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1984

Annual  
Report

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1984

National  
Biotechnology  
Advisory  
Committee

Canada



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Report**

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Biotechnology  
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Committee**



Ministry of State

Science and Technology  
Canada

Ministère d'État

Sciences et Technologie  
Canada



Minister of State for Science and Technology  
House of Commons  
Ottawa, Ontario

Sir:

On behalf of the members of the National Biotechnology Advisory Committee, I respectfully submit the first annual report which covers the period October 1983 to November 1984.

Through its activities and recommendations, the Committee has endeavoured to transmit the special importance of biotechnology to Canada's science and industry. It is my hope that the efforts of the Committee members, along with all those who have generously contributed to the Committee's work, will strengthen and accelerate Canadian biotechnology developments.

A handwritten signature in black ink, appearing to read "John R. Evans".

**John R. Evans**  
*Chairman*



## Members of the National Biotechnology Advisory Committee, 1984

J.R. Evans (Chairman)	Allelix Ltd., Toronto
D.B. Shindler (Secretary)	Ministry of State for Science and Technology, Ottawa
A. Beaulnes	Institut Armand-Frappier, Montreal
R.G.S. Bidwell	Dalhousie University, Halifax
M. Brossard	National Research Council of Canada, Ottawa
W.A. Cochrane	Connaught Laboratories Ltd., Toronto
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J.A. Fortin	Laval University, Québec City
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M. Lamontagne	Corporate Director, Québec City
G.R. Lawford	George Weston Ltd., Toronto
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Pacific Isotopes &  
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Canada, Ottawa

## Executive summary

Advances in the biosciences have opened a window of opportunity for Canadian industrial development. If Canada's traditional markets are to be preserved and new markets developed, Canadian industries must accelerate the development and application of new technologies. As biotechnology applications are relatively new, Canadian research groups can rapidly gain the critical expertise necessary to provide a foundation for commercial developments. However, Canadian groups must recognize and seize opportunities to cooperate, in order to be able to convert the scientific possibilities into commercial successes.

The National Biotechnology Advisory Committee, consisting of members drawn from industry, university and the federal government, has been considering how to promote the development and commercial applications of biotechnology. In addition to providing advice on Canadian biotechnology to the Minister of State for Science and Technology, the Committee has endeavoured to become a national focal point for addressing the major biotechnology issues.

In its first year of operation, the Committee concentrated on the effectiveness of the National Biotechnology Strategy. The targeted industrial assistance and technology transfer programmes funded under the Strategy, along with the R&D networks and federal departmental research, have helped substantially to strengthen and bring together Canada's biotechnology efforts. The amount of commercial activity has increased substantially over the past five years and the federal government's efforts have begun to build confidence that Canada can participate in the commercial biotechnology markets.

Biotechnology can thrive only in close association with first-class research carried out in the universities and government departments. Expanded support of biotechnology research through the university Granting Councils is essential if Canada expects to make further progress. The establishment of a few industry-oriented university groups with adequate human and financial resources to carry out internationally competitive research in selected fields would markedly improve prospects for future scientific and commercial developments.

The availability of financing for start-up firms and for growth of existing firms is another important issue. The Committee considers that the investment climate for biotechnology could be enhanced by strengthening proprietary rights and tax incentives and by sustaining funding for targeted assistance programmes as levers for industrial investment.

Communication has been improved by the Committee's consultations and regional meetings, and fostered by the R&D Networks established in the priority areas of the Strategy. However, there is room for further strengthening of communications and sharing of resources among industry, university and federal and provincial departments.



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The overriding priority for the Committee is to persuade the federal government that if Canada is to take advantage of the current window of opportunity in biotechnology, the pace of development must be accelerated through substantially greater investment, both in the science base and in technology transfer and development programmes.



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### A. Elements of Canada's National Biotechnology Strategy

- *Biotechnology* is an important emerging technology area highly relevant to Canada's industrial development and natural resource economy.
- *Strategy Objective*: provide federal policy guidance and programme support to encourage the concerted action necessary to make commercial progress.
- *National Biotechnology Advisory Committee* has been established to advise the Minister of State for Science and Technology.
- *Strategic Priority Areas* have been identified for special attention:
  - Human and Animal Health Care
  - Mining and Mineral Leaching
  - Plant Strain Development and Nitrogen-Fixation
  - Cellulose Utilization and Waste Treatment
- *Networks* have been formed in each priority area to link researchers from industry, university and government to increase the industrial relevance of biotechnology research.
- *Federal Funds* have been allocated to fund the NRC PILP-biotechnology cost-share programme. The programme's purpose is to support industry projects in the priority areas which involve collaboration with universities or provincial research organizations.
- *Support to Federal Departments* has been provided for research projects and major biotechnology programmes, including the NRC Biotechnology Research Institute in Montreal, the NRC Plant Biotechnology Institute in Saskatoon, and the Agriculture Canada Food Research Institute in Ste. Hyacinthe, Quebec.

Recent advances in molecular biology have caused unprecedented scientific excitement and industrial interest. Knowledge of biological processes and their control has developed to the point where many promising industrial uses for cells and biological systems have become evident. This expansion and application of biological knowledge toward practical ends is called biotechnology.

Virtually every country has recognized the importance of biotechnology. New drugs and vaccines for people and animals, improved varieties of crop plants, and methods to turn wastes into high value products are being developed all over the world. The new technologies will be applied in a broad range of existing industries as well as provide for the formation of new industries.

