



Growing Our Future
An Integrated Life Sciences Strategy for Alberta



Alberta Science and
Research Authority



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EXECUTIVE SUMMARY

THE IMPORTANCE OF LIFE SCIENCES

Life sciences is our developing knowledge of living organisms and the use of that knowledge to grow and do things that improve our lives. Developments in life sciences will change all our lives in fundamental ways – how we live and die – what we work at – the things we eat – how we manage our health. Alberta has the choice of either walking the path of change life sciences will create, or helping determine the direction of that path.

THE ECONOMICS OF LIFE SCIENCES

Life sciences is a significant element of the Alberta economy. It will make an increasing contribution to traditional and new value-added activities in agriculture and agrifood, forestry, environment and health. In 2001, it had combined revenues of \$13.45 billion and employed more than 35,000 workers.

Alberta's life sciences sector is growing. Exports of value-added ag and forestry products are increasing. In biotechnology, a core element of the life sciences, the two largest finance and partnering deals done in Canada since 2000 involved Alberta companies. The current market capitalization of Alberta biotech companies is close to \$1 billion.

Though Alberta's life science sector is growing, it is not growing at a rate in keeping with the global industry. The current global biotechnology market is \$60 billion with annual growth of 25 per cent. It is expected that by 2010, \$3,000 billion worth of goods will be biotechnology based, derived or processed. Alberta wants a share of this growth.

THE POTENTIAL FOR GREATER GROWTH

The high technology portion of life sciences is the area with the greatest potential for growth. This area will make a vital contribution to meeting the targets for the more broadly defined life sciences sector. However, businesses in this area face real challenges. The development time for products is longer than in most industries. Often, new companies do not begin to realize a profit until 10 years after startup, depending on the product and the regulatory system.

High-tech life sciences includes the emerging biotechnology and biomedical device industries as well as functional foods and nutraceuticals. Revenue in these areas of rapid growth was \$280 million in 2001, and may exceed \$1.5 billion by 2010.

SUSTAINING ALBERTA'S ECONOMIC GROWTH

Agriculture, energy, forestry, health, and Information and Communications Technology (ICT) are currently the key drivers of Alberta's economy. However, global developments are dramatically changing the playing field for these traditional economic sectors.

Margins on commodity products are decreasing. The need for the sustainable development of our natural resources will impact our economic growth. Health systems are facing local, national, and international pressures. Knowledge is becoming the basis of the new economy.

Life sciences is key to maintaining the economic prosperity that has made Alberta the envy of Canada. If Alberta takes the lead in life sciences innovation, the health and well-being of Albertans will be enhanced. Our economy will be stronger, more diversified, and sustainable.

THE GOAL

Implementation of the Life Sciences Strategy, will allow Alberta to accelerate its bioeconomy through innovation and bioproducts that will help provide a sustainable quality of life for all Albertans.

By 2020, the life sciences industry will generate \$55 billion in revenue and 70,000 new high tech and value-added jobs will be created.

AREAS OF OPPORTUNITY

Alberta can compete effectively. But given the scope of life sciences, Alberta must concentrate on areas in which it can build on its current strengths and/or exploit existing opportunities. This is why the Life Sciences Strategy focuses on developing opportunities in:

- Bioproducts and biomaterials
- Bioenergy
- Health
- Nutrition
- Environment and Climate Life Sciences.

Development of new and existing strengths in these areas will produce the opportunity to create value in traditional sectors that is far beyond current levels and to ensure that economic growth is sustainable.

THE BENEFITS OF CONVERGENCE

Life sciences is about the power of convergence. Alberta has an opportunity to build at the overlap of traditional sectors by capitalizing on the strengths that already exist in Alberta – leadership – high quality people – a robust business environment and research excellence.

For example, work at the intersection of agriculture, health and nutrition could produce a significant functional foods and nutraceuticals industry based on foods and food ingredients or extracts that have been developed to provide a health benefit beyond the traditional nutrients they contain. The growth of this industry could enhance individual health, reduce the stress on the health system, and strengthen Alberta's agricultural economy.

Similar opportunities exist at the intersection of forestry, energy, agriculture, environment and ICT.

Potential synergies like these make the life sciences key to producing real and lasting benefits to Albertans.

WHAT IS NEEDED?

A number of factors will determine if life sciences is to play a real role in Alberta's economic development.

