Canadian and U.S. biotechnology firms came up with almost identical estimates when asked to forecast their growth in sales revenue between 1988 and 1992. Canadian firms forecast an increase of 4.6-fold; U.S. firms forecast 4.9-fold. These projections amount to annual growth of 46-49 per cent per year in sales revenue.

To put these estimates into perspective, it should be noted that between 1986 and 1987 the sales revenue of Canadian biotechnology firms surveyed grew, on average, at a rate of 28 per cent per year. Revenues from diagnostics firms grew most rapidly, at a rate of 107 per cent, and agriculture firm revenue grew at a rate of 87 per cent.

Growth in sales revenue in the year preceding the survey was quite comparable in Canada and the U.S., except in the case of mid-sized companies which grew very rapidly in Canada.

	Canada	U.S.
Small	36%	41%
Mid-size	72%	30%
Large	24%	24%

- *Growth in foreign sales:* Canadian companies rely upon export markets to a much greater extent than do the U.S. biotechnology companies. The biotechnology firms of both countries expect to increase their sales to foreign markets.

	Canada	U.S.
1988	52%	17%
1992	63%	30%

- *Product sales as a percentage of total revenue:* Over 90 per cent of revenues in Canadian biotechnology companies, as reported in the survey, derive from the sale of biotechnology products. In the U.S., such sales account for 72 per cent of total revenues. The balance of revenues are made up primarily of contract research revenues, royalties and interest.

- *Product sales per employee:* In Canadian firms, the sales revenue per employee ranged from a low of \$21,000 for mid-sized firms, to \$33,000 for small firms and \$113,246 for large firms. This compares favourably with the U.S. which reported that product sales per employee rose from approximately \$30,000 for small and mid-sized companies to nearly \$70,000 for large companies. It is not surprising that the mid-sized firms are lowest on this scale in Canada since it is these companies which forecast the highest growth rates over the next five years and spend the highest proportion of their revenues on R&D.

For the purposes of these calculations from the Canadian survey, only revenue from the sale of products of biotechnol-



ogy was taken into account and the number of employees was taken as the number devoted to biotechnology-related activities.

- *R&D expense as a percentage of product sales:* In sectors such as biotechnology where commercialization is just getting off the ground, R&D represents a high proportion of total sales revenues. Later in its development, a company settles down to a level of R&D that ensures a steady stream of new products. In the pharmaceutical industry, this level is typically in the vicinity of 12-16 per cent.

Comparison of Canadian results with those of the U.S. for biotechnology indicates that the overall performance in these two countries based on this indicator is quite similar. The differences are also worth noting: it is the diagnostics companies and suppliers in Canada who have the highest R&D spending per revenue dollar while it is the therapeutics and agriculture firms in the U.S. who do.

	Canada	U.S.
Small	135%	125%
Mid-size	278%	130%
Large	11%	33%
All companies	42%	43%
Diagnostics	214%	35%
Therapeutics	32%	104%
Agriculture	39%	116%
Suppliers	112%	12%

## *Alliances*

The activity of industrial biotechnology seems inextricably linked to the formation of a wide variety of liaisons. These include alliances with academic institutions, research institutions, government laboratories, other biotechnology companies, companies in traditional industrial sectors, manufacturers, distributors and venture capital firms.

The surveys in Canada, the U.S., the U.K. and Japan underscored this point. In Canada, 87 per cent of those surveyed had alliances, with an average of 8.3 each. In the U.S., 68 per



cent of those surveyed had alliances, with an average of 8 each. In the U.K., companies had an average of 5.5 alliances each. In Japan, 73 per cent have some form of alliance.

- *Reasons for forming alliances:* The primary reasons for forming alliances differed somewhat from country to country. Canadian companies place priority on teaming up with allies who provide credibility and technology. U.S. firms, on the other hand, are most concerned about accessing capital and marketing expertise.

	Domestic Alliances	Foreign Alliances
Canada	credibility access to technology research capability	credibility marketing expertise access to technology
U.K.	access to technology access to sales/markets access to research capability	
U.S.	availability of capital marketing expertise research expertise	marketing expertise availability of capital regulatory expertise

- *Foreign alliances:* More than half of the alliances of Canadian biotechnology companies are foreign (53%). Of these, 33 per cent are in the U.S., 13 per cent in the U.K., 3 per cent with Japan and 3 per cent with other countries. In contrast, U.S. firms have more alliances in Western Europe than in Japan and fewer still in Canada. This non-reciprocal relationship between the U.S. and Canada is a result of the fact that many Canadian firms see the U.S. as their most important market, and half of the U.S. firms surveyed see the Canadian market as being too small to warrant marketing efforts.

## Acquisitions

Expectations of biotechnology firm takeover are higher in Canada than in the U.S. Those surveyed in Canada believed that 60 per cent of Canadian firms will have been taken over by 1998. In the U.S., those surveyed indicated, on average, that 46 per cent of the U.S. biotechnology firms would be acquired by other companies by 1998.

In the U.S. study, small companies typically expected to be

acquired while large companies expected to do the acquiring. While this general trend was discernible in the Canadian data, small firms expected to make almost as many acquisitions as large firms by 1992, with large firms pulling into a definite lead by 1998.

## *Growth in employment*

The U.S. has the most ambitious plans for increasing staff sizes between 1988 and 1992, with an expectation of an increase of 95 per cent in this period. Canada follows at 78 per cent, and the U.K. data, when extrapolated forward from a one-year projection, suggests an increase of 52 per cent.

Companies in all three countries expect to increase their staffs much more in the areas of sales, marketing and production than in the areas of research and development, management and administration. This correlates well with the fact that many products of biotechnology have now been developed, patented and approved by regulatory agencies. The challenge for the next few years will be to manufacture these products in large quantities and create and penetrate markets.

- *Overall employment by the biotechnology industry:* The estimated total employment in Canada's 220 industrial biotechnology firms as of 1988 was in the vicinity of 6,500. The U.S. had approximately 26 times as many in the same year with a total of about 170,000 in the 1037 firms across the country.
- *Demand for personnel between 1988 and 1992:* Canada is expected to need 5,000 new employees in the biotechnology industry between 1988 and 1992. U.S. demand is expected to be 33 times that number, with a total demand in the range of 164,000 new employees.

## *Financial indicators*

- *Profits and losses:* In both the Canadian and the U.S. survey, about one-quarter of the biotechnology companies experienced positive net incomes in the most recent fiscal year. In the case of Canada, this was a minimum estimate since only half of the companies provided complete financial information suitable for further analysis and over half of these reported positive net incomes. In the U.K. survey, half

of the companies providing financial data reported profits. In all three studies, losses were greater than profits, so that the average net income per company after taxes was negative in the most recent fiscal year. The average loss per company was much greater for U.S. companies than for Canadian ones, \$1,291,000 as compared with \$13,000 per company.

In the previous fiscal year, Canadian firms had experienced an average profit of \$38,000 each. The U.S. study also reported higher net incomes in the previous fiscal year. This trend is consistent with the increasing investment in R&D and manufacturing facilities at a time when revenues are just beginning to grow.

- *Liquidity ratio:* The ratio of current assets to current liabilities is referred to as the liquidity ratio in the Canadian study and as the current ratio in the U.S. study. It is a good indicator of the extent to which a biotechnology company has stockpiled reserves of cash to pay for R&D, scale-up, testing and launch of products at a time when its sales revenues have just begun to develop.

Liquidity ratios in both Canadian and U.S. companies increased over the two most recent fiscal years. However, overall reserves are much greater for the U.S. companies. The median liquidity ratio for all Canadian companies increased from 2.0 to 2.3 while that for U.S. firms increased from 4.0 to 4.6. Pharmaceutical manufacturers typically have a liquidity ratio in the range of 1.8-1.9.

Mid-sized companies had the highest liquidity ratios with a median of 6.5 for Canadian companies (up from 3.5 the previous year), and a median of 5.9 for U.S. companies. These companies are poised for major aggressive growth as indicated by their plans for new manufacturing facilities and forecasts for sales revenue.

- *Debt-to-equity ratio:* The ratio of debt to equity in the pharmaceutical sector is reported as 1.0 in Canada and 1.3 in the U.S. By comparison, the biotechnology companies surveyed in both Canada and the U.S. have much lower debt as a proportion of equity. The median value for Canadian companies decreased from 0.68 to 0.47 in the two fiscal years preceding the survey. U.S. companies decreased from 0.27 to 0.22 in the same timeframe. These reductions reflect the increasing importance of both private and public equity as a source of financing in these companies.

## *Patent disputes*

While patent disputes in the therapeutics sector draw much publicity and frequently involve companies in more than one country, a majority of biotechnology companies surveyed have not, as yet, been involved in patent disputes. In Canada, only 20 per cent had ever been involved in patent disputes and, of these, only four companies had been involved in litigation in connection with a dispute. In the U.S., 29 per cent of those surveyed had been involved in patent litigation, with only 3 per cent reporting more than five litigated disputes. The U.K. study reported a relative lack of awareness of the importance of patents. In both Canada and the U.S., a significant number of the companies believed that patent issues will increase in importance for industrial biotechnology and that disputes are likely to increase as well.

## *Product liability*

Some biotechnology companies in Canada and the U.S. reported that product liability concerns have caused problems in the past. A much greater number of Canadian companies believed that this issue will grow in importance and will significantly affect their ability to commercialize products in the future.

	Canada	U.S.
Past	20%	14%
Future	38%	45%

The pattern was the same in the United States but much more extreme. ☐

# U.S. Summary

In the 18 months from mid-1987 until the end of 1988, biotechnology in the U.S. witnessed both Genentech's long-awaited introduction of Activase®, a drug that has captured broad public attention, and the 1987 stock market crash which challenged the ability of biotechnology companies to find financing.

To understand these events and their impact upon industrial biotechnology in the U.S., Arthur Young surveyed 291 U.S. companies and published the results in *Biotech 89: Commercialization*, its third annual survey of business and financial issues in this sector. Data were analyzed by sector and by size of company. The four sectors used were diagnostics, therapeutics, ag-bio (plant and animal) and suppliers. Companies were divided into three categories based on the total number of employees: small, 1-50; mid-size, 51-135; and large, 136 and more.

The complete report is available from Ernst & Young (formerly Arthur Young in the U.S. and Clarkson Gordon in Canada). The *Key Findings* section of that publication is reproduced here in its entirety in unedited form with the permission of Ernst & Young. It provides a basis for direct comparison with the results of the Canadian survey.

## Key Findings of the U.S. Survey

### Earnings, Growth, Staying Power

- *Product sales advance substantially* On a year-to-year basis, product sales in small companies increased by 41 percent, in mid-size companies by 30 percent, and in large companies by 24 percent.

- *Projected sales growth* Estimated

sales per company are projected to increase on average more than 60 percent within two years and to reach nearly five times current sales within five years.

- *Still more hope than earnings*

Although 26 percent of all respondents recorded a profit, on an aggregate basis the industry continues to lose money. By size, mid-size companies reported the largest losses; by market, the therapeutic group sustained the largest losses.

- *Net income down in some segments*

More than two-thirds of ag-bio and therapeutic firms reported lower net income or greater losses on a year-to-year basis, suggesting decreased emphasis on the bottom line as companies spend to achieve product development goals.

- *A tendency to sprint* For the industry as a whole, burn rates have risen on a year-to-year basis and survival indices have dropped.

- *Consolidation expected* Biotech executives expect nearly half of the industry to be acquired within ten years, and a full third within five years.

- *Biotech companies continue to be each other's principal competition* As in previous years, companies of all sizes and in most markets rate other biotech companies as their primary competitors. While the industry's patent disputes have dramatized this finding, biotech companies also compete for key people, equity, and strategic partners.

- *As companies grow, downstream functions gain in importance* When the factors contributing to current competitive advantage are projected

into the future, downstream activities such as production and marketing increase in relative importance, while research expertise, although still the most important factor, decreases in relative importance.

- *Costs reflect business maturity* The primary cost for each size category illustrates the shifting focus of growing companies: general and administrative for small companies; R&D for mid-size companies; cost of product sales for large companies.

- *High projected spending on manufacturing facilities* Projected average spending on domestic and foreign manufacturing facilities combined over the next five years is \$51 million per company.

- *Liquidity remains excellent* 44 percent of total assets are held in the form of cash and short-term investments, supporting an industry-wide current ratio of 4.5.

- *Current ratio: liquidity fuels growth* The current ratio of mid-size companies is highest, reflecting the deliberate accumulation of liquid assets as a prelude to the increased burn rates typical at this stage of growth.

- *Use of debt growing, still low* The median debt/equity ratio for all companies is 0.27, up from 0.22 for the same companies last year, but still much less than the median 1.3 for manufacturers of drugs and medicines. The majority of firms in each market segment have increased their debt/equity ratio in the past year, an indication that debt financing has grown in importance since the market crash.

## Effects of the Stock Market Crash

### • *IPO's and secondary offerings dry up*

The equity market for initial public offerings of all types is cyclic in the best of times, with "windows of opportunity" opening and closing, sometimes rapidly. In the post-crash environment, few biotech companies have approached the equity market, although finance professionals see opportunities.

• *Strategic partnering: more important than ever* Rising over past levels, strategic partnering is perceived as the leading alternative to public equity in the post-crash environment.

• *Mid-size and therapeutic firms most affected* Evidence throughout the survey indicates that the market crash has had the greatest effect on mid-size companies and therapeutic firms.

• *Survival index: private firms less secure* The survival index for public companies is four times the 12-month survival index for private companies, indicating a more difficult situation for many private companies in the post-market crash environment.

• *Manufacturing: effects depend on size* Mid-size companies are most likely to have changed their manufacturing strategy in the aftermath of the crash, presumably because small companies are not yet committed to manufacturing, while large companies have sufficient cash reserves to continue planned strategies. The most common response is to delay construction of new facilities; increasing outside production is less common.

• *Marketing: proceeds according to plan* Most companies of all sizes and in all markets report no significant impact on marketing strategy. Given their investment in research and product development, biotech companies are unlikely to endanger future revenues by scaling back on marketing. A minority of companies demonstrate greater interest in seeking strategic partners to assist in marketing.

### • *Personnel: mid-size growth squeezed*

In the wake of the market crash, the majority of mid-size companies have cut back on staff additions. Because mid-size companies have typically reached a stage at which downstream functions require new personnel, some are delaying expansion plans.

## International Expansion

• *Foreign contribution to strategic advantage* Expansion into the Western European and Japanese markets is increasingly recognized as a strategic advantage. Currently regarded as less important, the Japanese market is expected to gain in importance in the future. The diagnostic segment is most concerned with foreign markets, the ag-bio segment least concerned.

• *Sales: foreign share growing* Within five years, the contribution to foreign sales to total sales is projected to grow from the current 17 percent to 30 percent; projections for diagnostic firms lead at 39 percent, ag-bio trails at 17 percent.

• *Foreign sales not uncommon* Two-thirds of all respondents, including more than half of the companies in each size category, have foreign sales.

• *Market entry barriers differ* Market entry barriers differ in type and importance in Japan, Western Europe, and Canada. The Japanese market is large but somewhat feared, owing to business and cultural obstacles. The European market is more easily approached but language and cultural obstacles remain; the Canadian market, while nearby and similar to the U.S. market, is much smaller.

• *Investment in overseas manufacturing: dramatic growth expected* Cumulative spending on foreign manufacturing facilities over the next five years is estimated to be 90 times the level of spending in the current year, compared to tenfold growth in spending on domestic manufacturing facilities.

• *Motives for foreign alliances differ* Access to marketing expertise is the primary motive for foreign alliances, while capital availability - the leading motive for domestic alliances - is less important.

## Personnel

• *Importance of production and operations* By 1990, production and operations are projected to employ 40 percent of the personnel in a biotech company, ahead of R&D (28 percent), marketing and sales (19 percent), general and administrative (11 percent), and regulatory affairs (2 percent).

• *Needs of commercialization affect staffing projections* Projected personnel expansion is most marked in downstream functions. Marketing and sales, as well as production and operations, are each projected to double between 1988 and 1993, while R&D and general and administrative functions are projected to show more modest growth.

• *Projected personnel growth* The number of foreign employees is projected to increase rapidly in the next few years. On average for the industry as a whole, the number is projected to double by 1990 and nearly to double again by 1993. Large companies expect to have 65 employees overseas by 1993.

## The Product Liability Issue

• *Product liability issue of growing importance* Companies in all markets and of all sizes expect product liability concerns to have an important effect on future commercialization plans.