Canada is not among the leading countries. Since the inception of the National Biotechnology Strategy two years ago, real progress has been made in building Canada's biotechnology efforts and fostering industrial awareness and R&D. The seeds have been planted for future commercial activity and continued concerted efforts will certainly result in benefit to Canada.

The challenge of biotechnology centres on converting scientific possibilities into commercial reality. Although biotechnology has the potential to transform health care, farming and chemical production, the desired results require many innovative steps. In advanced technology fields, the innovations which lead to new products and processes are complicated and risky and require dedicated development effort over several years. To achieve success the producers and users of knowledge must play different roles over time. Cooperation among industries, financial institutions, universities and government has become essential. It is those countries with industries and organizations which can effectively coordinate and apply the varied resources required for training, research, regulation, investment and marketing, that will be the leaders in commercial biotechnology.

Beginning in the late seventies, several isolated industry and government actions marked the entry of Canada into the "new" biotechnology. In an attempt to develop a national approach to biotechnology which would build upon the initial steps taken, the federal government launched an extensive series of consultations through which a Task Force developed and recommended a national strategy. The National Biotechnology Strategy (see A), adopted by the federal government in 1983, was constructed on two fundamental principles, leverage and complementarity: leverage in terms of redistribution of human and financial resources; complementarity in support of industrial, academic, federal and provincial activities. The ultimate success of future Canadian bio-industry development will depend not only on such principles but also upon how well Canadians can cooperatively apply their resources, energies and talents to make progress.

## Window of Opportunity and Challenge

The ability to remain competitive in the natural resource sectors and to build new industries will depend upon the capability to apply new technologies. Advances in biology and biochemistry have opened a window of opportunity and, at the same time, have provided a challenge for Canada's industrial base. Industries and governments throughout the world are moving swiftly to capitalize upon these opportunities. The reaction of Canadian industry must be accelerated substantially if Canada's traditional markets are to be preserved and new markets developed.

Canada has the required elements for success in a number of fields where biotechnology will have an impact. There are also some serious deficiencies: the lack of a broad, strong, interdisciplinary science base; low industry awareness; lack of R&D commitment from the pharmaceutical, chemical and resource industries; a reluctance to commit development capital; gaps in policy; and a lack of communications and planning to ensure complementarity among industry, university and government R&D. The National Biotechnology Advisory Committee urges the government to confront these problems and adopt measures such as those suggested in this report, to meet the challenge of commercial biotechnology.

## **B. The National Biotechnology Advisory Committee (NBAC)**

### **Function:**

to advise the Minister of State for Science and Technology on:

- the effectiveness of the National Biotechnology Strategy and possible future modifications;
- the evolution of scientific and technical aspects of biotechnology;
- commercial developments arising from the application of biotechnology;
- federal programmes, policies and regulations which influence industrial and human resource development in biotechnology;
- provincial biotechnology initiatives and possibilities for federal-provincial cooperation;
- approaches to biotechnology pursued by other nations and methods to foster Canada's participation in international collaborations.

### **Membership:**

25 members drawn from industry, universities and the federal government (Annex I).

### **Secretariat:**

located at the Ministry of State for Science and Technology.

The Committee was established in 1983 to advise the Minister of State for Science and Technology on the National Biotechnology Strategy (see B). The Committee provides strategic advice to the Minister and monitors the Strategy. Members were drawn from industry, university and the federal government to form a representative body (Annex I).

Since October 1983, the Committee has been actively assessing Canada's prospects for the application of biotechnology. The Committee, through an intensive series of activities (Annex II), has sought to become a national focal point for addressing the major biotechnology issues. The members are dedicated to fostering biotechnology development for the benefit of Canada.



## 1. Exploiting the Window of Opportunity for Industrial Biotechnology

### C. Examples of promising commercial biotechnology developments

- Connaught Laboratories, Toronto, began the development in 1981 of hapten-conjugate vaccine technology. Initial approval for an adult vaccine against viral meningitis is expected in 1985, with a vaccine for infants expected shortly thereafter. The technology is applicable to other vaccines.
- QuadraLogic Technologies, Inc., Vancouver, will market monoclonal antibody diagnostic kits this year for early detection of leukemia and rubella. Clinical trials on a lung cancer test are beginning. Projects have been supported by PILP-biotechnology and involve collaborations with the University of British Columbia.
- Rhizotec Inc., Quebec, has successfully utilized microbial fertilizer technology developed at Laval University to produce trees which can grow rapidly in poor soils. Millions of such trees have been used in reforestation projects at the Manic 5 and James Bay hydroelectric sites.
- Helix Biotech Ltd., Richmond, B.C., has developed a simple, reliable and inexpensive cow heat test for dairy farmers through collaboration with the University of British Columbia and Jorden Diagnostics (Toronto) with initial funding from Agriculture Canada. Shering-Plough (U.S.) will assist in international marketing. In addition, a salmon-sex test is under development for fish farming.
- Research initiated in 1974 at Connaught Laboratories, Toronto, has resulted in the development of encapsulation technology for insulin producing cells. A world market of \$2-3 billion is predicted for the resulting implant for diabetics. A 1984 joint-venture between Connaught and Damon Biotech, named Vivotech, will develop the technology through to clinical trials in 1988, with the objective of marketing a product in 1991.