Access to Specialized Capital Start-up and development capital is in short supply for businesses in this sector. Because of long product development and approval times (5-10 years) significant patient capital is required.

More High Quality People Because of the highly specialized knowledge involved, there is a current shortage of research, technical and management expertise in this sector.

Increased R&D Capacity Increased investment and coordination of research activities are imperative for the development of new technologies, processes, and products. A consolidated and focused funding system



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improves performance as does development and expansion of networks and partnerships among universities, industry, and government agencies.

Greater Commercialization Ability Enhanced capability to commercialize scientific and technological developments.

A Fertile Business Environment – Policies to improve the environment for the growth of high-tech life sciences businesses because of their specific needs.

A Supportive Community – Public acceptance and encouragement of life science-based initiatives to enhance the quality of life.

IS IT DOABLE?

By addressing these issues, other jurisdictions have had great success.

In 1981, North Carolina made a commitment to developing its biotechnology sector, a core component of the life sciences, and created a strategy for doing so. Since then more than 100 bioscience companies have headquartered in North Carolina. Products and services to the biotechnology industry are provided by 150 companies. Current annual revenues related to the industry are USD \$1.8 billion. By 2020, revenues are expected to grow to USD \$20 billion. Currently, more than 20,000 people are employed in biotechnology related occupations. By 2020, it is expected that 100,000 people will be employed in the sector.

Alberta has the advantage of being able to learn from the success of others. With an integrated strategy in place, Alberta has the potential to achieve success.

IMPLEMENTING THE STRATEGY

The Life Sciences Strategy is about coordinated innovation. It is about bringing together health, agriculture, forestry, environment, energy, and ICT into new areas of opportunity in the cross-sectoral platform technologies of functional genomics, proteomics, informatics, biodiversity, and nanobiotechnology. It is also about building a successful, sustainable bioeconomy.

The Life Sciences Strategy will:

- Establish Alberta's leadership in strategic areas of life sciences research, development, and industry innovation.
- Build life sciences research capacity and excellence.
- Ensure a progressive and innovative business climate to foster and sustain industry innovation and growth in the life sciences.
- Harmonize development of the life sciences with Albertan values and goals.
- Develop, attract, and retain high quality people in the life sciences.

The Life Sciences Strategy will enable Alberta to take a giant step toward a sustainable future.



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INTRODUCTION

WHY A LIFE SCIENCES STRATEGY?

The Life Sciences Strategy outlined in this document is in keeping with ASRA's mandate to develop science and research policies and priorities compatible with economic and social priorities of the government. The intent is to allow Alberta to take advantage of the economic opportunities presented by the global growth of the life sciences. The strategy focuses on the best methods for developing the people, research capacity, businesses, and actions required to do so within a framework that reflects the values and priorities of Albertans.

STRATEGY DEVELOPMENT PROCESS

The Life Sciences Strategy is the result of public consultations and earlier efforts including the *Commercialization of Biotechnology in Alberta (1995)* and the *Health Research Strategy (2000)*. It is an essential element for further strategic developments in agriculture, forestry, health, and the environment.

The Life Science Strategy rounds out the high-tech component of Alberta's 2001 economic development strategy, "*Get Ready Alberta: Strengthening the Alberta Advantage*" complementing the *Information and Communications Technology Strategy (1998)* and the *Energy Research Strategy (2001)*. Together, these put Alberta on track to become a world leader in innovation, research, development, and commercialization of new ideas.

DOCUMENT STRUCTURE

This document is divided into two major sections.

The first section provides background information on life sciences including:

- economic importance to Alberta
- role in creating a sustainable future for Alberta
- potential benefits to various sectors of the Alberta economy
- the current resources Alberta can use to develop a bioeconomy
- issues and concerns related to developments in life sciences.

The second section of the document outlines life sciences goals, action plan, and enabling strategy.

WHAT IT ALL MEANS

To truly appreciate the developments and issues in life sciences, and the magnitude of the challenges and opportunities they present, a basic understanding of the vocabulary of the field is needed. Brief explanations of the frequently used terms are provided in Appendix I of this document.

AN OVERVIEW OF LIFE SCIENCES

WHAT IS LIFE SCIENCES?

In essence, life sciences involves anything to do with biology. It encompasses everything from agriculture and forestry, to genetic research and health care products and procedures.