• *Liability fears affecting product development decisions* One-third of respondents report that product liability concerns have influenced product development choices and marketing strategy.



## Patents

- *Fewer patents on average than might be expected* On an industry-wide basis, biotech companies hold six patents and have another 21 pending.

- *Patent litigation uncommon* Seventy-one percent of all companies report that they have not been involved in patent litigation, while only 3 percent report that they have had more than five litigated disputes.

- *Seeking alternatives to patent litigation* Sixty-eight percent of respondents believe that alternatives to litigation should be used to resolve patent disputes.

## U.K. Summary

In the U.K. Arthur Young teamed with the Association for the Advancement of British Biotechnology to publish the results of their survey of U.K. biotechnology companies titled *UK Biotech 88: Industry in Evolution?* The report analyses responses from 78 biotechnology companies to a survey of financial and managerial issues. These responses were organized with respect to ownership of the company - independent or a specialist division of a group - and the primary markets which the company addresses. The market sectors identified were: pharmaceutical, animal agriculture, plant agriculture, food and beverage, chemical, environmental and equipment supply. The results of the U.K. survey are summarized below. A copy of the full U.K. report is available from Ernst & Young.

### Key findings of the U.K. survey

- *A young industry* A high proportion of the responding companies were formed in the eighties. In most cases, one or more of the key founders are still with the company.

- *Companies are active in several market sectors*

Approximately two thirds of the responding companies are active in two or more market sectors. Pharmaceuticals and animal agriculture are the two sectors where there is most activity.

- *Companies compete with each other and with foreign competitors*

Independent biotechnology companies perceive other biotechnology companies as providing the greatest competitor threat. They are also concerned about international competition, particularly from the United States and Western Europe and, to a lesser extent, from Japan. Divisions are concerned about the United States and Japan.

- *The features that give companies their competitive edge are changing* Key people and research expertise will continue to provide a competitive edge. Marketing and production capability may not have been important in the past, but will be key in the future. The divisions will exploit their greater financial resources for competitive advantage. Patents are ranked well below many other features and, in some sectors, are expected to decline in importance.

- *Own risk research and development is a significant activity for most companies*

The very high commitment to own risk research and development belies the general perception that most UK companies are concentrating on contract work for others. Companies prefer to raise external finance to fund research and development involving a high degree of technical risk or involving long time scales.

- *In-house production is a top priority*

Over 70 percent of responding companies carry out a significant proportion of their manufacturing in-house. Factors taken into account in the decision to manufacture in-house include the need to protect proprietary technology, required capital expenditure, and the availability of sub-

contractors. The complexity of the product and volumes are not viewed as significant.

- *Most companies use direct marketing* Over 70 percent of responding companies perform the majority of their own selling, although a significant part is also played by distributors. Licensing agreements seem to have only a minor role.

- *Strategic alliances are made for diverse reasons* Strategic alliances proliferate, particularly with educational and government institutions. The more important reasons for alliances include access to technology, sales/marketing channels and research personnel. Divisions are less concerned with access to sales and marketing channels. Many divisions are involved in research clubs, which do not appear to be common in the independent sector.

- *There will not be dramatic growth in headcount*

The responding companies expect an average 11 percent (divisions six percent) increase in headcount, with the marketing and sales function forecast to grow the fastest. The market sector forecasting the highest growth in employee numbers is food and beverage.

- *Salary levels are low*

70 percent of all staff employed by the independents receive less than £15,000 per annum, with marketing and sales being the best paid function. Employee share ownership is relatively uncommon and only 11 percent of independents have share option schemes.

- *Funding continues to be a problem*

Private placing of equity and corporate venturing are expected to be of significantly greater importance in the future. Grants and venture capital show some reduction in popularity with a very marked decline in bank borrowing. Less than half the responding companies had received grants. Within the sample most of the

grants received in the past have been for small sums, with 64 percent in the range of £100,000 -£300,000. Companies are generally satisfied with the grant procedure but a high proportion do not make claims, either because they are unaware of the grant or believe that the procedure takes too long.

## Japan Summary

Biotechnology has been designated by the Japanese government as one of the key technologies to lead the country into the 21st century. There are over 400 institutions actively involved in biotechnology. In addition to the pharmaceutical companies, Japanese companies from the food, chemical, textile, pulp and paper, and electronics industries are actively involved.

In September, 1988, the *Nihon Keizai Shimbun* (Japan Economic Journal) conducted a major bioindustry survey of the research and development trends in biotechnology.

A detailed questionnaire was distributed to 297 major organizations to determine the extent of R&D activity, commercialization, technical competitiveness and level of co-operation.

The results of the survey clearly demonstrate the increasing level of effort that companies in Japan are putting into the biotechnology sector, a trend that will increase during the next 15 years.

The key findings were:

### R&D Activity

Many of the responding companies are currently involved in several biotechnology sectors: pharmaceuticals (39%) and equipment and reagents (39%) were the major areas of company activity followed closely by food (38%) and agricul-

ture and horticulture (34%).

When asked about future biotechnology involvement, 25 per cent expected to expand into pharmaceuticals; 17 per cent into diagnostics; and 20 per cent cited agriculture and horticulture as their target area.

Cell fusion, large scale cell culture, fermentation, recombinant DNA studies, bioreactors, protein engineering, and computer drug design, were among the priority areas of current research and development. When companies were asked about their future R&D plans, 32 per cent said they were interested in large scale cell culture, 28 per cent in cell fusion, 26 per cent in bioreactors, 19 per cent in protein engineering and 14 per cent in computer drug design.

### Commercialization

Almost half of the companies surveyed had commercialized the results of their R&D, almost double the figure obtained from the 1986 survey. This reflects the overall maturing of the Japanese biotech industry. The major products being exploited are diagnostic monoclonal antibodies, restriction enzymes, insulin, hepatitis -B vaccine and interferon.

### Technical competitiveness

Interestingly enough, only six per cent of the companies rated their technology the best in the world. Twenty per cent rated their technology at the same level as the United States, 28 per cent saw themselves as second behind the USA, and 25 per cent believed they were second to USA and Europe.

The industries which ranked themselves at the highest technical level were in beverage, food, chemical, steel, non-ferrous metals, electronics and machinery.

### Industrial Co-operation

Almost a third of the companies have established international co-operation with overseas companies and research institutes. An increasing trend is for Japanese companies to invest in United States biotechnology companies.

Domestically, the majority of companies (73%) have alliances with other companies and research organizations in the form of exchange of researchers, funding or participation in national projects.

### Market Projections

The current market size of the Japanese bioindustry is estimated by major companies at 230 billion Yen. This is predicted to increase to 5,100 billion Yen by the year 2000. The market size by sector in year 2000 is projected at: 920 billion Yen for pharmaceuticals, 680 billion Yen for foods, 530 billion Yen for chemicals/pulp and paper, and 530 billion Yen for livestock.



# Appendix I: Survey Questionnaire

The survey was divided into two major parts, Part A and Part B. Part A was completed during an interview with companies. Part B, dealing mainly with financial questions, was completed by companies in private and sent to Statistics Canada. All questionnaires were coded prior to analysis to ensure confidentiality. Only aggregate data were prepared for use in the study.

## Part A

Part A was composed of four major subdivisions — general company information, markets, commercialization and alliances — and had a total of 64 questions.

### I. General Company Information

Companies were asked whether the company is public, the year of the first public offering and approximate number of shareholders, whether the company is a subsidiary, the year founded, the number of full time employees, part-time employees and the number of employees dedicated to biotechnology.

### II. Markets

Companies were asked to name their existing primary and secondary products (1988) and to indicate how this might change by 1992.

### III. Commercialization

This portion of the survey was divided into nine subsections to deal with questions of company growth, manufacturing facilities, competition, marketing and sales, personnel, patents, product liability, regulations and tax.

*Growth:* Six subjects were explored in this section: (1) estimates for 1988 and 1992 of total revenues from sales and the proportion of these revenues which are expected to be based on biotechnology; (2) estimates of the geographic distribution of

sales as a percentage of total sales of biotechnology products for 1988 and 1992; (3) the number of products of biotechnology at the stage of R&D, at the stage of testing or scale-up, and at the production stage; (4) obstacles to getting products to market; (5) sources of most valuable advice concerning technology, financing, marketing and manufacturing were chosen from a prepared list; and (6) the names of industry associations of which the company is a member.

*Manufacturing:* Three questions were asked in this section: (1) whether the company had any manufacturing facilities, and if not, why not; (2) whether the company expected to build new production facilities within the next two years or the next five years; and (3) estimated capital requirements in 1988, 1989 and 1990-1992.

*Competition:* Two questions were asked in this section: (1) evaluation on a scale of 1 to 5 of the competitive threat posed by a predetermined list of possible competitors; and (2) evaluation on a scale of 1 to 5 of the importance of a predetermined list of assets to establishing a competitive advantage.

*Marketing and Sales:* Four questions were asked in this section: (1) present mechanisms used to distribute products in the domestic market and expectations concerning mechanisms to be used in 1992; (2) present mechanisms used to distribute products in each foreign market of relevance and expectations concerning mechanisms to be used in 1992; (3) the percentage of the domestic market captured by the company's primary product, whether the company is satisfied with this market share, and whether the company believes a strong domestic demand would help the company enter foreign markets; and (4) whether there are any significant obstacles to entry into foreign markets, and if so, what they are.

*Personnel Resources:* There were eight questions in this section: (1) actual number of employees in management, general & administration, research and development, production/operation/quality

control, and sales/marketing, and estimates of the expected number in each of these categories in the year 1992; (2) actual numbers of employees with various academic backgrounds — biological sciences, chemistry, physics, engineering, computer sciences, management, sales and marketing — and forecasts of the needs for 1992; (3) whether the company has any employees in foreign countries and, if so, how many; (4) whether the company has difficulty attracting qualified personnel in Canada and, if yes, what specific types are hardest to find; (5) how important factors such as location of company, level of compensation, quality of equipment and facilities, stature of existing personnel and ability to obtain work permits are to the company's ability to attract qualified personnel; (6) whether the company uses an employee stock option or profit sharing plan; (7) whether the company has a Scientific Advisory Board, and what the composition of the Board of Directors is; and (8) how important other categories of companies, universities and the government are in competing for personnel.

*Patents:* There were twelve questions in this section: (1) whether the company finds it worthwhile to patent its products and, if not, why not; (2) how many different biotechnology patented inventions (improvements) the company holds; (3) how many different biotechnology patents are pending; (4) the average number of countries per patent; (5) whether the company believes it can afford to defend its patents; (6) how many months on average it takes to obtain patent approval in Canada; (7) whether the company believes patent disputes are likely to increase; (8) whether the process for applying for patents and defending patents should be changed, and if so, how; (9) whether the company is familiar with the patent approval process in foreign countries and, if yes, which ones are better than Canada's system and which ones are worse, and in which order does the company file its patents; (10) whether the company believes that the provisions of the new Patent Act (Bill C-22) have increased the attractiveness of patenting in Canada; (11) how much the company expects to spend obtaining and defending patents in 1988 and in the four years 1989-1992; (12) whether the company has experienced patent disputes and, if yes, whether it required formal litigation.

*Product Liability:* There were two questions in this

section: (1) whether product liability concerns have significantly affected the company's ability to commercialize products up to the time of the survey and, if so, what the specific nature of the problem was; and (2) whether the company expects product liability concerns to significantly affect its ability to commercialize products in the future.

*Regulations:* There were six questions in this section: (1) whether the company knows what regulatory approval is needed for its products; (2) if so, which regulatory authorities control its products and how many months it takes to obtain approval; (3) whether the company believes products of biotechnology should be regulated and, if so, who should regulate them; (4) whether the company is familiar with Bill C-74, the proposed federal regulations for products of biotechnology; (5) whether the company is satisfied with these proposed regulations, and, if not, what the nature of the concern was; and (6) whether the company had communicated its concerns to the drafters of the proposed regulations at Environment Canada.

*Tax Matters:* There were five questions in this section: (1) how satisfied the company is with the procedures to claim Scientific Research and Experimental Development (R&D) Tax Credits; (2) how many months it took to receive the R&D tax credit refund for the latest completed tax year; (3) how important this refund is to managing the company's cash flow; (4) how important limited partnerships have been in the past; and (5) any major improvements in the tax system that the company thinks would promote industrial biotechnology in Canada.

#### IV. Alliances

There were five questions in this section: (1) whether the company had any alliances (defined to include contracts) with other firms; (2) how many alliances the company had with each of a list of other organizations including universities, pharmaceutical companies, chemical companies, food companies, petrochemical companies, biotechnology companies, distributors, suppliers, government and venture capital companies; (3) how many alliances the company had with companies in Canada, the U.S., the United Kingdom, Western Europe, Japan and elsewhere; and (4) how important the following assets are in

considering a domestic alliance with another company or institution: availability of capital, research capability, access to technology, management expertise, manufacturing capability, regulatory expertise, marketing expertise/capability and credibility; and how important these same assets are in selecting a foreign alliance.

## V. Mergers and Acquisitions

There were four questions in this section: (1) what percentage of Canada's biotechnology companies the respondent believed would be acquired by other companies between 1988 and 1992, and then between 1992 and 1998; (2) whether the company expected to acquire another biotechnology company during the periods 1988-1992 or 1992-1998; (3) how an acquired company should be managed — independent from the parent or integrated with the parent; (4) whether the company expected to be acquired by another biotechnology company between 1988 and 1992, or between 1992 and 1998, and, if yes, what type of company would be most likely to do the acquiring.

## Part B

Part B was composed of fourteen questions dealing with financial matters. It was filled out in private by the companies surveyed and sent directly to Statistics Canada for analysis.

The first eleven questions asked for specific financial performance in the two most recent completed fiscal years of the companies surveyed: (1) product sales revenue, (2) contract and collaborative revenues, (3) royalties and licence fees, (4) total revenue, (5) research and development expenses, (6) income (loss) before tax, (7) net income (loss) after tax, (8) current assets, (9) current liabilities, (10) total assets, and (11) total liabilities.

The remaining three questions dealt with future financing: (1) the three largest sources of financing during start-up, expansion, most recent raising of capital, and expectations concerning future raising of capital; (2) when additional financing would be needed; and (3) whether the company had plans to go public by the year 1992.

**A. Lassonde & Fils Inc.**  
170-5e Avenue  
Rougemont (Québec)  
J0L 1M0  
**Contact:** Yves Dumont  
Tel.: (514) 878-1057  
Activity: Enzymatic clarification of fruit juices

**AB Biological Supplies Inc.**  
P.O. Box 65  
Grimsby, Ontario  
L3M 4G1  
**Contact:** G. Machan  
Tel.: (416) 945-9661  
Activity: Diagnostic kits monoclonals

**ABI Biotechnology Inc.**  
40 Scurfield Blvd.  
Winnipeg, Manitoba  
R3V 1G4  
**Contact:** Dr. A. Friesen  
Tel.: (204) 488-4063  
Activity: Growth factors; diagnostics

**Acadian Seaplants Ltd**  
Tower D, Suite 304  
202 Brownlow Avenue  
Dartmouth, Nova Scotia  
B3B 1T5  
**Contact:** Louis Deveau  
Tel.: (902) 468-2840  
Activity: Marine plant cultivation

**ADI Ltd**  
1133 Regent Street  
Fredericton, New Brunswick  
E3B 3Z2  
**Contact:** Robert C. Landine  
Tel.: (506) 452-9000  
Activity: Treatment systems

**ADS Environment Inc.**  
2155, rue Guy, Suite 1200  
Montréal (Québec)  
H3H 2L9  
**Contact:** A. D'Aragon  
Tel.: (514) 932-4454  
Activity: Waste treatment; Feed for animals

**Advanced Biotechnology Ltd.**  
28355 Fraser Highway  
Aldergrove, British Columbia  
V0X 1A0  
**Contact:** Dwight Jefferson  
Tel.: (604) 533-4444  
Activity: Financing industry

**Agri Forest Technologies**  
2330 Enterprise Way  
Kelowna, British Columbia  
V1X 4H7  
**Contact:** Dr. Reg Tomiye  
Tel.: (604) 860-5815  
Activity: Plant tissue culture; commercial micropropagation

## Appendix II: Directory of Canadian Biotechnology Firms

Based on the 1988 Canadian Biotechnology Industry Sourcebook published by the Ministry of State for Science and Technology. Additions and deletions have been made to reflect changes in the industry known to the Editors at the time of publication.