New technologies bring new industrial opportunities. In this way, biotechnology is changing the world's industrial structure. In the pharmaceutical sector for instance, the discoveries of new therapies and medicines and the development of novel biological production methods have occurred outside the traditional chemically-based industries. Likewise, the application of biotechnology for more efficient resource production and processing — ranging from crop production to mineral leaching — has arisen primarily from university and government research.

In emerging fields such as biotechnology, relatively small research groups, including those in Canadian universities, can rapidly gain the critical expertise necessary to create a foundation for commercial opportunities. Opportunities must be recognized and capitalized upon before the "window" closes leaving the major competing groups and industries of the U.S., Japan and Europe completely dominant. Establishing a scientific base at the outset of biotechnology developments is critical if Canada is to attain an industrial presence and have a share of the markets. This will require increased funding of groups with potential in selected fields.

The number of firms which are employing or developing biotechnology in Canada has increased substantially to about 90 from a handful of firms engaged in biotechnology five years ago. Many of these companies are new and only a few of them have been able at this early stage of biotechnology to bring products to market. There are some very promising developments (see C), but the leadtime is generally 5-10 years as is typical of new technologies. Companies which specialize in biotechnology applications will serve as the base for the free-standing Canadian biotechnology industry of the future.

The resource industries should constitute an important part of Canadian biotechnology. However, in spite of the fact that many of the greatest, long-term opportunities will be in those countries with natural resources which can be processed or transformed by biotechnology, Canadian industries in such fields as mining and forestry — with a few notable exceptions — have been very conservative about investing in biotechnology R&D. This hesitancy must be overcome if Canada is to succeed in advanced technology development and applications.

- Safer-Agro Chemicals Ltd., Victoria, B.C. has developed a safe, biodegradable, fungal pest control agent based on fatty acids and elemental sulfur. Rapid development, with assistance from the National Research Council PILP-biotechnology programme since 1984, will result in first sales in late 1985.
- ABI Biotechnology Inc., Winnipeg, is commercializing bioprocess technology for the production and purification of therapeutic agents developed at the non-profit Winnipeg Ph Institute.
- Denison Mines Ltd., Elliot Lake, Ontario, is carrying out a demonstration project to assess in-situ microbial leaching of minerals. The project is supported by a National Research Council PILP-biotechnology grant and involves researchers from Dalhousie and Laurentian Universities.
- Diagnostic Chemicals Ltd., P.E.I., is utilizing unique technology to isolate and purify enzymes used in medical diagnostic tests and kits.
- Meigenics, Ottawa, has developed a DNA probe assay to detect viral contaminants in seed potatoes. Certification that seed potatoes are free of pathogens will assist in maintaining Canadian exports.
- Institute Armand Frappier Production Inc., Laval, Quebec, marketed a monoclonal antibody kit (Herpes D Kit) in 1984 for the specific diagnosis of herpes infections in man. Foreign marketing is handled through Gibco-BRL (US) and Institute Pasteur Production (France).
- Bio-Mega Inc., Montreal is commercializing diagnostic kits in Canada and the U.S.A. in the area of medical endocrinology, including a human fertility test.
- Chembiomed Ltd., Edmonton, a University of Alberta biotechnology company, is manufacturing and marketing carbohydrate-based haptens and antigens, lectins and a line of monoclonal reagents for blood typing. Chembiomed also manufactures and markets a line of immuno-absorbents (Synsorbs and Bio-Synsorbs) used in the plasma fractionation industry, and in ABO-incompatible organ transplants.

- Aqua Health Ltd., Toronto, has achieved sales and licenses in the U.S., Denmark and England for vaccines to prevent diseases in fish farming. New fish-health products aimed at major aquaculture markets, for instance Japan, should be launched within the next two years.

#### **D. Priority issues identified by the advisory committee during its first year**

1. **Exploiting the "Window of Opportunity" for Industrial Development Provided by New Scientific Advances**
  - Strengthening financial assistance and tax incentives
  - Protecting intellectual property rights
  - Promoting technology transfer to industry
  - Improving access to foreign technology and markets
2. **Strengthening the S&T Capability for Biotechnology**
  - Concentrating talent and resources to achieve world-class scientific groups
  - Training and developing human resources
  - Orienting and linking university and government research to support and stimulate commercial development
3. **Overcoming Fragmentation of and Improving Communications through:**
  - the R&D networks established under the National Strategy
  - Communications vehicles such as newsletters, sourcebooks, seminars, etc.
  - Working groups formed to analyze opportunities in specific sectors such as Agriculture, Health and Forestry
  - Regional meetings involving interested groups and representatives from the provinces
  - International linkages

#### **Biotechnology Policy Needs**

Although biotechnology provides promising commercial opportunities, the long-term and risky nature of the R&D required and the uncertain economic environment have inhibited activities in individual companies. As a result, government policies and assistance will continue to be important to:

- strengthen the science base for the new biotechnology;
- increase industrial research and training;
- encourage investment and industrial participation; and
- improve collaboration of industry with university and government.

Canada has many of the basic ingredients necessary for commercial biotechnology development including:

- good universities and a pool of able graduates;
- abundant natural resources and energy supplies;
- an efficient and well-organized health care system;
- R&D support programmes; and
- favourable R&D tax incentives.