THE IMPORTANCE OF LIFE SCIENCES

The importance of life sciences is illustrated by this quote from David S. Weir, director of the Delaware Biotechnology Institute and former vice president of global research and development at DuPont.

The study of the life sciences and the development of biotechnologies are aimed at understanding how natural systems function, then applying that understanding to improve the quality of life.

Genomics holds the promise of curing diseases that have plagued humans since the beginning of time. It holds the promise of repairing environmental damage and of improving the quality and quantity of agricultural production. It also allows us to begin the transition to a sustainable, biologically-based production system...

A LEAP INTO THE FUTURE

Human development is not just a continuous, interconnected series of events that build one upon the other. It is about leaps created by new technology – the wheel – iron smelting – electricity – the microchip.

Life sciences presents the next quantum leap into the future. The technological developments of the 20th century have changed how we live and die, work and play. As this document illustrates, life sciences has the potential to have a profound effect on all aspects of life in the 21st century.

The life sciences will change our world more in the next 50 years than electronics technology has in the last 50 years, and Alberta can be a leader in this transformation, creating lasting economic, social and scientific benefits.

THE IMPACT OF LIFE SCIENCES

Current activity in life sciences will directly affect the nature of the food we eat, how we prevent and treat sickness and disease, how we harvest our forests and power our cities. What we do or don't do in regard to life sciences will both directly and indirectly help determine Alberta's rate of economic growth and job creation.

The choice facing Alberta is clear: Do we buy the products and services created by life sciences, or do we participate in the creation of those products and services and sell them to Canada and the world?

This document outlines an integrated strategy designed to improve the quality of life and the sustainable prosperity of Albertans by creating a globally competitive bioeconomy based on innovative life sciences products, processes and services.



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THE ECONOMICS OF LIFE SCIENCES

Sustainability is key to Alberta's future and life sciences will help reduce our dependence on non-renewable resources. Our ever-increasing technical knowledge of living things can be used to create new, renewable "bioproducts." These include alternative energy sources, medical and health products, and new or improved foodstuffs.

It is estimated that by 2010 there will be more than \$3,000 billion worth of products and services that will be biotech, biotech-derived or biotech processed. It is also estimated that globally biotech will create 3 million new direct and indirect jobs by 2010.

Alberta's share of the economic development and job creation that will accrue from life sciences will depend on what it does in the immediate future.

THE RACE IS ON

Globally, a limited number of centres of excellence will emerge. About three quarters of these are already in place. Other provinces, American states, and countries are developing their life science sectors.

British Columbia, Saskatchewan, Ontario and Quebec all have initiatives underway.

Alberta has already made a mark in the area of life sciences. The scope of activities and the real depth of Alberta's expertise in this area can be readily ascertained by examining the list of life sciences organizations in Appendix II of this document. If we intend to build on this strength, we cannot afford to wait.

CAPTURING THE POTENTIAL

To fully benefit from the life sciences, Alberta must increase its performance in developing ideas and in commercializing them.

BUILDING ON OUR STRENGTHS

Alberta has an active life sciences community with several key areas of strength. In these and other areas, new developments are occurring rapidly. This activity is supported by the activities of provincial funding bodies such as Alberta Heritage Foundation for Medical Research (AHFMR), Alberta Ingenuity Fund, and the research institutes for agriculture, forestry and energy. It is performed at the research universities in Calgary, Edmonton and Lethbridge, by the Alberta Research Council and by numerous other private and public organizations, both small and large. Building on the success of this community is a logical next step in Alberta's development.

PLATFORM TECHNOLOGIES

Alberta is developing strengths in several platform technologies that provide a base for further development of life sciences products and processes.

Genomics and Proteomics – The expertise concentrated at Alberta's three research universities is being used to develop novel and exciting initiatives with far-reaching potential applications such as Project CyberCell and a beef genomics initiative.

Bioinformatics – Alberta is quickly moving to the forefront in this area. It is building on the growing expertise throughout the province, including the Sun Visual Genomics Lab and the Genome Canada bioinformatics platform project led from Alberta.

Nanobiotechnology – The National Institute of Nanotechnology being developed in Edmonton will make Alberta the national

focus of efforts to develop this field that includes significant activity at the interface of biology and nanotechnology.