**Agropur, Coopérative Agro-Alimentaire**  
510, rue Principale  
Granby (Québec)  
J2G 7G2  
**Contact:** Dr. Roger Giroux  
Tel.: (514) 375-1991  
Activity: Processing milk products, especially cheese

**Aliments Carrière Inc**  
(see Les Aliments Carrière Inc)

**Allelix Crop Technologies**  
6850 Goreway Drive  
Mississauga, Ontario  
L4V 1P1  
**Contact:** J. Castagno  
Tel.: (416) 677-0831  
Activity: Plant breeding; Microbial inoculants

**Allelix Biopharmaceuticals**  
6850 Goreway Drive  
Mississauga, Ontario  
L4V 1P1  
**Contact:** Graham Strachan  
Tel.: (416) 677-0831  
Activity: Biopharmaceuticals

**ADI Diagnostics Inc**  
30 Meridan Road  
Rexdale, Ontario  
M9W 4Z7  
**Contact:** Stephen Hayter  
Tel.: (416) 674-0863  
Activity: Diagnostic kits monoclonals

**Alta Genetics Inc.**  
Site 12, Box 12, R.R. 4  
Calgary, Alberta  
T2M 4L4  
**Contact:** T. Mitenko  
Tel.: (403) 239-8882  
Activity: Livestock genetics and reproductive technologies

**APO Diagnostics Inc.**  
91 Esna Park Drive, Unit 2  
Markham, Ontario  
L3R 2S2  
**Contact:** Max Marmel  
Tel.: (416) 475-1582  
Activity: Microbiological test kits

**Applied Bio-Nomics Ltd.**  
P.O. Box 2637  
Sidney, British Columbia  
V8L 4C1  
**Contact:** Dr. Linda Gilkeson  
Tel.: (604) 656-2123  
Activity: Biological control agents for crop protection

**Aqua Health Ltd**  
West Royalty Industrial Park  
Charlottetown, Prince Edward Island  
C1E 1B0  
**Contact:** Dr. W. Patterson  
Tel.: (902) 566-4966  
Activity: Fish vaccines

**Aquaresearch Ltd.**  
Case postale 208  
North Hatley, PQ  
J0B 2C0  
**Contact:** Dr. K. Ehrlich  
Tel.: (819) 842-2890  
Activity: Waste Management, Aquaculture

**Aquaterre Inc.**  
119-2065 ouest, boulevard Charest  
Ste-Foy (Québec)  
G1C 2G1  
**Contact:** Alain Andersen  
Tel.: (418) 681-6931  
Activity: Composting of marine biomass

**Atlantic Microbiology Ltd.**  
27 Clyde Street  
Saint John, New Brunswick  
E2L 5A8  
**Contact:** W. Wilson  
Tel.: (506) 634-1771  
Activity: Specialty chemicals in pulp and paper

**B.C. Research Corp**  
3650 Westbrook Mall  
Vancouver, British Columbia  
V6S 2L2  
**Contact:** Dr. Doug Denen  
Tel.: (604) 224-4331  
Activity: Technical Services, Aquaculture, Waste Management, Mineral leaching and Forestry

**B.V. Sorbex Inc.**  
a/s Dept. of Chemical Engineering  
McGill University  
3480 University Street  
Montréal, Québec  
H3A 2A7  
**Contact:** Dr. B. Volesky  
Tel.: (514) 398-4276  
Activity: Design of biosorption process, Waste water treatment

**B2 Enterprises Ltd.**  
P.O. Box 185  
Choiaceland, Saskatchewan  
S0J 0M0  
**Contact:** Lloyd Bartlett  
Tel.: (306) 428-2192  
Activity: Growth regulators soilless mixtures

**Balco Canfor Reforestation Centre Ltd**  
R.R. 3  
Kamloops, British Columbia  
V2C 5X1  
**Contact:** Gary Hunt  
Tel.: (604) 578-7212  
Activity: Growing forest seedlings

**Bay D'Espoir Salmon Hatchery Ltd**  
St. Alban's, Newfoundland  
A0H 2E0  
**Contact:** Juanita Organ  
Tel.: (709) 538-3236  
Activity: Salmonid aquaculture

**Beak Consultants Ltd.**  
41 Abacus Road  
Brampton, Ontario  
L6T 5B7  
**Contact:** Dr. D. Lush  
Tel.: (416) 458-4044  
Activity: Regulatory policies, Environmental protection

**Better Yield Insects**  
P.O. Box 3451  
Tecumseh Station  
Windsor, Ontario  
N8N 3C4  
**Contact:** Pat Coristine  
Tel.: (519) 727-6108  
Activity: Rearing beneficial insects

**Bio Field Technologies Research Inc.**  
1311 - 50 O'Connor Street  
Ottawa, Ontario  
K1P 6L2  
**Contact:** David Grayson  
Tel.: (613) 563-8105  
Activity: Algae for soil and crop improvement

**Bio-Hol Developments**  
 Weston Research Centre  
 1047 Yonge Street  
 Toronto, Ontario  
 M4W 2L2  
**Contact:** Dr. Ross Lawford  
 Tel.: (416) 922-5100  
 Activity: Biomass utilization,  
 Contract pilot plant

**Bio-Méga Inc.**  
 2100, rue Cunard  
 Laval (Québec)  
 H7S 2G5  
**Contact:** Jacques Gauthier  
 Tel.: (514) 682-4640  
 Activity: Pharmaceutical and  
 diagnostics

**Bio-Research Laboratories**  
 87, rue Senneville  
 Senneville (Québec)  
 H9X 3R4  
**Contact:** Ried Jilek  
 Tel.: (514) 457-2280  
 Activity: Contract research -  
 clinical, preclinical

**Bio-Response Systems Ltd.**  
 P.O. Box 2564, Station M  
 Halifax, Nova Scotia  
 B3J 3N5  
**Contact:** Michael Scott  
 Tel.: (902) 477-0155  
 Activity: Toxicity testing

**Biogénie S.R.D.C. Inc.**  
 4700, boul. Wilfrid Hamel  
 Bureau 302  
 Québec (Québec)  
 G1P 2J9  
**Contact:** J. L. Sansregret  
 Tel.: (418) 877-1349  
 Activity: Industrial waste  
 treatment

**Biomira Inc.**  
 9411 A - 20th Avenue  
 Edmonton, Alberta  
 T6N 1E5  
**Contact:** Gordon Politeski  
 Tel.: (403) 450-3761  
 Activity: Cancer diagnosis and  
 therapy

**Bionov CNP Inc.**  
 81, rue St-Pierre, 4e étage  
 Québec (Québec)  
 G1K 4A3  
**Contact:** Yvan Pouliot  
 Tel.: (418) 692-1357  
 Activity: Consultants - Aquaculture, Waste treatment

**Bioprotein Canada Inc.**  
 Division of Protein Foods  
 Group Inc.  
 154 Main Street East  
 P.O. Box 463, Station B  
 Hamilton, Ontario  
 L8L 7W9  
**Contact:** Dr. C. Findlay  
 Tel.: (416) 522-9214  
 Activity: Immobilized systems  
 using Biobone

**Bioquest International Inc.**  
 3-1329 Niakwa Road East  
 Winnipeg, Manitoba  
 R2J 3T4  
**Contact:** Dr. Martin Samiloff  
 Tel.: (204) 254-0712  
 Activity: Biomonitoring, toxicology assessment

**Biorex Groupe Conseil Inc.**  
 2065 ouest, boulevard Charest  
 Suite 119  
 Ste-Foy (Québec)  
 G1N 2G1  
**Contact:** Mark Gagnon  
 Tel.: (418) 681-6931  
 Activity: Marine biotechnology,  
 Turnkey aquaculture projects

**BIOSCAN Continental Inc.**  
 350, boulevard Industriel  
 Suite 201  
 St-Eustache (Québec)  
 J7R 5V3  
**Contact:** V. Banik  
 Tel.: (514) 491-5807  
 Activity: Health care products

**Bioshell Inc.**  
 6070 est, rue Sherbrooke  
 Montréal (Québec)  
 H1N 1C1  
**Contact:** Roger Paquet  
 Tel.: (514) 252-8300  
 Activity: Biomass densification  
 into wood pellets

**Biostar Inc.**  
 Box 1000, Sub. P.O. Box 6  
 Saskatoon, Saskatchewan  
 S7N 0W0  
**Contact:** Dr. Stephen Acres  
 Tel.: (306) 966-7473  
 Activity: Animal health care  
 products

**Biosyn**  
 1080 Côte Beaver Hall, Suite  
 1806  
 Montréal, Québec  
 H2Z 1S8  
**Contact:** Guy Gravel  
 Tel.: (514) 875-6434  
 Activity: Biomass gasification

**Biosystech Consulting Inc.**  
 2383 Edenhurst Drive  
 Mississauga, Ontario  
 L5A 2L1  
**Contact:** Dr. Hugh Lawford  
 Tel.: (416) 279-5337  
 Activity: Consulting biosystems  
 technologies

**BioTechnica Canada Inc**  
 170, 6815 - 8th Street N.E.  
 Calgary, Alberta  
 T2E 7H7  
**Contact:** Dr. W. Scowcroft  
 Tel.: (403) 295-0383  
 Activity: Plant breeding, crop  
 protection

**Blueberry Acres Ltd**  
 (Nova Biotechnology Inc.)  
 R.R. #2  
 Centreville, Nova Scotia  
 B0P 1J0  
**Contact:** Robert Aucoin  
 Tel.: (902) 582-3832  
 Activity: Plant tissue culture

**Bocknek Ltd.**  
 165 Bethridge Road  
 Rexdale, Ontario  
 M9W 1N4  
**Contact:** Paul Haffenden  
 Tel.: (416) 745-0796  
 Activity: Manufacture tissue  
 culture products

**Boojum Research Ltd.**  
 139 Amelia Street  
 Toronto, Ontario  
 M4X 1E6  
**Contact:** M. Kalin  
 Tel.: (416) 963-9420  
 Activity: Mining wastewater  
 treatment

**Brookside Farms Ltd**  
 31212 Peardonville Road  
 Abbotsford, British Columbia  
 V2S 5W6  
**Contact:** Stephen Smith  
 Tel.: (604) 852-5940  
 Activity: Food confectionary,  
 Biochemicals

**C-I-L Inc.**  
 P.O. Box 200, Station "A"  
 North York, Ontario  
 M2N 6H2  
**Contact:** Neil Gray  
 Tel.: (416) 229-7000  
 Activity: Microbial pesticides,  
 Forage inoculants

**Cape Breton Development Corporation**  
 Cabot House, King's Road  
 P.O. Box 2500  
 Sydney, Nova Scotia  
 B1P 6K9  
**Contact:** J. Campbell  
 Tel.: (902) 564-2894  
 Activity: Use bacteria to reduce  
 explosive hazard in coal  
 mining

**Canadian Bioclinical**  
 81 Finchdene Square  
 Scarborough, Ontario  
 M1X 1B4  
**Contact:** Dr. J. Clapp  
 Tel.: (416) 293-2492  
 Activity: Diagnostic kit  
 manufacture

**Canadian Liposome Co**  
 (see The Canadian Liposome  
 Co.)

**Canadian Red Cross (BTS)**  
 1800 Alta Vista Drive  
 Ottawa, Ontario  
 K1G 4J5  
**Contact:** Dr. Peter Ganz  
 Activity: Human health care

**Canadian Seed Coaters Ltd**  
 P.O. Box 219  
 210 Wanless Drive  
 Brampton, Ontario  
 L6V 2L2  
**Contact:** T.S. Bailie  
 Tel.: (416) 846-5080  
 Activity: Seed coating

**Canber Industries Ltd.**  
 Site 34, P.O. Box 58  
 6028 Mountainview Road  
 Lantzville, British Columbia  
 V0R 2H0  
**Contact:** Allan McInnes  
 Tel.: (604) 390-3113  
 Activity: Fermentation  
 technology

**Cangene Corporation**  
 3403 American Drive  
 Mississauga, Ontario  
 L4V 1T4  
**Contact:** Dr. James Rae  
 Tel.: (416) 673-0200  
 Activity: Genetic engineering

**Canpolar Inc.**  
 421 Eglinton Avenue West,  
 Suite 4  
 Toronto, Ontario  
 M5N 1A4  
**Contact:** Dr. James Rossiter  
 Tel.: (416) 487-1581  
 Activity: Biosensors for food  
 processing



**Canpro Laboratories**  
77 Champagne Drive  
Downsview, Ontario  
M3J 2C6  
**Contact:** H. Tenebaum  
Tel.: (416) 635-8692  
Activity: Pesticides/herbicides,  
Health care

**Canviro Consultants**  
180 King Street South, Suite  
600  
Kitchener, Ontario  
N2J 1P8  
**Contact:** Dr. Earl Shannon  
Tel.: (519) 579-3500  
Activity: Environmental con-  
sulting, Biological waste treat-  
ment

**Carratech Inc.**  
West Royalty Industrial Park  
Charlottetown, P.E.I.  
C1E 1B0  
**Contact:** George Mason  
Tel.: (902) 566-5325  
Activity: Chemicals from algae

**Casco Inc**  
401 The West Mall  
Etobicoke, Ontario  
M9C 5H9  
**Contact:** G. Fulford  
Tel.: (416) 620-2300  
Activity: Enzyme application  
to starch and corn

**CBM Bioventures**  
P.O. Box 2010  
101-9865 West Saanich Road  
Sidney, British Columbia  
V8L 3S3  
**Contact:** Dr. Bryan Imber  
Tel.: (604) 655-1944  
Activity: Consulting, Biodegra-  
dation, mineral binding

**Cedarlane Laboratories Ltd**  
5516 8th Line, R.R. 2  
Hornby, Ontario  
L0P 1E0  
**Contact:** C. Greer  
Tel.: (416) 878-8891  
Activity: Manufacture reagents  
for immunology

**Centre d'insémination  
artificielle du Québec**  
3450, rue Sicotte  
Case postale 518  
Saint-Hyacinthe (Québec)  
J2S 7B8  
**Contact:** Sylvie Des Marchais  
Tel.: (514) 774-1141  
Activity: Bovine semen and  
embryos

**Centre de Recherche en  
Sylviculture de l'Outaouais  
Inc.**

11, rue Main  
Case Postale 38  
Gatineau (Québec)  
J8P 6J1  
**Contact:** Yvon Gauthier  
Tel.: (819) 643-9099  
Activity: Biomass conversion

**Champlain Industries Ltd**  
7200 West Credit Avenue  
Mississauga, Ontario  
L5N 5N1  
**Contact:** Jane Rich  
Tel.: (416) 826-0801  
Activity: Manufacture of  
casein peptones

**Chateau des Charmes Wines  
Ltd.**  
P.O. Box 280  
St. David's, Ontario  
L0S 1P0  
**Contact:** Paul Bose  
Tel.: (416) 262-4219  
Activity: Viticulture, winery

**CHEMBIOMED Ltd.**  
Edmonton Research and De-  
velopment Park  
P.O. Box 8050  
Edmonton, Alberta  
T6H 4N9  
**Contact:** Dr. Frank Unger  
Tel.: (403) 450-6800  
Activity: Manufacture blood  
typing reagents and immuno-  
sorbents

**Chemfet Canada Ltd.**  
340 - 342 Saulteaux Crescent  
Winnipeg, Manitoba  
R3J 3T2  
**Contact:** Dr. Garry Smith  
Tel.: (204) 831-8077  
Activity: Manufacture  
chemical sensor products

**Chemlab Inc.**  
27 Clyde Street  
Saint John, New Brunswick  
E2L 5A8  
**Contact:** W. Wilson  
Tel.: (506) 634-1771  
Activity: Production of sugars,  
Mineral leaching

**Ciba-Geigy Canada Ltd.**  
6860 Century Avenue  
Mississauga, Ontario  
L5N 2W5  
**Contact:** J. Wells  
Tel.: (416) 821-4420  
Activity: Pesticides, seeds,  
animal health care, plant  
protection

**Clay, Les & Son Ltd.**  
(see Les Clay & Son Ltd.)

**Clearwater Fine Foods, Inc.**  
757 Bedford Highway  
Bedford, Nova Scotia  
B4A 2X3  
**Contact:** Thomas Morse  
Tel.: (902) 443-0550  
Activity: Shellfish harvesting,  
processing and marketing

**Coastech Research Inc.**  
869 Third Street West  
North Vancouver,  
British Columbia  
V7P 1E2  
**Contact:** P. Marchant  
Tel.: (604) 980-5992  
Activity: Biobleaching-gold