Nevertheless, improvements and adjustments in policy (see D) are necessary to maximize future opportunities and build upon what has already been accomplished.

The Committee's recommendations, aimed at strengthening biotechnology research and accelerating industrial application, reflect the need to stimulate Canada's industries to maintain and develop markets for their products and processes to improve their international competitiveness.

#### **Tax Incentives for R&D**

*Tax incentives* provide an effective means to encourage industrial innovation while leaving the responsibility for selecting the fields for research to the private sector. The tax arrangements as modified in 1984 are expected to provide a reasonable incentive for Canadian biotechnology companies and investors. However, the Committee expressed concerns that:

- Revenue Canada's narrow definition and interpretation of "research" may discriminate against firms where most of the activity is based upon trial development and applications of biotechnology;

**F. Summary of recommendations submitted October 1984 to the Commission of Inquiry on the Pharmaceutical Industry**

In examining the policies which could stimulate research and development, contribute to the growth of the Canadian pharmaceutical sector and also stimulate R&D in other biotechnology fields, the Committee identified proprietary rights issues as being among the most important factors.

Proprietary rights are essential in creating a favourable climate for industrial innovation. Throughout the world, patent legislation has been used to encourage innovation by protecting inventions and assuring prospects for an attractive return on investment and to provide for the dissemination of knowledge.

Using proprietary rights legislation for other objectives, as Canada does to control the price of medicines, runs counter to policies pursued by almost every other developed nation. Within the international and domestic investment communities, there is a perception that Canada does not encourage innovation.

Since biotechnology represents a major opportunity for scientific advancement in the pharmaceutical/health care product fields, the Committee recommended that:

1. The Commission of Inquiry recognize the benefits to the Canadian public of encouraging the activities of an innovative pharmaceutical sector.
2. The Commission recognize the value and encourage the continuation of recent initiatives by the federal and provincial governments to promote commercial biotechnology.
3. Section 41.4 of the Patent Act, relative to compulsory licensing of drugs, be removed in the spirit of restoring the Patent Act to its intended purpose.
4. Section 41.3, which covers compulsory licensing of foods — another area where biotechnology developments will be important — be removed.
5. Appropriate federal and provincial mechanisms be established to address the very real concern over the costs and availability of drugs to Canadians.

**Intellectual Property**

Proprietary rights policies influence investor and corporate decisions on whether to enter innovative and competitive biotechnology fields. With respect to biotechnology, Canada's intellectual property framework is deficient and current policies will inhibit commercial developments in sectors which have special promise for the application of new biological techniques.

There is an urgent need to signal potential investors and the R&D community that Canada has an environment conducive to commercial investments and activities in biotechnology. The Committee has urged that the government give priority attention to intellectual property matters.

The first deficiency involves the use of *compulsory licensing and import provisions of the Patent Act* to control the prices of medicines. This has inhibited both R&D and commercial investment in the Canadian health care sector. In other countries, the health care industries are the leaders in commercial biotechnology and will be major beneficiaries.

The Committee submitted a brief to the Commission of Inquiry on the Pharmaceutical Industry (see F) and underlines the urgency of actions to remedy the situation.

The second area where Canada is out of line with other industrialized countries is the *lack of Plant Breeders' Rights legislation*. New seeds and varieties in Canada do not enjoy proprietary protection and this discourages the commercial development of new and improved crop plants. This is particularly damaging since Canada has scientific strength in agricultural biotechnology.

The Committee has urged that Plant Breeders' Rights legislation be reintroduced to Parliament.

(Agriculture Canada has indicated that the proposed legislation will be reintroduced.)

6. A serious examination of Section 41 in its entirety be carried out to reconsider the necessity of such provisions in view of the potential negative impacts on several major areas of biotechnology — food, agriculture and pharmaceuticals.

#### **G. Examples of federal laboratories which carry out and support biotechnology R&D**

- NRC Biotechnology Research Institute, Montreal
- NRC Plant Biotechnology Institute, Saskatoon
- Agriculture Canada Chemistry and Biology Research Institute, Ottawa
- Agriculture Canada Animal Disease Research Institute, Nepean, Ontario and Lethbridge, Alberta
- Agriculture Canada Food Research Institute, Ste Hyacinthe, Quebec
- Agriculture Canada, Petawawa National Forestry Institute, Chalk River, Ontario
- Health and Welfare Laboratory Centre for Disease Control, Ottawa
- Energy Mines and Resources, Canada Centre for Mineral and Energy Technology, Ottawa
- Environment Canada Wastewater Technology Centre, Canada Centre for Inland Waters, Burlington, Ontario
- Fisheries and Oceans West Vancouver Laboratory, B.C.

The third deficiency is related to *uncertainty over the patentability and disclosure of biotechnology inventions* in Canada. This arises because the Patent Act contains several technical provisions (section 41) which may limit the scope of product patents. Moreover, patentability criteria and disclosure requirements for man-modified living agents (e.g., novel plants and bacteria) in Canada are unclear.

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The Committee has noted that clarifications are required to remove uncertainty over patentability and disclosure.

(The Committee understands that Agriculture Canada, Consumer and Corporate Affairs and the Ministry of State for Science and Technology have been actively considering the intellectual property issues.)

#### **Technology Transfer to Industry**

Although the potential of biotechnology can often be identified at the laboratory research stage, a great deal of energy and cooperation is required to turn the laboratory discoveries into commercial opportunities. The process of technology transfer usually takes years and builds upon years of fundamental research.