BIOMEDICAL RESEARCH

More than 20 years of work by the Alberta Heritage Foundation for Medical Research has succeeded at attracting and developing world-class biomedical researchers. As a result, Alberta has developed significant expertise in many areas of biomedical research:

- Cardiovascular Research
- Bone and Joint
- Vaccines for Infectious Diseases
- Cancer especially Reovirus, Vaccines, Diagnostics, Epidemiology
- Diabetes and Islet Transplantation Research – Edmonton Protocol.

AGRICULTURE, FORESTRY AND ENVIRONMENT

Alberta has developed life science expertise in several areas related to primary industry in these areas, value-added products and resources and environmental management. These areas of opportunity overlap with energy and health concerns and include:

- Sustainable forest and agricultural production
- Plant-based bioproducts
- Functional foods and nutraceuticals
- Environmental enhancement.



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THE POWER OF CONVERGENCE

Agriculture, energy, forestry, health, and ICT are currently the key drivers of Alberta's economy. Though each of these sectors has its own unique strengths, they and their efforts at innovation have the potential to interact with one another to create a whole that is much stronger than its parts.

Adequate funding, a supportive environment for growth and coordinated research, development and innovation are the keys to success.

The energy driving the phenomenal growth in life sciences is being created by the convergence of scientific disciplines. The silos that previously isolated researchers in different fields have come down. Researchers are now working together, sharing their successes and discussing their challenges in order to determine if what has been discovered in one area has applicability to another. They often find that they have been looking at the same problem, but from entirely different perspectives.

The opportunities for cross-discipline and cross-sector activity are limited only by imagination and desire. Project CyberCell shows how diverse Alberta expertise can be focused on basic science with profound medical applications.

Project CyberCell is a developing computer simulation of an *E. coli* cell to extend the research of microbiologists and biochemists studying this important organism. It is well within the realm of possibility that the computer simulation technology used in the oil patch to model oil reservoirs can be used

to visualize drug effects on a simulated *E. coli* cell and revolutionize drug discovery. But to make this happen researchers require the experience and abilities of database experts to manage the data, computer simulation experts to do the modeling, and visualization experts to make the results of the simulations visual and interpretable.

Examples such as this exist throughout the Alberta life sciences, and are providing new opportunities for research, business growth and enhanced quality of life.

THE BENEFITS OF LIFE SCIENCES

HEALTH

The quality and sustainability of Alberta's health care system is vital to Albertans. As recognized in the Mazankowski Report, (*A Framework for Reform: Report of the Premier's Advisory Council on Health*, 2001), R&D is a key element of creating and maintaining a successful health system. Life sciences research has the potential to develop:

- more cost-efficient methods for the treatment of sickness and the prevention of disease
- functional foods which can help maintain health
- new, less costly, and more effective made-in-Alberta therapies
- methods for reducing environmental factors that negatively impact health
- ways to incorporate research findings from other areas (agriculture, forestry, energy, information and communications technology) into health care.

The Alberta Heritage Foundation for Medical Research shows what a strategic focus can produce. Established by the Government of Alberta in 1980, the Alberta Heritage Foundation for Medical Research (AHFMR) supports biomedical and health research at Alberta universities, affiliated institutions, and other medical and technology-related institutions. AHFMR has funded more than \$700 million in medical research since its inception and has contributed to the growth of significant medical research strength in the province.

Life sciences research holds great promise for maximizing human health and minimizing the social and economic effects of disease. This is particularly true for diseases generally associated with an aging population. Globally, research is underway to find ways of re-growing brain cells destroyed by diseases such as stroke, as well as Parkinson's, Alzheimer's, and Huntington's diseases.

The Edmonton Protocol for Pancreatic Islet Transplantation is one example of the kinds of breakthroughs that can be achieved by the right mix of governance, research funding, expertise, and focus. By working together on a common problem, researchers from various fields have created hope for millions of diabetics and have made the world aware of the medical expertise that exists in Alberta.

Economic Opportunities: Alberta's experience has already shown that health research attracts investment and encourages entrepreneurship. The end result is often the creation of marketable products and the development of spin-off companies that create high-paying jobs. By increasing this trend Alberta can become a significant player in the national and international health industry as well as in the biomedical research sector.