**Connaught Laboratories Ltd.**  
1755 Steeles Avenue West  
Willowdale, Ontario  
M2R 3T4  
**Contact:** Dr. John Vose  
Tel.: (416) 667-2701  
Activity: Vaccines, Insulin

**Connors Bros. Ltd.**  
Blacks Harbour, New Bruns-  
wick  
E0G 1H0  
**Contact:** Ken Hirtle  
Tel.: (506) 456-3391  
Activity: Salmonid and fish feed

**Continental Pharma Cryosan  
Inc.**  
1625 ouest, rue Sherbrooke  
Montréal (Québec)  
H3H 1E2  
**Contact:** Thomas Hecht  
Tel.: (514) 935-4004  
Activity: Sourceplasma + blood  
derivatives, vaccines

**Coolwater Farms Ltd**  
591 Liverpool Road  
Pickering, Ontario  
L1W 1R1  
**Contact:** John Neil  
Tel.: (416) 831-0697  
Activity: Aquaculture produc-  
tion of edible fish

**Corey Feed Mills Ltd.**  
P.O. Box 391, Station "A"  
Fredericton, New Brunswick  
E3B 4Z9  
**Contact:** Lee Corey  
Tel.: (506) 459-5588  
Activity: Animal and fish feed

**Corporation BDG**  
1708, rue de Pont Grévé  
St-Bruno (Québec)  
J3V 4Y4  
**Contact:** Gilles Brisson  
Tel.: (514) 653-2205  
Activity: Consultant-  
diagnostic equipment

**COSEM Neurostim Ltée**  
2954, boulevard Laurier  
Suite 330  
Ste-Foy (Québec)  
G1V 2M4  
**Contact:** J. Gauthier  
Tel.: (418) 657-7387  
Activity: Cochlear implants,  
Health care products

**Crosbys Molasses Ltd.**  
P.O. Box 2240  
Saint John, New Brunswick  
E2L 3V4  
**Contact:** J. Leonard  
Tel.: (506) 634-7515  
Activity: Quality control-food

**CSP Foods Ltd.**  
870 - 360 Main Street  
Winnipeg, Manitoba  
R3C 3Z3  
**Contact:** Mark Pickard  
Tel.: (204) 947-6871  
Activity: Production of edible  
oils

**Cyanamid Canada Inc.**  
88 McNabb Street  
Markham, Ontario  
L3R 6E6  
**Contact:** D. Lawson  
Tel.: (416) 470-3600  
Activity: Animal & human  
health, Pesticides, herbicides

**Cyberfluor Inc.**  
179 John Street  
Toronto, Ontario  
M5T 1X4  
**Contact:** Ms. Thealzel Lee  
Tel.: (416) 977-5450  
Activity: Manufacture instru-  
ments & tests for health care

**D. McLeay & Associates Ltd.**  
300 - 1497 Marine Drive  
West Vancouver, British Co-  
lumbia  
V7T 1B8  
**Contact:** Dr. Don McLeay  
Tel.: (604) 922-0355  
Activity: Aquaculture and  
aquatic toxicology

**Dearborn Environmental  
Consulting Group**  
P.O. Box 3060, Station "A"  
Mississauga, Ontario  
L5A 3T5  
**Contact:** Igor Marvan  
Tel.: (416) 279-2222  
Activity: Waste water  
treatment

**Degremont - Infilco Ltée**

160, boul. St-Joseph  
Lachine (Québec)  
H8S 2L3  
**Contact:** Robert Cyr  
Tel.: (514) 634-8011  
Activity: Waste water treatment

**Denison Mines Ltd.**

Elliot Lake Operations  
P.O. Box B2600  
Elliot Lake, Ontario  
P5A 2K2  
**Contact:** Peter Townsend  
Tel.: (705) 461-6200  
Activity: Bioleaching-uranium ore

**Dextran Products Ltd.**

415-421 Comstock Road  
Scarborough, Ontario  
M1L 2H5  
**Contact:** George Usher  
Tel.: (416) 755-2231  
Activity: Veterinary pharmaceuticals, Tissue culture products HPLC columns

**Diagnostic Chemicals Ltd.**

16 First Street  
West Royalty Industrial Park  
Charlottetown, Prince Edward Island  
C1E 1B0  
**Contact:** Dr. Regis Duffy  
Tel.: (902) 566-1396  
Activity: Manufacture specialty chemicals enzymes and diagnostic kits

**Diversified Research Laboratories Ltd (George Weston Ltd)**

1047 Yonge Street  
Toronto, Ontario  
M4W 2L2  
**Contact:** Dr. Ross Lawford  
Tel.: (416) 922-5100  
Activity: Contract research, Pilot scale fermentations

**Dominion Biologicals Ltd**

179 Esplanade  
Truro, Nova Scotia  
B2N 5G9  
**Contact:** Sam Brushett  
Tel.: (902) 895-2846  
Activity: Health - human diagnostics

**Domtar Inc.**

Case Postale 300  
Sennerville (Québec)  
H9X 3L7  
**Contact:** Dr. S. Danyluk  
Tel.: (514) 457-6810  
Activity: Specialty chemicals, waste treatment

**Du Pont Canada Ltd.**

Box 2300 Streetsville  
Mississauga, Ontario  
L5M 2H3  
**Contact:** P. Hamilton  
Tel.: (416) 821-3300  
Activity: Fund R&D at universities

**ELANCO (Eli Lilly Canada Inc.)**

3650 Danforth Avenue  
Scarborough, Ontario  
M1N 2E8  
**Contact:** Dr. Gerry McManus  
Tel.: (519) 681-5291  
Activity: Manufacture animal health care products

**Elite Seed Potato Farm**

R.R. 1  
Alberton, P.E.I.  
C0B 1B0  
**Contact:** Alan Parker  
Tel.: (902) 853-2619  
Activity: Plant tissue culture

**Endogro Systems Inc.**

67 Eaglewood Drive  
Bedford, Nova Scotia  
B4A 3B3  
**Contact:** Sean Morrison  
Tel.: (902) 835-9125  
Activity: Mycorrhizal fungi

**Encor Inc**

156 Duncan Mill Road  
Don Mills, Ontario  
M3B 3N2  
**Contact:** Dr. Samuel Asculai  
Tel.: (416) 449-3535  
Activity: Pesticides, Human health care

**Envirocon Pacific Ltd.**

205 - 2250 Boundary Road  
Burnaby, British Columbia  
V5M 3Z3  
**Contact:** Ross Murray  
Tel.: (604) 291-0292  
Activity: Commercial smelt production, environmental resource consultants

**Enviromine Inc.**

24, rue Viger  
Beauport (Québec)  
G1B 1L4  
**Contact:** André Paquet  
Tel.: (418) 666-9430  
Activity: Biodegradation of cyanides, Reclamation of mining sites

**Equipement Moniteur Inc.**

445, boul. Industriel  
Ste-Eustache (Québec)  
J7R 5R3  
**Contact:** Ervin Mak  
Tel.: (514) 472-6620  
Activity: Distribution of diagnostics, Manufacture blood serum analysers

**ESSA - Environmental and Social**

**Systems Analysts Ltd.**  
705 - 808 Nelson Street  
Vancouver, British Columbia  
V6Z 2H2  
**Contact:** David Marmorek  
Tel.: (604) 689-2912  
Activity: Environmental consultants

**Export Packers Co. Ltd.**

70 Irene Street  
Scarborough, Ontario  
M1N 2E8  
**Contact:** Leslie Carvalho  
Tel.: (204) 477-1830  
Activity: Egg processing, Biochemical manufacturing

**Falconbridge Ltd**

Falconbridge, Ontario  
POM 1S0  
**Contact:** P. Michelutti  
Tel.: (705) 693-2761  
Activity: Mining waste management

**Fermtech R&D Inc.**

2383 Edenhurst Drive  
Mississauga, Ontario  
L5A 2L1  
**Contact:** Dr. Hugh Lawford  
Tel.: (416) 978-7096  
Activity: Microbial inoculants, Fermentation technology

**FMG Integrated Biotechnical Labs Ltd.**

214 - 7080 River Road  
Richmond, British Columbia  
V6X 1X5  
**Contact:** Dr. S. Goh  
Tel.: (604) 273-7157  
Activity: Diagnostics, Aquaculture

**F.V.M.P.C.A. Dairyland Food**

6800 Lougheed Highway  
Burnaby, British Columbia  
V5A 1W2  
**Contact:** R. Irwin  
Tel.: (604) 420-6611  
Activity: Dairy processing

**Forintek Canada Corp**

6620 N.W. Marine Drive  
Vancouver, British Columbia  
V6T 1X6  
**Contact:** Dr. J. Dangerfield  
Tel.: (604) 224-3221  
Activity: Wood products, Biomass conversion, Biocontrol of decay

**Frank Maine Consulting Ltd.**

71 Sherwood Drive  
Guelph, Ontario  
N1E 6E6  
**Contact:** Dr. F. Maine  
Tel.: (519) 823-1465  
Activity: Consulting

**Frappier Diagnostic Inc.**

527, boulevard des Prairies  
Laval (Québec)  
H7N 4Z9  
**Contact:** Dr. Claude Vezina  
Tel.: (514) 687-5010  
Activity: Diagnostics-monoclonals

**Gelda Scientific & Industrial Development Inc.**

5266 General Road, Suite 8  
Mississauga, Ontario  
L4W 1Z7  
**Contact:** Dr. S. Gelda  
Tel.: (416) 624-2779  
Activity: Technology development, food

**Gemini Biochemical Research Ltd.**

#350-4526 16th Avenue N.W.  
Calgary, Alberta  
T3B 0M6  
**Contact:** Dr. Ian Forrester  
Tel.: (403) 288-7771  
Activity: Contract research

**Gendron Lefebvre**

2, place Laval  
Laval (Québec)  
H7N 5N6  
**Contact:** Michèle Prévost  
Tel.: (514) 384-1260  
Activity: Waste water management

**Giant Bay Resources Ltd**

#107F, Discovery Park  
3700 Gilmore Way  
Burnaby, British Columbia  
V5G 4M1  
**Contact:** Ralph Hackl  
Tel.: (603) 434-6344  
Activity: Mineral leaching

**Gore & Storrie Ltd.**

1670 Bayview Avenue  
Toronto, Ontario  
M4G 3C2  
**Contact:** John Stephenson  
Tel.: (416) 485-7715  
Activity: Waste water management

**Griffiths Laboratories Ltd.**

(see The Griffiths Laboratories Ltd.)

**Groupe SNC Inc.**

(see Le groupe SNC Inc.)

**Hara Products Ltd.**  
P.O. Box 134  
Swift Current, Saskatchewan  
S9H 3V5  
**Contact:** Tony Juffinger  
Tel.: (306) 773-2131  
Activity: Insect traps for  
pheromone bait

**Helix Biotech Ltd.**  
215-7080 River Road  
Richmond, British Columbia  
V6X 1X5  
**Contact:** Dr. Terrance Owen  
Tel.: (604) 270-7468  
Activity: Diagnostics

**HSC Research Development Corp**  
89 Elm Street  
Toronto, Ontario  
M5G 1X8  
**Contact:** Dr. Sandy Lowden  
Tel.: (416) 598-5982  
Activity: Technology transfer  
contract research

**Hybrisens Ltd.**  
4700 Keele Street  
York University Campus  
Farquharson Building, Suite  
104  
Toronto, Ontario  
M3J 1P3  
**Contact:** Dr. Ezekiel Shami  
Tel.: (416) 736-5504  
Activity: Contract research -  
monoclonals

**Hypercube Inc.**  
16 Blenheim Road  
Cambridge, Ontario  
N1S 1E6  
**Contact:** John Unsworth  
Tel.: (519) 622-0260  
Activity: Molecular modelling

**IAF Biochem Inc.**  
531, boulevard des Prairies  
Ville de Laval (Québec)  
H7N 4Z3  
**Contact:** Dr. F. Bellini  
Tel.: (514) 687-5010  
Activity: Diagnostics & health  
care products

**Inrad Industrial Research  
and Development Ltd.**  
128 Adelaide Street  
Winnipeg, Manitoba  
R3A 0W5  
**Contact:** Edward Speers  
Tel.: (204) 943-6870  
Activity: Plant/tree strain  
improvement

**Institut Rosell Inc.**  
8480, boulevard Saint-Laurent  
Montréal (Québec)  
H2P 2M6  
**Contact:** Édouard Brochu  
Tel.: (514) 381-5631  
Activity: Production of  
microorganisms

**Institute for Chemical Sci-  
ence and Technology (ICST)**  
P.O. Box 2712  
Sarnia, Ontario  
N7T 7V9  
**Contact:** W. Stadelman  
Tel.: (416) 425-4126  
Activity: Support petrochemi-  
cal research

**IOGEN Corporation**  
400 Hunt Club Road  
Ottawa, Ontario  
K1G 3N3  
**Contact:** Brian Foody  
Tel.: (613) 733-9830  
Activity: Biomass conversion

**Ionizing Energy Company of  
Canada**  
P.O. Box 393, Station "A"  
Fredericton, New Brunswick  
E3B 4Z9  
**Contact:** Graeme Ross  
Tel.: (506) 458-8840  
Activity: Specialized  
technology in irradiation

**John Meunier Inc.**  
6290, Pétrinault  
Montréal (Québec)  
H4K 1K5  
**Contact:** Gabriel Meunier  
Tel.: (514) 334-7230  
Activity: Manufacture of water  
treatment systems

**Joldon Diagnostics**  
81 Finchdene Square  
Scarborough, Ontario  
M1X 1B4  
**Contact:** Dr. D. Segal  
Tel.: (416) 292-1699  
Activity: Manufacture and sale  
of diagnostic kits

**Joseph E. Seagram & Sons  
Ltd.**  
225, avenue Lafleur  
Ville LaSalle (Québec)  
H3A 1S9  
**Contact:** A. Peterson  
Tel.: (514) 366-2410  
Activity: Alcohol fermentation

**Kemic Bioresearch Labora-  
tories Ltd.**  
70 Exhibition Street  
P.O. Box 878  
Kentville, Nova Scotia  
B4N 4H8  
**Contact:** Dr. Peter Mullen  
Tel.: (902) 678-8195  
Activity: Contract research -  
pharmacokinetics, toxicology.  
Conference organization &  
training courses

**King Agro**  
P.O. Box 1088  
Chatham, Ontario  
N7M 5L6  
**Contact:** Frank Scott-Pearse  
Tel.: (519) 354-3210  
Activity: Seed production and  
sale

**Koppernaes Engineering  
Ltd.**  
1248 Bedford Highway  
Bedford, Nova Scotia  
B4A 1W4  
**Contact:** Peter Mitchell  
Tel.: (902) 835-8348  
Activity: Plant design, waste  
treatment

**Labatt Brewing Company  
Ltd.**  
150 Simcoe Street  
London, Ontario  
N6A 4M3  
**Contact:** Dr. Graham Stewart  
Tel.: (519) 663-5050  
Activity: Manufacture of malt-  
based beverages

**Lalla & Associates**  
6 Hawthorne Terrace  
Fredericton, New Brunswick  
E3B 2S5  
**Contact:** Satnarine Lalla  
Tel.: (506) 454-3259  
Activity: Consultant - food and  
chemical

**Lallemand Inc.**  
1620, rue Préfontaine  
Montréal (Québec)  
H1W 2N8  
**Contact:** Richard Degré  
Tel.: (514) 522-2133  
Activity: Production of yeasts.  
Fermentation and downstream  
processing

**Lane, P. and Associates Ltd.**  
(see P. Lane and Associates  
Ltd.)

**Langford Inc.**  
400 Michener Road  
Guelph, Ontario  
N1K 1E4  
**Contact:** Dr. R.C. Povey  
Tel.: (519) 837-2040  
Activity: Animal health  
products

**Lassonde, A. & Fils Inc.**  
(see A. Lassonde & Fils Inc.)

**Le groupe SNC Inc.**  
2, place Felix Martin  
Montréal (Québec)  
H2Z 1Z3  
**Contact:** Jacques Martel  
Tel.: (514) 866-1000  
Activity: Process engineering

**Les Aliments Carrière Inc.**  
540, chemin des Patriotes  
St-Denis sur Richelieu  
(Québec)  
J0H 1K0  
**Contact:** Michael Casgrain  
Tel.: (514) 584-2235  
Activity: Extraction of additives  
from wastes. Lactic fermenta-  
tion of vegetables

**Les Clay and Son Ltd.**  
3666 - 224 Street  
Langley, British Columbia  
V3A 4R3  
**Contact:** Les Clay  
Tel.: (604) 530-5188  
Activity: Plant tissue culture