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Programmes which make possible and support technology-transfer from university or government laboratories to industry have been recognized by the Committee as critical bridges to commercial biotechnology.

The NRC PILP programmes, NSERC's Industrial Professorship programmes and National Biotechnology Strategy Funds for strengthening federal capacity and scientific interactions, have been particularly important promoters of technology transfer. As the biotechnology programmes of federal departments develop, particularly in the NRC and Agriculture Canada (see G), they can be expected to provide a major impetus to Canadian biotechnology.

### **Improving Access to Foreign Technology and Markets**

Canada produces only a small portion of the world's technology and therefore must have access to technologies developed elsewhere. Any barriers to technology transfer from foreign sources should be removed. Moreover, biotechnology innovations must generally be aimed at international markets. In many cases, Canadian companies with useful biotechnology innovations must link with foreign companies to take advantage of their marketing abilities and to achieve foreign market penetration. An earlier section, *C. Examples of Promising Commercial Biotechnology Developments*, illustrates this point.

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The Committee recognizes that licensing and joint-ventures will be major trends in Canadian biotechnology developments and should be encouraged.



### H. Concentration of talent and resources to strengthen the university science base and training opportunities in biotechnology

The Committee recommended that the federal government provide funding for the establishment of industry-oriented biotechnology groups, built on existing university excellence and strengths in the various regions of Canada.

The Committee suggested that three centres be established initially, each having 5-10 professionals dedicated to carrying out applied research in collaboration with industries. Each group would concentrate on R&D in a specific field which has particular significance to Canadian biotechnology development (e.g., plant molecular biology, bioprocess engineering). Funding and support should come from both government and industry.

#### Objectives:

1. To strengthen and develop internationally recognized groups in biotechnology.
2. To enhance technology transfer and collaboration with industry.
3. To increase training opportunities.

#### Principles:

- Location and selection on the basis of existing scientific strength and excellence, and possibilities for industry collaboration.
- Substantial industrial guidance on projects and participation on management boards.
- Funding for an initial five-year period primarily from government, but within ten years the groups must be largely self-supported from industrial contracts and research grants won in open competitions.

### Concentration of Talent and Resources

The ability to continue to develop biotechnology will depend upon first-class research in fundamental bioscience disciplines.

Adequate support for fundamental research through the Research Councils (NSERC and MRC) is essential. This is illustrated by the situation in the U.S., where the competitive industrial lead in biotechnology is a direct result of the support of fundamental research by U.S. taxpayers through the National Science Foundation and the National Institute of Health. Biotechnology can thrive only in close association with fundamental research in the disciplines upon which it is based.

Excellent Canadian research is being carried out by individuals and organizations in several areas of biotechnology. The scientific base needs to be strengthened by promoting the development of strong and visible university groups which are more productive in research and serve as key locations for training. Such groups also attract industrial collaborations which enlarge the scope of commercial developments.

The Committee recommends that Canada build upon existing strengths at a few universities and establish strong scientific groups oriented to the needs of industry (see H).

The Committee has discussed the development of the *Industrial Professorships Programme* with NSERC. Subsequently, the programme was modified to increase industrial orientation.

It would be desirable to ensure industrial participation in both the management and funding of individual projects supported by NSERC Industrial Professorships.

The Committee recognizes that the NSERC programme, along with similar MRC programmes, are excellent mechanisms to catalyze the development of strong university groups.

■

The Committee urges that other federal and provincial agencies should also support such groups to further consolidate their strength.

Some fields, such as *plant biology* and *bioprocess engineering*, have special significance for Canadian biotechnology development.

■

The Committee recommends that biotechnology professorships be established at selected universities which plan to build high quality groups in fields of strategic significance to Canada, such as plant molecular biology and bioprocess engineering.

These are two of the fields identified by the U.S. National Academy of Sciences as likely to return the highest research dividends if government support is increased.

### **Sustaining Government In-house Capability**

In many fields of basic and applied biology research, federal and provincial government departments have considerable scientific strength (for example, see G). The level of expertise in some centres is highly developed and internationally recognized and government scientists often work in close collaboration with industry and universities. Such expertise is a major component of Canada's present strengths in biotechnology.

■

The Committee recommends that support to this Sector be sustained and built upon as an integral component of national capability.

### **Human Resource Development and Training**

There are about 300 biotechnology researchers in industry, about the same number as in federal and provincial laboratories. Approximately 1000 university researchers are carrying out work in fields related to biotechnology. Although many advanced degrees are awarded each year, the supply of graduates skilled in specific fields such as plant genetics, microbial physiology and bioprocess engineering is limited.

## **I. Biotechnology training**

To augment existing training opportunities, the Committee suggests that new mechanisms be examined:

- to establish 1-2 year programmes to provide cross-disciplinary training to engineers, chemists and microbiologists;
- to provide short-term re-training programmes for working scientists, engineers and managers;
- to sponsor workshops or summer courses on specific topics;
- to allow more interchanges of scientists and managers among industry, university and government;
- to increase training opportunities in finance and marketing and to initiate such training at the under-graduate level; and
- to develop new training models based upon successful training arrangements in U.S., U.K. and Japan.