NUTRITION: THE HEALTH – AGRICULTURE CONVERGENCE

Human nutrition is at the core of both health and agriculture. The increasing overlap of these areas, both scientifically and practically, creates enormous potential for the Alberta life sciences to develop:

- the best possible foods
- functional foods tailored to address specific health issues
- safe edible vaccines to prevent infectious disease
- nutraceuticals as disease treatments.

Alberta is already building a functional foods and nutraceuticals industry building on research conducted at the three research universities. Further work in these areas and other contact points between agriculture, nutrition and health is a key focus of the agricultural research plan currently being developed for Alberta.

Economic Opportunities: Growth is already occurring at the intersection of agriculture and health. Increased focus and effort resulting through the broad development of the life sciences will not only improve rural economies but also enhance the nutrition and health of all Albertans.

A BETTER ENVIRONMENT THROUGH SUSTAINABLE PRIMARY PRODUCTION AND CLEAN INDUSTRY

The Government of Alberta is committed to resource development and management that does not put the environment at risk. This commitment is reflected in its endorsement of *Alberta: Working for a Sustainable Future* (1992) authored by the Alberta Round Table on Environment and the Economy. Life sciences holds the promise of reducing environmental impacts and repairing existing damage to the environment by developing:

- crops and trees that are inherently pest and disease resistant resulting in reduced pesticide use
- new nitrogen-fixing crops that reduce fertilizer use
- improved land management practices
- economical life science-based industrial processes
- modified biological processes that can clean contaminated environments
- improved, bio-based monitoring systems that provide early warning of environmental degradation.

Economic Opportunities: Positive developments in sustainable production will maintain a healthy environment for future generations that is good for people and for business. They will also improve the bottom line for primary producers through reduced input costs, lead to new exportable crops, products and processes, and allow Alberta to develop a significant environmental business sector.

BIOENERGY

The bioenergy sector can be developed to fully utilize our energy-related life sciences capacity in a way that makes sense for Alberta and that will maintain existing industries while developing new ones. There is potential for Alberta to:

- make existing sectors more efficient by utilizing forestry and agricultural by-products as energy sources
- employ bioenhanced systems to improve tar-sands extraction and processing
- create a clean bioadditive and biofuel industry to complement existing energy strengths.

Alberta is already developing expertise in biofuels and is funding research to explore life sciences options for improving other energy development.

Economic Opportunities: Sustainability of Alberta's energy industry will require making the highest and best use of our petrochemical resources. Bio-based fuels such as fermentation ethanol present an opportunity for replacement of petrochemicals with renewable resources. Ethanol is important because it can be used for the production of chemicals used for solvents, synthetic fibres, clothing, paints, and plastics.

BIOMATERIALS – NEW OPPORTUNITIES IN FORESTRY AND AGRICULTURE

Alberta's 2010 targets for value added revenues in forestry and agriculture are \$7 and \$20 billion respectively. To reach these targets Alberta will have to improve its existing activities and quickly develop new business areas. Biomaterials is one area with tremendous potential for these industries. There are also many potential uses for bioproducts in the health and environment sectors. Some of the opportunities that could be developed in Alberta are:

- creating blended fibre products
- using crops and trees as factories to produce pharmaceutical and industrial compounds
- utilizing by-products to develop new business lines, like making ethanol from straw
- growing wood with properties tailored to specific end-uses
- using nanotechnology to create new products by linking biological and other materials at the molecular level.

These and other areas are included in focused research being developed in Alberta.

Economic Opportunities: From a life sciences perspective, trees, forests and agricultural environments are underdeveloped resources. Integration of Alberta's life sciences research and development activities in these areas will create the potential to develop entirely new industries based on agriculture and forestry.



ICT – BIOINFORMATION RUNS THROUGH IT

Bioinformatics is key to the capture and use of the massive amounts of data created by life sciences research. Not only is this area essential for success in Alberta’s other areas of life science opportunity, it is also a significant opportunity in its own right.

Alberta’s private sector has a history of working with large amounts of highly dispersed data. The geomatics group at the University of Calgary has become a world leader and Calgary has become a major centre for wireless and Information and Communications Technology (ICT) development. Building on this, the development of significant bioinformatics excellence in Alberta has us poised to create another ICT cluster of activity at the interface of life sciences and ICT.

In conjunction with cellular/molecular biology and nanotechnology, ICT technology is also being used to create “biochips.” Biochips test for disease and perform many complex diagnostic procedures that previously took a great deal of time and could only be conducted in laboratories. The implications for faster health care delivery and cost reduction are significant.