**MacMillan Bloedel Ltd.**  
1075 West Georgia Street  
Vancouver, British Columbia  
V6E 3R9  
**Contact:** Dr. O. Forgacs  
Tel.: (604) 661-8000  
Activity: Silviculture. Anaero-  
bic digestion

**Mann Testing Laboratories  
Ltd.**  
5550 McAdam Road  
Mississauga, Ontario  
L4Z 1P1  
**Contact:** John Martin  
Tel.: (416) 890-2555  
Activity: Analytical testing,  
immunoassay-based technol-  
ogy



**Marbicon Biological Consultants**

P.O. Box 900  
Berwick, Nova Scotia  
B0P 1E0  
**Contact:** Jim Jotcham  
Tel.: (902) 538-7101  
Activity: Pesticide screening  
plant tissue culture

**McLeay, D. & Associates Ltd.**  
(see D. McLeay & Associates Ltd.)

**MDS Health Group Ltd.**  
100 International Boulevard  
Etobicoke, Ontario  
M9W 6J6  
**Contact:** Dr. John Nixon  
Tel.: (416) 675-7661  
Activity: Medical and  
diagnostic services

**Medicorp Inc.**  
6100, rue Royalmount  
Montréal (Québec)  
H4P 2R2  
**Contact:** Dr. Elliott Block  
Tel.: (514) 496-1922  
Activity: Human health care

**Merck Frosst**  
16711 Trans Canada Hwy.  
Kirkland, Quebec  
H9H 3L1  
**Contact:** Dr. S. Goldstein  
Tel.: (514) 695-7920  
Activity: Pharmaceuticals

**Microbe Inc.**  
85 Midpark Road  
London, Ontario  
N6N 1B2  
**Contact:** Dr. J. Insell  
Tel.: (519) 668-1005  
Activity: Waste water treatment, Microbial degradation

**Microbix Biosystems Inc.**  
341 Bering Avenue  
Toronto, Ontario  
M8Z 3A8  
**Contact:** William Gastle  
Tel.: (416) 425-5959  
Activity: Manufacture of  
diagnostic kits

**Microtek Research and Development Ltd**  
P.O. Box 2460  
101-9865 West Saanich Road  
Sidney, British Columbia  
V8L 3Y3  
**Contact:** Dr. Stephen Newman  
Tel.: (604) 655-1455  
Activity: Aquaculture -  
vaccines, diagnostics

**Molson Breweries of Canada Ltd.**

3300 Bloor Street West  
Suite 3500  
Toronto, Ontario  
M8X 2X7  
**Contact:** Dr. David Hysert  
Tel.: (416) 232-1786  
Activity: Brewing, genetic  
engineering of yeasts

**Monsanto Canada Inc.**  
Business Development  
P.O. Box 787 (Streetsville)  
Mississauga, Ontario  
L5M 2G4  
**Contact:** Jack Wearing  
Tel.: (416) 826-9222  
Activity: Manufacture of  
agricultural and industrial  
chemicals

**Mycotech**  
142 Whitchurch Mews  
Mississauga, Ontario  
L5A 4B3  
**Contact:** Dr. Mujeeb Zoberi  
Tel.: (416) 279-4154  
Activity: Contract research,  
biodegradation, biomonitoring  
and bioengineering

**Nelson's Dairy**  
180 Ormont Drive, Weston  
City of North York, Ontario  
M9L 1N7  
**Contact:** Arvind Gelda  
Tel.: (416) 742-6811  
Activity: Immobilization of  
lactase enzymes

**New Age Devices**  
P.O. Box 1809  
740 Baker Crescent  
Kingston, Ontario  
K7M 6P6  
**Contact:** Michael Bye  
Tel.: (613) 384-1753  
Activity: Automation of  
research equipment

**Noranda Research Centre**  
240, boulevard Hymus  
Pointe Claire (Québec)  
H9R 1G5  
**Contact:** George Kubanek  
Tel.: (514) 697-6640  
Activity: Contract-out research,  
Mineral leaching, hazardous  
waste treatment - pulp technology  
**Nova Chem Ltd**  
P.O. Box 1030, Armdale  
Halifax, Nova Scotia  
B3L 4K9  
**Contact:** Dr. D. Davies  
Tel.: (902) 455-4690  
Activity: Contract research  
chitosan and derivatives

**Nova Husky Research Corporation Ltd.**

2928 - 16 Street North East  
Calgary, Alberta  
T2E 7K7  
**Contact:** Dr. Mike Francis  
Tel.: (403) 250-4700  
Activity: Petroleum microbiology  
waste treatment

**Novo Laboratories Ltd.**  
1755 Steeles Avenue West  
Willowdale, Ontario  
M2R 3T4  
**Contact:** Dr. John Clement  
Tel.: (416) 663-6686  
Activity: Manufacture of  
insulin pharmaceuticals

**Ortho Pharmaceutical Canada Ltd**  
19 Greenbelt Drive  
Don Mills, Ontario  
M3C 1L9  
**Contact:** Dr. Laurence Russ  
Tel.: (416) 449-9444  
Activity: Human pharmaceuticals  
and medical devices

**P. Lane and Associates Ltd.**  
1046 Barrington Street  
Halifax, Nova Scotia  
B3H 2R1  
**Contact:** Dr. P. Lane  
Tel.: (902) 423-8197  
Activity: Waste water treatment,  
Aquaculture: shellfish  
and fin fish

**Pacific Pharmaceuticals Ltd.**  
1176 West Georgia Street  
Suite 1130  
Vancouver, British Columbia  
V6E 4A2  
**Contact:** Michael Warren  
Tel.: (604) 683-8566  
Activity: Cancer therapeutics

**Paques Lavalin**  
2235 Sheppard Avenue East  
Willowdale, Ontario  
M2J 5A6  
**Contact:** Derk Matt  
Tel.: (416) 756-9687  
Activity: Industrial waste water  
treatment

**Paladin Hybrids Inc.**  
210 Wanless Drive  
Brampton, Ontario  
L6V 2L2  
**Contact:** Gabe Eros  
Tel.: (416) 846-3983  
Activity: Hybrid canola cultivar  
development

**Palliser Animal Health Laboratories Ltd.**

P.O. Box 1327  
(2825-12th Avenue N)  
Lethbridge, Alberta  
T1J 5K1  
**Contact:** Dr. J. Bradley  
Tel.: (403) 328-1844  
Activity: Diagnostics - Animal  
health

**Paracel Laboratories Ltd.**  
8-17 Grenfell Crescent  
Nepean, Ontario  
K2G 0G3  
**Contact:** Dr. W. Craig  
Tel.: (613) 225-2447  
Activity: Diagnostics. Indoor  
air monitoring

**Pegasus Industrial Specialties Ltd**  
4490 Sheppard Avenue East  
Agincourt, Ontario  
M1S 4J9  
**Contact:** Neal Trent  
Tel.: (416) 298-3141  
Activity: Supply & design  
fermentation systems

**Pharmacia (Canada) Inc.**  
500, boulevard Morgan  
Baie d'Urfe, PQ  
H9X 3V1  
**Contact:** Michel Geadah  
Tel.: (514) 457-6661  
Activity: Supplier to industry

**Phero-Tech Ltd**  
1140 Clark Drive  
Vancouver, British Columbia  
V5L 3K3  
**Contact:** Dr. Steve Burke  
Tel.: (604) 225-7381  
Activity: Insect pest management

**Philom Bios Inc.**  
15 Innovation Boulevard  
Saskatoon, Saskatchewan  
S7N 2X8  
**Contact:** Dr. John Cross  
Tel.: (306) 665-6211  
Activity: Manufacture bioherbicides,  
biofertilizers and biofungicides

**Pisciculture des Alleghanys Inc.**  
2755, chemin Grande Ligne  
Saint-Philemon  
Comté de Bellechasse  
(Québec)  
G0R 4A0  
**Contact:** Yves Boulanger  
Tel.: (418) 469-2823  
Activity: Production of salmonidae

**Pollutech Ltd**  
768 Westgate Road  
Oakville, Ontario  
L6L 5N2  
**Contact:** Richard Laughton  
Tel.: (416) 847-0065  
Activity: Environmental consultants, waste treatment

**POS Pilot Plant Corp**  
118 Veterinary Road  
Saskatoon, Saskatchewan  
S7N 2R4  
**Contact:** Roy A. Carr  
Tel.: (306) 975-7066  
Activity: Contract pilot plant facility. Analytical Services, test marketing

**Precision Biologicals Inc**  
11 Pettipas Drive, Unit 2  
Dartmouth, Nova Scotia  
B3B 1K1  
**Contact:** Tony Bebbington  
Tel.: (902) 463-0119  
Activity: Manufacture clinical diagnostic products

**Premier Peat Moss Ltd.**  
Case postale 2600  
Chemin Témiscouata  
Rivière-du-Loup (Québec)  
G5R 4C9  
**Contact:** Dr. Michel Caron  
Tel.: (418) 862-6356  
Activity: Manufacture of peat moss based products

**Probtac Corp**  
Room 236, Farquharson Building  
4700 Keele Street  
North York, Ontario  
M3J 1P3  
**Contact:** Dr. Barry Glickman  
Tel.: (416) 736-5390  
Activity: Diagnostic - health care

**Proplant Garden Products Ltd.**  
2552 Burns Road  
Port Coquitlam, British Columbia  
V3C 3V4  
**Contact:** Dr. R. Polonenko  
Tel.: (604) 942-5756  
Activity: Plant tissue culture

**Pulp & Paper Research Institute Canada (PAPRICAN)**  
570 boulevard St. John  
Pointe Claire (Québec)  
H9R 3J9  
**Contact:** Dr. Lubo Jurasek  
Tel.: (514) 630-4100  
Activity: Pulp and paper biotechnology

**Purdal Coopérative Agro-alimentaire**  
155, rue St-Jean-Baptiste  
Rimouski (Québec)  
G0L 1B0  
**Contact:** Alexandre Blais  
Tel.: (518) 736-4363  
Activity: Dairy and fishery products

**QA Laboratories Ltd**  
135 The West Mall  
Unit 2  
Etobicoke, Ontario  
M9C 1C2  
**Contact:** Michael Entis  
Tel.: (416) 622-6705  
Activity: Diagnostics - food and pharmaceutical

**Quadra Logic Technologies Inc.**  
520 West 6th Avenue  
Vancouver, British Columbia  
V5Z 4H5  
**Contact:** Ronald Mackenzie  
Tel.: (604) 872-7881  
Activity: Diagnostics and therapeutics

**Quality Seafarms Ltd.**  
P.O. Box 68  
Campbell River, British Columbia  
V9W 4Z9  
**Contact:** Keith Ware  
Tel.: (604) 286-3023  
Activity: Salmonid hatchery technology

**Raylo Chemicals**  
8045 Argyll Road  
Edmonton, Alberta  
T6C 4A9  
**Contact:** J. Colomb  
Tel.: (403) 468-6060  
Activity: Manufacture of specialty chemicals

**Reclomine Inc.**  
2095 ouest, boulevard Charest  
Suite 220  
Ste-Foy (Québec)  
G1N 4L8  
**Contact:** Dr. Roger Guay  
Tel.: (418) 687-5795  
Activity: Mineral leaching

**Rhizogen Corp.**  
Bay 5, 116-103 Street East  
Saskatoon, Saskatchewan  
S7N 1Y7  
**Contact:** Dr. J. Stephens  
Tel.: (306) 373-3060  
Activity: Nitrogen fixation

**Rhizotech Inc. (Les Laboratoires)**  
Case postale 797  
St-Jean - Chrysostome (Québec)  
G6Z 2L9  
**Contact:** Dr. Maurice Lalonde  
Tel.: (418) 839-5931  
Activity: Biofertilizers, biopesticides

**Rio Algom Ltd**  
P.O. Box 1500  
Elliott Lake, Ontario  
P5A 2K1  
**Contact:** Biman Bihari  
Tel.: (705) 461-4455  
Activity: Mineral leaching - uranium

**Royal Pacific Sea Farms Ltd**  
1407 - 700 W. Pender Street  
Vancouver, British Columbia  
V6C 1G8  
**Contact:** George Hunter  
Tel.: (604) 685-8340  
Activity: Production of salmon and trout

**Rutland Biotech Ltd**  
3220 Park Place  
666 Burrard Street  
Vancouver, British Columbia  
V6C 2X8  
**Contact:** William Gilles  
Tel.: (604) 669-9515  
Activity: Oral health care. Occupational health products

**Safer Ltd.**  
465 Milner Avenue, Unit #1  
Scarborough, Ontario  
M1B 2K4  
**Contact:** Paul Goodspeed  
Tel.: (416) 291-8150  
Activity: Pest controls, plant care products

**Sanexen International (Groupe Sanivan)**  
7777 boul. Louis-Hippolyte  
Lafontaine  
Anjou (Québec)  
H1K 4E4  
**Contact:** Diana Mourato  
Tel.: (514) 355-3351  
Activity: Wastewater treatment

**SCI CAN Diagnostics**  
14601 - 134 Avenue  
Edmonton, Alberta  
T5L 4S9  
**Contact:** Garth Likes  
Tel.: (403) 455-6079  
Activity: Immunological-based products

**Seagram, Joseph E. & Sons Ltd.** (see Joseph E. Seagram & Sons Ltd.)

**Seasprings Farms Ltd.**  
38 Water Street  
P.O. Box 2377  
Charlottetown, P.E.I.  
C1A 8C1  
**Contact:** O. Dyrkton  
Tel.: (902) 566-1145  
Activity: Intensive density fish farming

**Semico Inc.**  
4905, boulevard Laurier  
Ste-Rosalie (Québec)  
J0H 1X0  
**Contact:** René Cloutier  
Tel.: (514) 799-3225  
Activity: Plant breeding

**Serdary Research Laboratories Inc.**  
P.O. Box 5036  
1643 Kathryn Drive  
London, Ontario  
N6G 2R7  
**Contact:** Mark Olbrychski  
Tel.: (519) 434-4419  
Activity: Biochemicals for medical research

**Shaver Poultry Breeding Farms Ltd.**  
Box 400  
Cambridge, Ontario  
N1R 5V9  
**Contact:** Dr. R. Gowe  
Tel.: (519) 621-5191  
Activity: Animal breeding

**Specialty Marine Products Ltd.**  
1814 Maritime Mews  
Granville Island  
Vancouver, British Columbia  
V6H 3X2  
**Contact:** D. Saxby  
Tel.: (604) 685-5499  
Activity: Aquaculture. Extraction of chemicals from ocean

**SPI Synthetic Peptides Inc.**  
University of Alberta  
Department of Biochemistry,  
Room 355  
Medical Sciences Building  
Edmonton, Alberta  
T6G 2H7  
**Contact:** Dr. Robert Hodges  
Tel.: (403) 432-3155  
Activity: Diagnostics, pharmaceuticals

**St. Lawrence Reactors Ltd.**  
50 Elmwood Avenue South  
Mississauga, Ontario  
L5G 3J7  
**Contact:** P. Campbell  
Tel.: (416) 271-1100  
Activity: Starch conversion

**Stake Technology Ltd**  
2838 Highway #7  
Norval, Ontario  
L0P 1K0  
**Contact:** John Taylor  
Tel.: (416) 842-4560  
Activity: Biomass conversion

**Sylvan Industries Ltd.**  
28355 Fraser Highway  
Aldergrove, British Columbia  
VOX 1A0  
**Contact:** Neil MacDonald  
Tel.: (604) 533-4444  
Activity: Specialty mushroom farm

**Syndel Laboratories Ltd.**  
8879 Selkirk Street  
Vancouver, British Columbia  
V6P 4J6  
**Contact:** J. Little  
Tel.: (604) 266-7131  
Activity: Manufacture fish pharmaceuticals, diagnostics

**Synphar Labs. Inc. and Talho Alberta Ltd.**  
#24, 4290-91A Street  
Edmonton, Alberta  
T6E 5V2  
**Contact:** Dr. R. Micetich  
Tel.: (403) 462-4044  
Activity: Pharmaceuticals

**Syntex Inc.**  
2100 Syntex Court  
Mississauga, Ontario  
L5N 3X4  
**Contact:** Ginette Leclair  
Tel.: (416) 821-4000  
Activity: Pharmaceuticals

**TCI Superior**  
6500 Northwest Drive  
Mississauga, Ontario  
L4V 1K4  
**Contact:** Brian Smith  
Tel.: (416) 677-9000  
Activity: Bioreactors