## **J. Significant federal government biotechnology initiatives 1983**

Establishment of:

- the National Biotechnology Advisory Committee to advise the Minister of State for Science and Technology (\$0.2 million/year);
- a fund administered by the NRC PILP office to support industry/university projects (\$7.7 million/year) (See F);
- biotechnology networks and funding for strengthening federal research programmes and interactions among government laboratories, industries, universities and provincial research organizations (\$3.1 million/year);
- the NRC Biotechnology Research Institute, Montreal (\$61 million);
- the NRC Plant Biotechnology Institute at Saskatoon (\$6 million);

NRC estimates that 54 additional Ph.D. level bioprocess engineers will be needed over the next 5 years. Hardly any are being trained at present. Chemical engineers could substitute in some cases, but few are being trained (32 Ph.D. chemical engineers in 1982) and there is already a strong international demand with excellent opportunities in other well-established fields. An additional problem is that remuneration offered to graduates in biotechnology may not be equal to that offered in other, established industries. There is likely to be a pronounced shortfall in the supply of skilled engineers needed for industrial scale-up of biotechnology processes in Canada.

Senior researchers and research managers with the required industrial experience are also in demand in many countries. Supply is likely to be limited everywhere as biotechnology applications expand. Commercial marketing and financial consultant expertise is also difficult to obtain.

If the growth of biotechnology research in industry, university and government laboratories continues at the present rate, the Canadian demand for biotechnology researchers and managers will double in the next few years. To make better use of Canadian graduates and professionals, training opportunities must be markedly increased.

A good deal of scientific training, particularly in universities, is already underway and steps have been taken through the initiation of NSERC and MRC programmes to provide increased research training opportunities.

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New cross-disciplinary and re-training opportunities are required to better match the training and experience of new graduates as well as employed researchers and managers with the skills in demand (See I).

## **Orientation and Linkage of the Science Base in University and Government to Industry**

The initiatives shown (see J), indicate a significant federal commitment to strengthen Canada's biotechnology capability. The largest component of investment is for the new federally-operated institutes which build upon existing federal scientific strength in biotechnology. The steps taken were designed to rapidly enlarge the national biotechnology efforts.

At the March 1984 Vancouver Workshop on Engineering and Fermentation Aspects of Industrial Biotechnology,

- the Agriculture Canada Food Technology Research Institute, Ste. Hyacinthe, Quebec (\$30 million); and
- a major Science Council study on Biotechnology in Canada's Natural Resource Sectors.

the Committee noted the importance of information and communication:

- to raise awareness of biotechnology activities in Canada so that potential users can have access to existing and planned facilities; and
- to avoid duplication of expensive facilities.

In the spirit of the cooperative theme of the National Strategy, it is crucial that the industry, university and government research sectors share and collaborate as much as possible to maximize the utilization of facilities and expertise.

### 3. Networking to Overcome Fragmentation and Improve Communications

#### K. Biotechnology networks

##### **Purpose and Organization:**

Networks are associations that link the scientists who produce basic knowledge with those who develop and apply the knowledge in order to strengthen the industrial relevance of biotechnology research. Each network is administered by a federal science department.

Membership is open to industry, university and government representatives actively working in relevant fields. To ensure effective communication and collaboration, the networks' operations are directed by the participants. Each network holds at least one meeting per year where topics relating to research, commercial goals, industrial problems, regulations and policies are discussed.

<i>Area</i>	<i>Coordinating department(s)</i>
Nitrogen Fixation, Plant Strain Development	Agriculture Canada
Human and Animal Health Care Products <b>BIONET</b>	National Health and Welfare and Agriculture Canada
Mineral Leaching and Metal Recovery <b>BIOMINET</b>	Energy, Mines and Resources
Forest-based Industries <b>BIOFOR</b>	National Research Council

#### **National Strategy Networks**

Networks are designed to provide the opportunity for industry, government, university and financial groups to exchange information and plan cooperative projects. Major goals are the acceleration of the transfer of information between the producers and users of scientific knowledge and raising the awareness of Canadian commercial opportunities, industrial problems and research advances. National Biotechnology Strategy R&D networks (see K) have been formed in each priority area with federal departments serving as administrators. Each network is led by an elected steering committee. Due to their initial success, additional networks are being formed in agricultural and forestry pest management and waste utilization.

Participants have reported that several cooperative research projects have been launched as a result of network activities. For example, BIOMINET activities have resulted in the successful integration of federal and university R&D with a Denison Mines' major demonstration project of in-place bacterial leaching at Elliot Lake, Ontario.

The networks also serve as a forum for discussion of policy issues facing the biotechnology community. The networking concept, developed as a unique Canadian approach to overcoming fragmentation of effort caused by geography and a thinly spread industrial and science base, has attracted attention in the U.S. and other countries.

The Committee has recognized that networking and cooperation among industries, universities and governments, along with targeted assistance, are helping to bring together and focus Canada's biotechnology efforts.

#### **Communications**

In a large and diverse country such as Canada, it is important for biotechnology researchers and managers to keep up with policy, financial and scientific developments. Additional national communications vehicles are required.

The Committee has recommended that:

- the Secretariat produce a "Biotechnology Sourcebook" which will serve as a guide to the key industry, university and government R&D groups, consultants and sources of financing; and

## **L. National Biotechnology Advisory Committee publications**

- Proceedings of the March 1984 Workshop on Engineering and Fermentation Aspects of Biotechnology
- Biotechnology in Agriculture — Presentations at the June 1984 Workshop (prepared by Agriculture Canada)
- Plant Breeders' Rights — Presentations at the June 1984 Workshop (prepared by Agriculture Canada)
- Brief to the Commission of Inquiry on the Pharmaceutical Industry, October 9, 1984
- Proceedings of the November 1984 Workshop on Biotechnology in Saskatchewan

## **M. National Biotechnology Advisory Committee workshops**

- Fermentation and Bioprocessing — Vancouver, March 1984
- Biotechnology in Agriculture, Plant Breeders' Rights — Ottawa, June 1984
- Saskatchewan Biotechnology — Saskatoon, November 1984
- Biotechnology in the Maritime Provinces — planned for Halifax, July 1985.

- MOSST explore the establishment of a national biotechnology newsletter. The goal is to improve communications and awareness among the Canadian industrial, research and policy communities and to effectively convey information on government policies and financial incentives.

The Committee has noted that the network newsletters and membership databases are steps in the right direction. In addition, the Committee Secretariat has produced several publications (see L). Effective communication not only enhances awareness but also contributes to building confidence.

## **Strategic Sector Studies**

The Committee has formed working groups to provide strategic analyses, communicate Canada's opportunities and derive recommendations related to the sectors where biotechnology will have major impacts: agriculture; health; forestry; environment; and chemicals.

The first three sector studies are to be carried out during 1985. The objective is to bring more detailed analyses to bear on the critical Canadian biotechnology development issues and to be more precise in recommending implementation mechanisms. The joint efforts of the members of the working groups, made up of both committee and external representatives, will also serve the purpose of involving more people in considering national biotechnology issues.

## **Regional Activities**

During 1983 and 1984, the Committee met in Montreal, Ottawa, Toronto, Saskatoon and Vancouver. *Workshops* were held and are being planned to discuss and identify key biotechnology development issues (see M). Workshop participants have been appreciative of the Committee efforts to bring national and regional representatives together.



As the Committee has no official *provincial representatives*, provincial Ministers with responsibility for S&T or biotechnology have been informed of the existence of the Committee and have designated officials to serve as liaisons. Workshops and related committee meetings held outside the National Capital Region have provided the opportunity for participation of representatives from the provinces. Provincial representatives have contributed to a better understanding of the regional needs in biotechnology.

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The Committee has recognized the need to more extensively explore the provincial biotechnology developments and their relationship to the National Strategy.

### **International Linkages**

Canada has active collaborations in biotechnology with several countries (U.S., U.K., Japan, France, Germany, etc.). Such international cooperation allows Canadian scientists to exchange the most up-to-date research information.

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It is important to develop policies to govern and promote beneficial scientific and technological exchanges while safeguarding Canadian proprietary interests.

(The Committee understands that the Ministry of State for Science and Technology and the Department of External Affairs intend to review Canada's international S&T relations in biotechnology.)

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Canada should also aim to encourage linkages between Canadian industries and those of other countries.

The France-Canada Conclave at Chateau Montebello, Quebec, April 27-28, 1984, organized by the Committee Secretariat and the Department of External Affairs, is an example of the effort which may be necessary to bring together industrialists.

## 4. Future Activities

### **N. Priorities for the committee's future attention:**

- strategic analyses to identify problems and opportunities in agriculture, health and forestry;
- further efforts to strengthen the scientific and training base for future biotechnology developments and to enhance technology transfer to industry;
- assessing mechanisms which would provide improved financing for industrial biotechnology developments;
- clarifying the regulatory framework to ensure safety and to allow effective planning for industrial biotechnology developments;
- monitoring the proprietary rights situation with respect to pharmaceuticals (compulsory licensing provisions of the Patent Act) and agriculture (Plant Breeders' Rights); and
- exploring provincial strengths in biotechnology and improving communications and networking.

The Committee proposes to build upon the work already carried out by examining issues which relate to industrial development, strengthening and orienting the S&T base for biotechnology, and communications (see N).

Through meetings and contacts with regional groups and representatives of industrial sectors, the Committee intends to continue its efforts to improve communications among industry, university and government and to identify the policies and resources required to facilitate commercial biotechnology developments.

*The overriding priority for the Committee* is to persuade the government that if Canada is to take advantage of the current window of opportunity in biotechnology, the pace of development must be accelerated in sectors of special significance to Canada through substantially greater investment, both in the science base and in technology transfer programmes.

**Annex I****National Biotechnology Advisory Committee  
(Initial Membership, October 1983)**

		Initial term of appointment (years)
Dr. J.R. Evans (Chairman)	Chairman and Chief Executive Officer ALLELIX LTD. Mississauga, Ontario (Physician)	3
Dr. D.B. Shindler (Secretary)	Project Director Biotechnology MINISTRY OF STATE FOR SCIENCE AND TECHNOLOGY Ottawa, Ontario (Microbiologist)	3
Dr. A. Beaulnes	Director INSTITUT ARMAND-FRAPPIER Montreal, Quebec (Physician)	3
Dr. R.G.S. Bidwell	I.W. Killam Research Professor DALHOUSIE UNIVERSITY Halifax, Nova Scotia (Biologist)	2
Dr. W.A. Cochrane	Chairman and Chief Executive Officer CONNAUGHT LABORATORIES LTD. Willowdale, Ontario (Physician)	3
Mr. J.V. Cross	President PHILOM BIOS INC. Saskatoon, Saskatchewan (Engineer)	2
Mrs. R. Dionne-Marsolais *	Independent Advanced Technology Consultant and Financial Advisor Montreal, Quebec (Economist)	3
Dr. J.R. Duffy	President DIAGNOSTIC CHEMICALS LTD. Charlottetown Prince Edward Island (Chemist)	3