**Technical Marketing Associates Ltd**  
6695 Millcreek Road, Unit 1  
Mississauga, Ontario  
L5N 5M5  
**Contact:** Pamela Cadman  
Tel.: (416) 826-7752  
Activity: Marketing scientific instrumentation

**Temfibre Inc.**  
P.O. Box 3000  
Témiscamingue (Québec)  
J0Z 3R0  
**Contact:** F. Dottori  
Tel.: (819) 627-9505  
Activity: Lignosulfonates, fermentation of spent sulfite liquor

**Terra Nova Fishery Co. Ltd**  
38 Bay Bulls Road  
St. John's, NFLD  
A1G 1A5  
**Contact:** Dr. Cosmas Ho  
Tel.: (709) 364-7371  
Activity: Aquaculture, recover by-products

**The Canadian Liposome Co. Ltd.**  
308-267 West Esplanade  
North Vancouver, British Columbia  
V7M 1A5  
**Contact:** Edward Mertz  
Tel.: (604) 988-5400  
Activity: Pharmaceuticals, Liposomes

**The Griffith Laboratories Ltd.**  
757 Pharmacy Avenue  
Scarborough, Ontario  
M1L 3J8  
**Contact:** Dr. John Holme  
Tel.: (416) 288-3330  
Activity: Manufacturing food products

**Thermo Tech Waste Systems Inc.**  
203, 1120 Austin Avenue  
Coquitlam, British Columbia  
V3K 3P5  
**Contact:** René Braconnier  
Tel.: (604) 937-3022  
Activity: Thermophilic processing of biodegradable materials

**Tyler Research Instruments Corp**  
6128 - 103rd Street  
Edmonton, Alberta  
T6H 2H8  
**Contact:** Dr. J. Tyler  
Tel.: (403) 435-7041  
Activity: Equipment design

**United Grain Growers**  
Box 6600  
Winnipeg, Manitoba  
R3C 3A7  
**Contact:** Gerry Moore  
Tel.: (204) 944-5554  
Activity: Hybrid spring canola

**Vancouver Island Antibodies Ltd.**  
265 Caldecote Road  
Victoria, British Columbia  
V8X 3X3  
**Contact:** Dr. T. Pearson  
Tel.: (604) 479-8671  
Activity: Development of immunodiagnostic reagents

**Vetrepharm Inc.**  
27-69 Bessemer Road  
London, Ontario  
N6E 2V6  
**Contact:** Dr. Stan Alkemade  
Tel.: (519) 685-5800  
Activity: Veterinary pharmaceuticals

**VIDO, Veterinary Infectious Disease Organization**  
124 Veterinary Road  
Saskatoon, Saskatchewan  
S7N 0W0  
**Contact:** Dr. Steve Acres  
Tel.: (306) 966-7465  
Activity: Animal health care products

**Vioclone Biologicals Inc.**  
30 Pemican Court  
Weston, Ontario  
M9M 2Z3  
**Contact:** Mark Perri  
Tel.: (416) 742-4171  
Activity: Diagnostics - health care

**W.G. Thompson & Sons Ltd.**  
P.O. Box 250  
122 George Street  
Blenheim, Ontario  
N0P 1A0  
**Contact:** D. Littlejohns  
Tel.: (519) 676-5411  
Activity: Plant breeding

**W.H.E. Bio-Systems**  
100 Klondike Drive  
Weston, Ontario  
M9L 1X3  
**Contact:** Dan Lynch  
Tel.: (416) 744-4155  
Activity: Fermentor and control design

**Waitaki International Biosciences**  
55 Glen Scarlett Road  
Toronto, Ontario  
M6N 1P5  
**Contact:** Elliott Young  
Tel.: (416) 761-4089  
Activity: Growth factors

**Wardrop Engineering Inc.**  
77 Main Street  
Winnipeg, Manitoba  
R3C 3H1  
**Contact:** Dr. Hadi Husain  
Tel.: (204) 956-0980  
Activity: Process engineering

**Westech Agriculture Ltd.**  
West Prince Industry Centre  
R.R. 1  
Alberton, P.E.I.  
C0B 1B0  
**Contact:** Richard Ozon  
Tel.: (902) 853-3636  
Activity: Plant tissue culture

**Western Biologicals Ltd.**  
P.O. Box 46466, Station "G"  
Vancouver, British Columbia  
V6R 4G7  
**Contact:** William Chalmers  
Tel.: (604) 228-0986  
Activity: Plant tissue culture

**Winnipeg Rh Institute Inc.**  
University of Manitoba  
Winnipeg, Manitoba  
R3T 2N2  
**Contact:** Dr. Albert Friesen  
Tel.: (204) 269-7291  
Activity: Manufacture of plasma products

**Xymotech Bio Systems**  
5250, rue Ferrier Suite 508  
Montréal (Québec)  
H4P 1L6  
**Contact:** Charles Salama  
Tel.: (514) 738-3377  
Activity: Fermentation equipment

**Zeton Inc.**  
4129 Harvester Road  
Burlington, Ontario  
L7L 5M3  
**Contact:** David Beckman  
Tel.: (416) 632-3123  
Activity: Design and manufacture of process development units

Each company is listed alphabetically under the appropriate province according to the location of its head office. This list contains only those companies listed in Appendix II: Directory of Biotech Firms.

#### British Columbia

Advanced Biotechnology Ltd.  
Agriforest Technologies Ltd.  
Applied Bionomics Ltd.  
B. C. Research Corporation  
Balco Canfor Reforestation Centre Ltd.  
Brookside Farms Ltd.  
Canber Industries Ltd.  
CBM Bioventures  
Coastech Research Inc.  
D. McLeay and Associates Ltd.  
Envirocon Pacific Ltd.  
Environmental & Social Systems Analysts Ltd.  
FMG Integrated Biotechnical Laboratories Ltd.  
F. V. M. P. C. A. Dairyland Foods  
Forintek Canada Corp.  
Giant Bay Biotech Ltd.  
Helix Biotech Ltd.  
Les Clay and Son Ltd.  
MacMillan Bloedel Ltd.  
Microtek Research and Development Ltd.  
Pacific Pharmaceuticals Ltd.  
Phero Tech Inc.  
Proplant Garden Products Ltd.  
Quadra Logic Technologies Inc.  
Quality Seafarms Ltd.  
Royal Pacific Sea Farms Ltd.  
Rutland Biotech Ltd.  
Specialty Marine Products Ltd.  
Sylvan Industries Ltd.  
Syndel Laboratories Ltd.  
The Canadian Liposome Co. Ltd.  
Thermo Tech Waste Systems Inc.  
Vancouver Island Antibodies Ltd.  
Western Biologicals Ltd.

#### Alberta

Alta Genetics Inc.  
Biomira Inc.  
BioTechnica Canada Inc.  
CHEMBIOMED Ltd.  
Gemini Biochemical Research Ltd.  
Nova Husky Research Corporation Ltd.  
Palliser Animal Health Laboratories Ltd.  
Raylo Chemicals  
SCI CAN Diagnostics  
SPI Synthetic Peptides Inc.  
Synphar Lab Inc.  
Tyler Research Instruments Corp.

#### Saskatchewan

B2 Enterprises Ltd.  
Biostar Inc.  
Hara Products Ltd.

## Appendix III: Listing of Canadian Biotechnology Firms by Province

Philom Bios Inc.  
POS Pilot Plant Corp.  
Rhizogen Corp.  
Veterinary Infectious Disease Organization (VIDO)

#### Manitoba

ABI Biotechnology Inc.  
Bioquest International Inc.  
Chemfet Canada Ltd.  
CSP Foods Ltd.  
Export Packers Ltd.  
Inrad Industrial R&D Ltd.  
United Grain Growers  
Wardrop Engineering Inc.  
Winnipeg Rh Institute Inc.

#### Ontario

AB Biological Supplies Inc.  
Allelix Crop Technologies  
Allelix Biopharmaceuticals  
ADI Diagnostics Inc.  
APO Diagnostics Inc.  
Beak Consultants Ltd.  
Better Yield Insects  
Biofield Technologies Research  
BioHol Developments  
Bioprotein Canada Inc.  
Biosystech Consulting Inc.  
Bocknek Ltd.  
Boojum Research Ltd.  
C-I-L Inc.  
Canadian Bioclinical  
Canadian Red Cross (BTS)  
Canadian Seed Coaters Ltd.  
Cangene Corp.  
Canpolar Inc.  
Canpro Laboratories  
Canviro Consultants  
Casco Inc.  
Cedarlane Laboratories Ltd.  
Champlain Industries Ltd.  
Chateau des Charmes Wines  
Ciba-Geigy Ltd.  
Connaught Laboratories Ltd.  
Coolwater Farms Ltd.  
Cyanamid Canada Inc.  
Cyberfluor Inc.  
Dearborn Environmental Consulting Group  
Denison Mines Ltd.  
Dextran Products Ltd.  
Diversifield Research Laboratories Ltd.  
Du Pont Canada Inc.  
ELANCO (Eli Lilly Canada)  
Encor Inc.  
Falconbridge Ltd.  
Fermtech R&D Inc.  
Frank Maine Consulting Ltd.  
Gelda Scientific and Industrial Development Corp.  
Gore & Storrie Ltd.  
HSC Research Development Corp.  
Hybrisens Ltd.  
Hypercube Inc.  
Institute for Chemical Science and Technology (ICST)

Iogen Corp.  
Joldon Diagnostics  
King Agro  
Labatt Brewing Company Ltd.  
Langford Inc.  
Mann Testing Laboratories Ltd.  
MDS Health Group Ltd.  
Microbe Inc.  
Microbix Biosystems Inc.  
Molsons Breweries of Canada Ltd.  
Monsanto Canada Inc.  
Mycotech  
Nelson's Dairy  
New Age Devices  
Novo Laboratories Ltd.  
Ortho Pharmaceutical Canada Ltd.  
Paladin Hybrids Inc.  
Paques Lavalin  
Paracel Laboratories Ltd.  
Pegasus Industrial Specialties Ltd.  
Pollutech Ltd.  
Protech Corp.  
QA Laboratories Ltd.  
Rio Algom Ltd.  
Safer Ltd.  
Serdary Research Laboratories Inc.  
Shaver Poultry Breeding Farms Ltd.  
St. Lawrence Reactors Ltd.  
Stake Technology Ltd.  
Syntex Inc.  
TCI-Superior  
Technical Marketing Associates Ltd.  
The Griffith Laboratories Ltd.  
Vetrepharm Inc.  
Vioclone Biologicals Inc.  
W. G. Thompson & Sons Ltd.  
W. H. E. Bio-Systems  
Waitaki International Biosciences  
Zeton Inc.

Prince Edward Island  
Aqua Health Ltd.  
Carratech Inc.  
Diagnostic Chemicals Ltd.  
Elite Seed Potato Farm  
Seasprings Farms Ltd.  
Westech Agriculture Ltd.

New Brunswick  
ADI Ltd.  
Atlantic Microbiology Ltd.  
Chemlab Inc.  
Connors Bros Ltd.  
Corey Feed Mills  
Crosbys Molasses  
Ionizing Energy Company of Canada  
Lalla and Associates

#### Newfoundland

Bay D'Espoir Salmon Hatchery Ltd.  
Terra Nova Fishery Co. Ltd.

#### Nova Scotia

Acadian Seaplants Ltd.  
BioResponse Systems Ltd.  
Blueberry Acres Ltd.  
Cape Breton Development Corp.  
Clearwater Fine Foods Inc.  
Dominion Biologicals Ltd.  
Endogro Systems Inc.  
Kemic Bioresearch Laboratories  
Koppernaes Engineering Ltd.  
Marbicon Biological Consultants  
Nova Chem Ltd.  
P. Lane and Associates Ltd.  
Precision Biologicals Inc.



Companies are listed here according to their principal areas of activity and therefore may be found under more than one sectoral heading. As a result, the 222 firms listed in Appendix II yield 332 listings here. The sectoral distribution of biotechnology activities based on this list may be a more accurate representation than that based only on the primary activity for each company (See table below).

#### Diagnostics

AB Biological Supplies Inc.  
 ABI Biotechnology Inc.  
 ADI Diagnostics Inc.  
 APO Diagnostics Inc.  
 Bio-Mega Inc.  
 Biomira Inc.  
 Biostar Inc.  
 Canadian Red Cross (BTS)  
 Canadian Biodinical  
 Cangen Corp.  
 CHEMBIOMED Ltd.  
 Corporation BDG  
 Cyberflour Inc.  
 Diagnostic Chemicals Ltd.  
 Dominion Biologicals Ltd.  
 FMG Integrated Biotechnical  
 Labs Ltd.  
 Frappier Diagnostics Inc.  
 Helix Biotech Ltd.  
 IAF Biochem Inc.  
 Joldon Diagnostics  
 Langford Inc.  
 Mann Testing Laboratories  
 Medicorp Inc.  
 Microtek Research and  
 Development Ltd.  
 Palliser Animal Health  
 Laboratories Ltd.  
 Paracel Laboratories Ltd.  
 Precision Biologicals Inc.  
 Probtex Corp.  
 QA Laboratories Ltd.  
 Quadra Logic Technologies  
 SCI CAN Diagnostics  
 SPI Synthetic Peptides Inc.  
 Syndel Laboratories Ltd.  
 VIDCO, Veterinary Infectious  
 Disease Organization  
 Vioclone Biologicals Inc.

#### Therapeutics

ABI Biotechnology Inc.  
 Allelix Biopharmaceuticals  
 Bio-Mega Inc.  
 Biomira Inc.  
 BIOSCAN Continental Inc.  
 Biostar Inc.  
 Canadian Red Cross (BTS)  
 Cangen Corporation  
 Canpro Laboratories  
 Ciba-Geigy Canada Ltd.  
 Connaught Laboratories Ltd.  
 Continental Pharma Cryosan  
 Cyanamid Canada Inc.  
 Dextran Products Ltd.  
 ELANCO (Eli Lilly Canada)  
 Ensor Inc.  
 IAF Biochem Inc.  
 Langford Inc.  
 Medicorp Inc.  
 Merck Frost  
 Novo Laboratories Ltd.  
 Ortho Pharmaceuticals  
 Canada Ltd.  
 Pacific Pharmaceuticals Ltd.  
 Quadra Logic Technologies  
 Raylo Chemicals  
 SPI Synthetic Peptides Inc.  
 Syndel Laboratories Ltd.  
 Synphar Laboratories Inc.  
 and Taiho Alberta Ltd.  
 Syntex Inc.  
 The Canadian Liposome Co.  
 Vetrepharm Inc.  
 VIDCO, Veterinary Infectious  
 Disease Organization

#### Agriculture

Agri Forest Technologies  
 Allelix Crop Technologies  
 Alta Genetics Inc.  
 Applied Bio-Nomics Ltd.  
 B2 Enterprises Ltd.  
 Balco Canfor Reforestation  
 Centre Ltd.  
 Better Yield Insects  
 Bio Field Technologies  
 Research Inc.  
 Bio-Response Systems Ltd.  
 Bio Technica Canada Inc.  
 Blueberry Acres Ltd.  
 C-I-L Inc.  
 Canadian Seed Coaters Ltd.  
 Canpro Laboratories  
 Centre d'insemination  
 artificielle du Quebec  
 Ciba-Geigy Canada Ltd.  
 Corey Feed Mills Ltd.  
 CSP Foods Ltd.  
 Cyanamid Canada Inc.  
 ELANCO (Eli Lilly Canada)  
 Elite Seed Potato Farm  
 Endogro Systems Inc.  
 Ensor Inc.  
 Fermtech R&D Inc.  
 Hara Products Ltd.  
 Inrad Industrial Research and  
 Development Ltd.  
 King Agro  
 Les Clay and Son Ltd.  
 Marbicon Biological  
 Consultants  
 Monsanto Canada Inc.  
 Paladin Hybrids Inc.  
 Phero-Tech Ltd.  
 Philom Bios Inc.  
 Premier Peat Moss Ltd.  
 Proplant Garden Products  
 Rhizogen Inc.  
 Rhizotec Inc.  
 Safer Ltd.  
 Semico Inc.  
 Shaver Poultry Breeding  
 Farms Ltd.  
 Sylvan Industries Ltd.  
 United Grain Growers  
 W.G. Thompson & Sons Ltd.  
 Waitaki International  
 Biosciences  
 Westech Agriculture Ltd.  
 Western Biologicals Ltd.