Dr. J.A. Fortin*	Professor of Forestry LAVAL UNIVERSITY Quebec, Quebec (Biologist)	3
Dr. J.D. Friesen	Chairman, Department of Medical Genetics UNIVERSITY OF TORONTO Toronto, Ontario (Molecular Geneticist)	2
Prof. B.A. Holmlund	Vice-President Special Projects UNIVERSITY OF SASKATCHEWAN Saskatoon, Saskatchewan (Electrical Engineer)	3
Dr. L. Jurasek	Head Biological Chemistry Section PULP & PAPER RESEARCH INSTITUTE Pointe-Claire, Quebec (Microbiologist)	3
Dr. J.G. Kaplan	Vice-President, Research UNIVERSITY OF ALBERTA Edmonton, Alberta (Biochemist)	3
Dr. D.G. Kilburn	Professor of Microbiology UNIVERSITY OF BRITISH COLUMBIA Vancouver, British Columbia (Biochemical Engineer)	2
Mrs. M. Lamontagne	Corporate Director Quebec, Quebec (Chemistry/Business)	3
Dr. G.R. Lawford	Technical Director WESTON RESEARCH CENTRE GEORGE WESTON LTD. Toronto, Ontario (Biochemist)	3

Dr. D.S. Layne	Vice-President, Research TORONTO GENERAL HOSPITAL Toronto, Ontario (Biochemist)	3
Dr. A.V. Mode*	Director B.C. RESEARCH Vancouver, British Columbia (Engineer)	2
Prof. H.R.S. Ryan*	Professor of Law QUEEN'S UNIVERSITY Kingston, Ontario (Lawyer)	2
Mr. D.J. Saxby	President PACIFIC ISOTOPES AND PHARMACEUTICALS LTD. Vancouver, British Columbia (Business Administration)	2
Dr. M. Brossard	Vice-President, Biotechnology NATIONAL RESEARCH COUNCIL Ottawa, Ontario (Biochemist)	3
Dr. E.J. LeRoux	Assistant Deputy Minister Research AGRICULTURE CANADA Ottawa, Ontario (Biologist)	3
Dr. K. Whitham	Assistant Deputy Minister Research and Technology DEPARTMENT OF ENERGY, MINES AND RESOURCES Ottawa, Ontario (Geophysicist)	3

Mr. R.H. McGee	Assistant Deputy Minister Consumer Goods DEPARTMENT OF REGIONAL INDUSTRIAL EXPANSION Ottawa, Ontario (Public Administrator)	3
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Dr. L.A. Slotin	Director Programs Branch MEDICAL RESEARCH COUNCIL Ottawa, Ontario (Biochemist)	3
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- Members are appointed by the Minister of State for Science and Technology, and are eligible for reappointment.
- Members receive no remuneration for their service but are reimbursed for travel/accommodation expenses associated with Committee meetings and functions.

\*resigned



## Annex II

### Committee Activities

April 1983	<i>National Biotechnology Strategy</i> approved by the government — MOSST directed to implement.
September 1983	<i>Minister nominates Committee</i> members and Chairman.
October 26, 1983	<i>First Meeting</i> of Advisory Committee held in Montreal. Following the meeting, the Committee met and discussed issues with the Minister and with the Chief Science Advisor.
December 12, 1983	<i>Second Meeting</i> of Advisory Committee, Toronto.
January 24, 1984	<i>Chairman meets with Minister</i> and Chief Science Advisor and presents first set of recommendations.
February 2, 1984	<i>Committee delegation</i> led by Chairman meets Minister of Consumer and Corporate Affairs to discuss effects of Patent Act compulsory licensing stipulations on Canadian biotechnology developments.
March 18-19, 1984	<i>Workshop on Fermentation and Engineering Aspects of Biotechnology</i> and <i>third meeting</i> of Advisory Committee, Vancouver.
April 27-28, 1984	<i>Canada / France Biotechnology Conclave</i> at Montebello, Quebec, where business, financial and government leaders discussed and planned cooperation and joint ventures. The event was organized by the Committee Secretariat.
June 27-28, 1984	<i>Workshop on Agricultural Biotechnology</i> and <i>fourth meeting</i> of Advisory Committee, Ottawa. Committee adopts work plan based on analyses of impacts of biotechnology in sectors: Agriculture; Health; Forestry; etc.
September 6, 1984	<i>Fifth meeting</i> of Advisory Committee, Ottawa.
October 9, 1984	<i>Committee submits Brief</i> to the Commission of Inquiry on the Pharmaceutical Industry.
October 23, 1984	<i>Chairman meets with Minister</i> , the Honourable Tom Siddon, and with the Chief Science Advisor.
November 20-21, 1984	<i>Workshop on Biotechnology Opportunities in Saskatchewan</i> and <i>sixth meeting</i> of Advisory Committee, Saskatoon.

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A photograph of a light brown, textured folder or envelope. The top edge shows a white sheet of paper with a black grid pattern, partially inserted into the folder. The folder is set against a dark background.

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