#### Suppliers

AB Biological Supplies Inc.  
 BIOSCAN Continental Inc.  
 Canadian Red Cross (BTS)  
 Canpolar Inc.  
 Cedarlane Laboratories Ltd.  
 CHEMBIOMED Ltd.  
 Chemfet Canada Ltd.  
 Continental Pharma Croysan  
 COSEM Neurostim Ltee.  
 Cyberflour Inc.  
 Dextran Products Inc.  
 Diagnostic Chemicals Ltd.  
 Dominion Biologicals Ltd.  
 DuPont Canada Ltd.  
 Equipment Moniteur Inc.  
 Export Packers Co. Ltd.  
 Fermtech R&D Inc.  
 Frappier Diagnostics Inc.  
 Helix Biotech Ltd.  
 Hybrisens Ltd.  
 Hypercube Inc.  
 IAF Biochem Inc.  
 Institut Rosell Inc.  
 Mann Testing Laboratories

MDS Health Group Ltd.  
 Medicorp Inc.  
 Microbix Biosystems Inc.  
 New Age Devices  
 Novo Laboratories Ltd.  
 Paracel Laboratories Ltd.  
 Pegasus Industrial Specialties  
 Pharmacia (Canada) Ltd.  
 Precision Biologicals Inc.  
 Premier Peat Moss Ltd.  
 QA Laboratories Ltd.  
 Raylo Chemicals  
 Rutland Biotech Ltd.  
 SCI CAN Diagnostics  
 Serdary Research  
 Laboratories Inc.  
 SPI Synthetic Peptides Inc.  
 Syndel Laboratories Ltd.  
 TCI Superior  
 Technical Marketing  
 Associates  
 Tyler Research Instruments  
 Corp.  
 Vancouver Island Antibodies  
 W.H.E. Bio-Systems  
 Waitaki International  
 Biosciences  
 Wardrop Engineering Inc.  
 Winnipeg Rh Institute Inc.  
 Xymotech Bio Systems  
 Zeton Inc.

#### Environmental

ADI Ltd.  
 ADS Environment Inc.  
 Aquaresearch Ltd.  
 B.C. Research Corp.  
 B.V. Sorbex Inc.  
 Bio-Hol Developments  
 Bio-Response Systems Ltd.  
 Biogenie S.R.D.C. Inc.  
 Bionov CNP Inc.  
 Bioquest International Inc.  
 Bioshell Inc.  
 Biosyn  
 Boojum Research Ltd.  
 Cape Breton Development  
 Corporation  
 Canber Industries Ltd.  
 Canviro Consultants  
 Centre de Recherche en  
 Sylvichimie de l'Ouatouais  
 Dearborn Environmental  
 Consulting Group  
 Degremont - Inflico Ltee.  
 Diversified Research  
 Laboratories Ltd.  
 Domtar Inc.  
 DuPont Canada Ltd.  
 Envirocon Pacific Ltd.  
 Enviromine Inc.  
 ESSA - Environmental and  
 Social Systems Analysts Ltd.  
 Falconbridge Ltd.  
 Fermtech R&D Inc.

Forintek Canada Corp.  
Gendron Lefebvre  
Giant Bay Resources Ltd.  
Gore & Storrie Ltd.  
Institute for Chemical Science  
and Technology (ICST)  
IOGEN Corporation  
John Menuier Inc.  
Joseph E. Seagram & Sons  
Koppnaes Engineering Ltd.  
Le Group SNC Inc.  
MacMillan Bloedel Ltd.  
Microbe Inc.  
Mycotech  
Noranda Research Centre  
Nova Husky Research  
Corporation Ltd.  
P. Lane and Associates Ltd.  
Paques Lavalin  
Pollutech Ltd.  
Premier Peat Moss Ltd.  
Pulp and Paper Research  
Institute of Canada  
(PAPRICAN)  
Sanexen International  
St. Lawrence Reactors Ltd.  
Stake Technology Ltd.  
Temfibre Inc.  
Thermo Tech Waste Systems  
Wardrop Engineering Inc.

#### Aquaculture

Acadian Seaplants Ltd.  
Aquaresearch Ltd.  
Aquaterra Inc.  
Bay D'Espoir Salmon  
Hatchery Ltd.  
Bio Field Technologies  
Research Inc.  
Bionov CNP Inc.  
Biorex Groupe Conseil Inc.  
Carratech Inc.  
Connors Bros. Ltd.  
Corey Feed Mills Ltd.  
D. McLeay & Associates Ltd.  
Envirocon Pacific Ltd.  
FMG Integrated Biotechnical  
Labs Ltd.  
Microtek Research and  
Development Ltd.  
Nova Chem Ltd.  
P. Lane and Associates Ltd.  
Pisciculture des Alleghany  
Purdell Cooperative  
Agro-Alimentaire  
Quality Seafarms Ltd.  
Royal Pacific Seafarms Ltd.  
Seaspring Farms Ltd.  
Specialty Marine Products  
Syndel Laboratories Ltd.  
Terra Nova Fishery Co. Ltd.

#### Food and Beverage

A. Lassonde & Fils Inc.  
Acadian Seaplants Ltd.  
ADS Environment Inc.  
Agropur Cooperative  
Agro-Alimentaire  
Bioprotein Canada Inc.  
Brookside Farms Ltd.  
Canpolar Inc.  
Casco Inc.  
Champlain Industries Ltd.  
Chateau des Charmes Wines  
Chemlab Inc.  
Crosbys Molasses Ltd.  
CSP Foods Ltd.  
Diversified Research  
Laboratories Ltd.  
F.V.M.P.C.A. Dairyland  
Foods  
Gelda Scientific & Industrial  
Development Inc.  
Ionizing Energy Company of  
Canada  
Joseph E. Seagram & Sons  
Labatt Brewing Company  
Lalla & Associates  
Lallemant Inc.  
Les Aliments Carriere Inc.  
Molson Breweries of Canada  
Nelson's Dairy  
Purdell Cooperative  
Agro-Alimentaire  
St. Lawrence Reactors Ltd.  
The Griffiths Laboratories

#### Forestry

Agri Forest Technologies  
Applied Bio-Nomics Ltd.  
Atlantic Microbiology  
B.C. Research Corp  
Balco Canfor Reforestation  
Centre Ltd.  
Better Yield Insects

Bioshell Inc.  
BioTechnica Canada Inc.  
Center de Recherche en  
Sylvichemie de l'Outaouais  
C-I-L Inc.  
Domtar Inc.  
Forintek Canada Corp.  
Inrad Industrial Research and  
Development Ltd.  
MacMillan Bloedel Ltd.  
Mycotech  
Noranda Research Centre  
Phero Tech Inc.  
Pulp and Paper Research  
Institute of Canada  
(PAPRICAN)

#### Mining

B.C. Research Corp.  
Boojum Research Ltd.  
B.V. Sorbec Inc.  
Cape Breton Development  
Corporation  
CB Research International  
Corp.  
Coastech Research Inc.  
Denison Mines Ltd.  
Enviromine Inc.  
Falconbridge Ltd.  
Giant Bay Resources Ltd.  
Institute for Chemical Science  
and Technology (ICST)  
Noranda Research Centre  
Nova Husky Research  
Corporation Ltd.  
Recbiomine Inc.  
Rio Algom Ltd.

#### Consultants and Contract Research

Advanced Biotechnology Ltd.

Beak Consultants Ltd.  
Bionov CNP Inc.  
Bio-Research Laboratories  
Biosystech Consulting Inc.  
Canpro Laboratories  
Canviro Consultants  
CBM Bioventures  
Corporation BDG  
Dearborne Environmental  
Consulting Group  
Diversified Research  
Laboratories Ltd.  
ESSA - Environmental and  
Social Systems Analysts Ltd.  
Frank Maine Consulting Ltd.  
Gelda Scientific & Industrial  
Development Inc.  
Gemini Biochemical  
Research Ltd.  
HSC Research Development  
Corp.  
Hybrisens Ltd.  
Hypercube Inc.  
Institut Rosell Inc.  
Kemic Bioresearch  
Laboratories Ltd.  
Koppnaes Engineering Ltd.  
Lalla & Associates  
Le Groupe SNC Inc.  
Marbicon Biological  
Consultants  
MDS Health Group Ltd.  
Microbix Biosystems Inc.  
Microtek Research and  
Development Ltd.  
Mycotech  
Noranda Research Centre  
Nova Chem Ltd.  
Pegasus Industrial  
Specialties Ltd.  
Pollutech Ltd.  
POS Pilot Plant Corp.

Sector	% from Survey	% from MOSST Sourcebook <sup>1</sup>	% from Appendix IV <sup>2</sup>
Diagnostics	16	30	10.2
Therapeutics	16	(included above)	9.6
Agriculture	18	18	13.9
Suppliers	6	4	15.4
Environmental	12	14	16.0
Aquaculture	6	6	6.9
Food & Beverage	8	12	8.1
Forestry	5	4	5.4
Mining	4	5	4.5
Consultants	9	7	9.9

1 By primary sector of activity only.

2 Analysis based on all significant areas of biotechnology activity of each company.

## Appendix V: Venture Capital Firms in Canada

In Canada, most of the professionally managed venture capital firms are members of the Association of Canadian Venture Capital Companies ("Association"). As a service to its members and to other interested parties, the Association publishes "Member Profiles" which describe each member's investment preferences such as the size, structure and form of deal, industry and use of funds. A copy of the Member Profiles can be obtained free of charge from:

Association of Canadian Venture Capital Companies  
Suite 600, 1881 Yonge Street  
Toronto, Ontario M4S 1Y6  
(416) 487-0519

Several of the Association's members are interested in the biotechnology industry, however, few have made investments to date in biotech. With the assistance of Venture Economics Canada Limited, a firm who monitors and publishes reports on the investment activities of the venture capital community, the following firms have been identified as investors in the biotech industry.

Agence Quebecois de  
Valorisation  
Mr. Claude Richard  
300 Leo Parizeau, #2111  
C.P. 116 Succ. Place Duparc  
Montreal, Quebec  
H2W 2P4  
(514) 873-3395

Alberta Opportunity  
Company  
Venture Funding Division  
Mr. John Kennedy  
1405 Canada Trust Tower  
10104 -103rd Avenue  
Edmonton, Alberta  
T5J 0H8  
(403) 428-6118

Altamira Capital Corp.  
Mr. C.J. Winn  
475 Michel Jasmin  
Dorval, Quebec  
H9P 1C2  
(514) 631-2682

Biocan Ventures  
c/o Federal Business Develop-  
ment Bank  
800 Place Victoria  
Suite 4600, Box 335  
Montreal, Quebec  
H4Z 1L4  
(514) 283-2252

Discovery Enterprises Inc.  
Mr. David Scott  
3700 Gilmore Way  
Suite 220  
Burnaby, British Columbia  
V5G 4M1  
(604) 430-3533

Federal Business Development  
Bank  
Venture Capital Division  
Mr. Marc C. Vaillancourt  
800 Victoria Square  
Suite 4600, Box 335  
Montreal, Quebec  
H4Z 1L4  
(514) 283-2252

Grayrock Shared Ventures Ltd.  
Mr. Wolf J. Gluk  
150 King Street West  
Suite 1212  
Toronto, Ontario  
M5J 1J9  
(416) 979-7677

Innovation Ontario Corporation  
Mr. Michael St. Amant  
7th Floor  
56 Wellesley Street West  
Toronto, Ontario  
M7A 2E7  
(416) 963-5717

MDS Ventures  
Mr. Ed Rygiel  
100 International Blvd.  
Etobicoke, Ontario  
M9W 6J6  
(416) 672-4217

Vencap Equities Alberta Inc.  
c/o Vencap Medical Ventures  
Division  
Mr. Sandy Slator  
1980, 10180 - 101 Street  
Edmonton, Alberta  
T2P 3T6  
(403) 237-8101

Ventures West  
Mr. Michael J. Brown  
321 Water Street  
Suite 400  
Vancouver, British Columbia  
V6B 1B8  
(604) 688-9495

## Appendix VI: Winter House Scientific Publications Inc

Winter House Scientific Publications Inc. specializes in scientific publishing, consulting, market research and the organization and sponsorship of seminars and conferences.

The company has been monitoring and analyzing developments in the Canadian biotechnology industry virtually since its inception.

As part of the company's mandate to provide up-to-the-minute information on this fast-growing industrial sector, three publications devoted to biotechnology are currently being published:

**New Biotech** - Canada's only monthly biotechnology magazine describing the progress and prospects of the industry. **New Biotech** regularly features research articles, sectoral surveys, information on new products and services, company profiles, and meeting reports.

**New Biotech Business** - a biweekly, intelligence newsletter for business professionals. Written for the industrial specialist and business and financial community, **New Biotech Business** reports on the market trends, company product and marketing strategies, government policies and programs, and upcoming meetings and events.

**New BioResources**, a bimonthly newsletter devoted to the application of biotechnology in the resource industries.

The company is currently involved in the design of an extensive electronic database on the industry.

In addition, it will be publishing its first Canadian Biotechnology Directory in 1990.

Drawing on extensive in-house experience in publishing, the company also undertakes market surveys, consulting, public relations and the design of company newsletters.

Mr Peter Winter, President, is an award-winning editor, writer and consultant. Prior to forming his publishing company, he worked as a biochemist in cancer research, followed by an extensive period in the pharmaceutical industry.



## Appendix VII: Ernst & Young Professional Advisers

Ernst & Young provides a full range of auditing and consulting services to more than 20,000 clients from 29 offices across Canada. Founded in 1864, the firm was known for generations as Clarkson Gordon. Today, we are part of Ernst & Young International, the preeminent professional service firm in the world, with approximately 70,000 people working in more than 100 countries. We have retained our Canadian ownership and traditions of quality and superior service while expanding our network of expertise on a world wide scale.

Our professionals are auditors, accountants, tax planners, business advisers, financing negotiators and advisers on mergers and acquisitions. Through Ernst & Young Consulting, we offer services in information and financial control, computer consulting, executive search, marketing and economics, and operations improvement and management.

### Services to the Biotech Industry

The biotechnology industry in Canada is served by the Ernst & Young National High Technology Network. This is one of our industry specialization groups, formed to co-ordinate our expertise from various disciplines to serve fast-growing technology oriented industries. The group is well equipped to assist biotech companies at any stage of development.

*Starting a Biotechnology Company:* We assist our clients in developing comprehensive, credible business plans. As part of this service, we have constructed a high-tech financial planning model to produce pro-forma financial statements, cash flow projections and other analyses. Our group can streamline the process of financing and provide the tax advice necessary to maximize government incentive programs, and to assist in corporate and personal tax planning. We can advise on the optimal form and structure for the emerging company.

*Knowing Your Market:* Biotechnology companies must identify and overcome constraints facing potential users, understand the impact of government regulations, identify the benefits gained from the technology, focus on the market segments with the best potential for early adoption and choose appropriate channels of distribution. Our specialists help clients find new markets, even where there is no history of demand, and develop creative strategies for entering them.

*Dealing With Growing Pains:* A company moving out of the start-up phase inevitably must change. A balanced management team is critical to the company's future development. Our Executive Search consultants can identify your requirements, assist in hiring and develop creative compensation packages to motivate and retain key employees. We are also experienced in developing and implementing systems for rapidly growing companies to manage information, production and financial operations. We can advise on how to avoid or overcome common growing pains experienced by biotech companies; uncontrolled growth and rapidly escalating costs; deficient planning and scheduling of manufacturing; inadequate sales forecasts and obsolete inventories; poor communications among departments and locations.

*Planning for the Future:* As a company grows into a complex organization, creativity can be smothered. Our consultants can help in team building and creating a corpo-

rate climate that continues to promote productivity and new product development. We also assist with a mature company's increased needs for internal controls, more detailed financial reports and new strategies to compete in the changing global marketplace.

### Our Publications

Ernst & Young professionals have published a wide array of books and brochures to support our services to, and participation in, many sectors in the high-technology field. These include *Outline for a New High Technology Business Plan*, *Outline for a New High Technology Marketing Plan* and *High Tech News*.

Ernst & Young International also has an extensive High Tech Network and has published four surveys on the U.S. biotechnology industry: *Biotech '86: At the Crossroads*, *Biotech '88: Into the Marketplace*, *Biotech '89: Commercialization* and *Biotech '90: Into the Next Decade*. Ernst & Young International also publishes a biotechnology newsletter: *BioFocus*.

To obtain copies of these publications or for further information on how the Ernst & Young High Technology Network can help your company, call Peter M. Farwell, Director, or John R. Goudey, National Co-ordinator of the High Technology Network, in Toronto at (416)864-1234, or contact the nearest Ernst & Young office.

#### Ernst & Young Offices Across Canada

Ernst & Young  
1150 rue Claire-Fontaine  
Suite 700  
Quebec, Quebec  
G1R 5G4

Ernst & Young  
2103 - 11th Avenue  
Bank of Montreal Building  
Suite 900  
Regina, Saskatchewan  
S4P 3Z8

Ernst & Young  
10711 Cambie Road  
Suite 206  
Richmond, British Columbia  
V6X 3G5

Ernst & Young  
One Brunswick Square  
Suite 1209  
Saint John, New Brunswick  
E2L 4V1

Ernst & Young  
219 Robin Crescent  
Suite 200  
Saskatoon, Saskatchewan  
S7L 6M8

Ernst & Young  
10 Fort William Place

7th Floor  
St. John's, Newfoundland  
A1C 1K4  
Ernst & Young  
215 Red River Road  
Suite 200  
Thunder Bay, Ontario  
P7B 5J9

Ernst & Young  
77 King Street West  
Royal Trust Tower  
Toronto-Dominion Centre  
Toronto, Ontario  
M5K 1J7

Ernst & Young  
1200 Markham Road  
Suite 200  
Scarborough, Ontario  
M1H 3C3

Ernst & Young  
P.O. Box 10101  
Pacific Centre  
700 West Georgia Street  
Vancouver, British Columbia  
V7Y 1C7

Ernst & Young  
P.O. Box 1205  
Bank of Commerce Building  
1175 Douglas Street  
Suite 1010  
Victoria, British Columbia  
V8W 2V3

Ernst & Young  
105 Erb Street West  
Waterloo, Ontario  
N2L 1T6

Ernst & Young  
374 Ouellette Avenue  
Suite 700  
Windsor, Ontario  
N9A 6W4

Ernst & Young  
360 Main Street  
Commodity Exchange Tower  
Suite 2700  
Winnipeg, Manitoba  
R3C 4G9

Ernst & Young  
300 John Street  
Suite 602  
Thornhill, Ontario  
L3T 5W4

Ernst & Young  
85 Bayfield Street  
Suite 401  
Barrie, Ontario  
L4M 3A7

Ernst & Young  
707-7th Avenue S.W.  
Suite 1300  
Calgary, Alberta  
T2P 3H6

Ernst & Young  
10060 Jasper Avenue  
Suite 1800, Esso Tower  
Edmonton, Alberta  
T5J 3R8

Ernst & Young  
35 Dufferin Street  
P.O. Box 337  
Granby, Quebec  
J2G 8E5

Ernst & Young  
Suite 1208, 12th Floor  
Purdy's Wharf  
1959 Upper Water Street  
Halifax, Nova Scotia  
B3J 2Z1

Ernst & Young  
100 King Street West  
Suite 440  
Hamilton, Ontario  
L8P 1A2

Ernst & Young  
P.O. Box 458  
305 King Street West  
9th Floor  
Kitchener, Ontario  
N2G 4A2

Ernst & Young\*  
251, rue Nairn  
Bureau 210  
La Malbaie, Quebec  
G5A 1M4

Ernst & Young  
3090, boulevard Le Carrefour  
Suite 600  
Laval, Quebec  
H7T 2J7

Ernst & Young  
Canada Trust-Tower B, City Centre  
380 Wellington Street  
London, Ontario  
N6A 5B5

Ernst & Young  
The Ernst & Young Tower  
90 Burnhamthorpe Road West  
Suite 1100  
Mississauga, Ontario  
L5B 3C3

Ernst & Young  
1 Place Ville Marie  
Suite 2400  
Montreal, Quebec  
H3B 3M9

Ernst & Young  
7305, boulevard Marie-Victorin  
3rd floor  
Brossard, Quebec  
J4W 1A6

Ernst & Young  
55 Metcalfe Street  
Suite 1600  
Ottawa, Ontario  
K1P 6L5

\*Please ship to the La Malbaie  
Office via the Quebec Office

# **Ernst & Young High Technology Network**

## **List of Key Contacts**

Barrie  
Tom Hards  
(705) 728-3397

Calgary  
Steve Slipp  
(403) 290-4100

Edmonton  
Rick Cormier  
(403) 423-5811

Granby-Bromont  
Gerald Allaire  
(514) 375-4400

Halifax  
John Carter  
(902) 420-1080

Hamilton  
Paul Jaggard  
(416) 526-8880

Kitchener  
Gary Pooley  
(519) 744-1171

La Malbaie  
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Denis Posten  
(204) 947-6519

York Region  
Jack Taylor  
(416) 731-1500

## Appendix VIII: Industry, Science and Technology Canada

Industry, Science and Technology Canada (ISTC) works in full partnership with the private sector, the science community and other levels of government to promote international competitiveness and industrial excellence in Canada. The Department strives to bring together the talents required to guarantee Canada's place in the first rank of industrial nations. The focus of its efforts both inside and outside government can be summed up as building competitiveness.

ISTC goals are to create a strong research base for the development of biotechnology, increase the supply of highly qualified personnel, enhance scientific cooperation and technology transfer, and foster an economic and regulatory climate conducive to commercial biotechnology investment and activity.

*Industry advocate:* The professionals at ISTC speak to, for and about the industry, the science and the technology of biotechnology in the government of Canada. ISTC assists industry to keep abreast of scientific and technological change and acts as a reasoned industry advocate on a broad spectrum of issues. Industry is closely consulted to ensure that the needs of the biotechnology community are understood when policies are developed.

*Program Service:* Financial assistance is provided to industry-led alliances to carry out research and development or technology applications of biotechnology under the Strategic Technologies Program. Such alliances will create a critical mass of scientists, capital and marketing resources that is beyond the scope of most individual Canadian biotechnology firms. This assistance will encourage companies to adopt new technologies, demonstrate the feasibility of new products and processes, and forge linkages between themselves and potential users of biotechnology.

*Communications and Linkages:* Communication between research workers and users of biotechnology is active through seven R&D networks funded by the National Biotechnology Strategy. The networks have a proactive role, responding to the needs of industry for strategic information on markets and technology opportunities while encouraging the development of collaborative research projects and the application of biotechnology to key industrial sectors.

ISTC provides information and data bases for business marketing needs and opportunities, assists entrepreneurs to search out, acquire and implement foreign technologies which can usefully be applied to their businesses and helps companies improve their competitive position.

Two publications that assist the biotechnology community in identifying its peers in industry and government entitled *The 1988 Canadian Biotechnology Sourcebook* and *Partnerships in Biotechnology* have recently been published.

*Regulatory Service:* Biotechnology regulations in Canada, as in the rest of the world, are in a state of flux. Most industrialized countries are examining the situation and trying to devise regulatory systems that protect the environment without creating unmanageable obstacles for industry. An information office has been established within ISTC to provide the biotechnology community and the public with up-to-date information about the Canadian regulatory situation as well as international developments.

Underlying all of ISTC's activities is the function as chief advocate, within government, for

Canada's business and scientific biotechnology community. All of the programs and activities are based on frequent and extensive consultation with the private sector, the science community, other levels of government and other interested Canadians.

For further information, copies of publications, or to obtain access to ISTC's services or programs, contact the officers listed below at ISTC's regional offices.

**Director**

Dr. Elizabeth Dickson, ISTC  
Biotechnology and Health Care Products  
235 Queen Street  
Ottawa, Ontario  
K1A 0H5

**Manager**

Ms. Carol Cheffins, ISTC  
Biotechnology Division  
Biotechnology and Health Care Products  
235 Queen Street  
Ottawa, Ontario  
K1A 0H5

**Regional Offices:**

Mr. Ron Farris, ISTC  
900-650 West Georgia Street  
Box 11610  
Vancouver, British Columbia  
V6B 5H8  
(604) 666-1409

Mr. Dalton Tamney, ISTC  
105-21st Street East  
6th Floor  
Saskatoon, Saskatchewan  
S7K 0B3  
(306) 975-5316

Mr. Mario Perek, ISTC  
Ms. Odette Corbu, ISTC  
One Front Street  
Toronto, Ontario  
(416) 973-5033/5056

Mr. Eric Anderson, ISTC  
Assumption Place  
770 Main Street  
Box 1210  
Moncton, New Brunswick  
E1C 8P9  
(506) 857-6460

Mr. Stu Shepherd, ISTC  
Confederation Court  
134 Kent Street, Ste. 400  
Box 1115  
Charlottetown, Prince Edward Island  
C1A 7M8  
(902) 566-7442

Ms. Michele Goshulak, ISTC  
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Calgary, Alberta  
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Mr. Doug Cable, ISTC  
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Ms. Charlotte Murray, ISTC  
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B3J 2V9  
(902) 426-9475

Ms. Patricia Hearn, ISTC  
Parson's Building  
90 O'Leary Avenue  
Box 8950  
St. John's, Newfoundland  
A1B 3R9  
(709) 772-4281

## Appendix IX: National Research Council of Canada (NRC)

### NRC Biotechnology Programs (NBP)

Objectives of the NRC Biotechnology Program include stimulating technological innovation in the private sector, increasing the commercial application of NRC supported research, and improving the return on investment from federally funded research for its economic and social benefits to Canada.

R&D and product firms may find an opportunity under the program to explore the most advanced high-risk concepts which can lead to the next generation of products and processes, and strengthen economic competitiveness.

The principal vehicle used to achieve these goals is the development and administration of cost-shared collaborative research projects with industrial partners to strengthen industrial biotechnology capabilities in Canada. This definition includes incorporated Canadian companies, non profit research corporations and provincial research organizations.

Proposals for collaborative research with the NRC are invited throughout the year and may be routed through any of the three biotechnology divisions: Biotechnology Research Institute (BRI) in Montreal, the Plant Biotechnology Institute (PBI) in Saskatoon, and the Division of Biological Sciences (DBS) in Ottawa. Responsibility for program delivery resides in Montreal at the Biotechnology Research Institute.

Biotechnology Research Institute  
6100 Royalmount Avenue  
Montreal, Quebec  
H4P 2R2  
A. Marsan  
(514) 496-6100

Division of Biological Sciences  
Building M-54  
Montreal Road  
Ottawa, Ontario  
K1A 0R6  
G.H.M. Adams  
(613) 993-6005

Plant Biotechnology Institute  
110 Gymnasium Road  
Saskatoon, Saskatchewan  
S7N 0W9  
W.G.W. Kurz  
(306) 975-5570

### **Centre for Protein Structure and Design (CPSD)**

The Centre for Protein Structure and Design is a national resource established to assist industrial and academic researchers working on enzymes, drugs and pesticides which have potential economic significance for Canada.

The Centre has an internal research program which supports protein engineering and rational drug design activities in NRC's three biotechnology divisions. As well, the Centre is geared for collaborations and joint ventures, and, in special cases, research service under contract with industrial and academic research communities.

#### **CPSD**

Biotechnology Research Institute  
6100 Royalmount Avenue  
Montreal, Quebec  
H4P 2R2  
A.C. Storer  
(514) 496-6256

#### **CSPD**

Division of Biological Sciences  
Building M-54  
Montreal Road  
Ottawa, Ontario  
K1A 0R6  
P.R. Carey  
(613) 990-0829

### **Industrial Research Assistance Program**

The Industrial Research Assistance Program (IRAP) was established to further the economic development of Canada through the encouragement of R&D in a variety of sectors and increased utilization of science and technology.

IRAP comprises the following five elements:

- IRAP-C for advice, guidance and assistance on industrial technology and government programs
- IRAP-H for tackling industrial problems through short-term support of undergraduates working with the firm
- IRAP-L for assisting short-term studies or tests contracted out to qualified organizations
- IRAP-M for assisting small R&D projects through support of the salaries of researchers

- IRAP-R for assisting longer term, higher risk major projects involving technology transfer through support of the salaries of researchers

For further information, advice or assistance in accessing any one of the above program elements, contact your nearest IRAP Industrial Technology Advisor through the yellow pages of your telephone directory under "Technology-Assistance."

#### **Cooperative Technology (CO-OP-TECH)**

The CO-OP-TECH program (formerly the Incubator Program) offers firms the opportunity to locate a technical team in a federal government laboratory for a maximum period of three years. Projects should focus on the development of a unique product or service of commercial importance, and should be of relevance to ongoing activities in the laboratory in which the cooperative work is to take place. For further information contact the federal government laboratory of your choice.

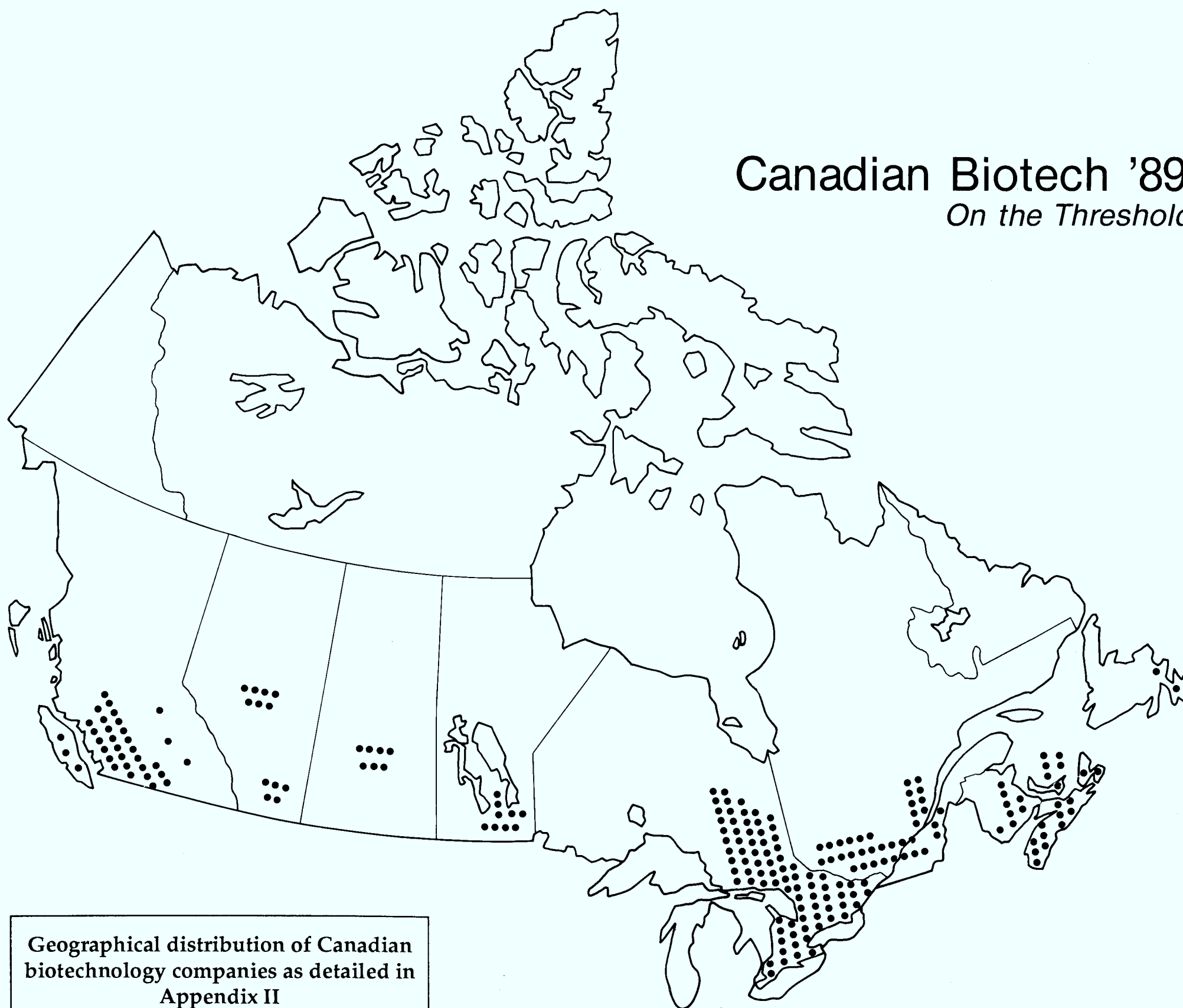
#### **Canada Institute for Scientific and Technical Information (CISTI)**

CISTI is responsible for building and maintaining the national collection of scientific, technical and medical literature. In addition, the Institute operates a wide variety of services, including document delivery, online information retrieval systems, reference and referral services, and publications, to facilitate Canadian access to the world's scientific and technical information resources.

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