Economic Opportunities: Alberta has a strong information and communications technology industry. As a result, there are significant opportunities to exploit the growing convergence of life sciences and technology. This is particularly true for the areas of biodata mining and management and Alberta-based biochip development for which there are global markets.

This interface may be one of the areas that Alberta can rapidly grow to economic significance given the rapid rate of development, Calgary’s pre-eminent position and the relative lack of regulatory barriers compared to other sectors of the life sciences.

KEY AREAS OF THE LIFE SCIENCES STRATEGY

The Life Sciences Strategy has four key areas of focus:

- Life sciences research
- Moving ideas from the lab to market.
- Life sciences education
- Responding to ethical and moral concerns.

LIFE SCIENCES RESEARCH

The Life Sciences Strategy concentrates on focusing research and development in Alberta's areas of life science opportunity. Some of the greatest opportunities occur when the research in one field has an application to another. For example, genomic research has applicability not only to human health, but agriculture and forestry as well. The Life Sciences Strategy is geared towards creating increased focus on these kinds of research opportunities.

TAKING IT TO MARKET

The Life Sciences Strategy recognizes that dollars committed to research and development are expected to create a return on investment. The focus is on streamlining the take-to-market process and reducing the time lag between expenditure and economic return. By working with others in the development of a positive environment for life sciences businesses, the strategy will stimulate improvement in this critical area.

LIFE SCIENCES EDUCATION

A bioeconomy driven by life sciences presents both benefits and challenges to all levels of education in Alberta.

The strategy outlined in this document will triple the life sciences work force by 2020. Albertans should be first in line for those jobs. To ensure that is the case, the life sciences strategy will work with the education and research systems to develop people with the skills to move the life sciences forward.

RESPONDING TO MORAL AND ETHICAL CONSIDERATIONS

Research and development in the life sciences raises social, legal, health and safety issues. As in other areas, work must proceed to make the development of science and technology best serve Albertans. Issues that must be addressed include:

- Morals and ethics – recent debates over stem cell research and cloning are cases in point.
- Safety – are new products, foods and health treatments as safe as traditional alternatives.
- Environmental protection – what are the environmental risks of using new life sciences products, for example genetically modified plants.

To address these issues, the Life Sciences Strategy will develop ways of providing balanced information, engaging those concerned in reasoned dialogue, and making development activities responsive to Albertans' goals and values.



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AN ENABLING STRATEGY FOR ALBERTA LIFE SCIENCES

This section lays out the mission and vision for Alberta Life Sciences and the strategies and critical actions for fulfilling the mission and vision.

MISSION

By 2020, Alberta will have accelerated its bioeconomy through innovation and bioproducts that ensure a sustainable quality of life for all Albertans.

VISION

The life sciences will generate \$55 billion in revenues by 2020 and will have created 70,000 new high-tech and value-added jobs.

STRATEGIES

- Establish Alberta's leadership in strategic areas of life sciences research, development, and industry innovation.
- Build life sciences research capacity and excellence.
- Ensure a progressive and innovative business climate to foster and sustain industry innovation and growth in the life sciences.
- Harmonize development of the life sciences with Albertan values and goals.
- Develop, attract, and retain high quality people in the life sciences.

To implement these strategies, several key actions must be taken. The summary in Table 1 includes the partners, timeline and resources required for success with each action.

MOVING FROM STRATEGY TO ACTION

The life sciences strategic plan can be summarized into the following five goals with the associated actions.

TABLE 1: LIFE SCIENCES Goals, Action Plan and Enabling Strategy

Goal	Action/Enabling Strategy	Time Line to Prioritization and/or Completion
Establish Alberta's leadership in strategic areas of life sciences research, development and industry innovation	Establish an International Council on Life Sciences to validate strategic directions and provide leadership toward enhancing the competitiveness of Alberta's life sciences industry	March 2004
	Develop the Alberta Life Sciences Alliance to set priorities and accountability in life sciences, and direct and coordinate the implementation of the Alberta Life Sciences Strategic Plan	March 2003
Build life sciences research capacity and excellence	Establish five Life Sciences Action Oriented Research Networks of: <ul style="list-style-type: none"> • Biomaterials and Bioproducts (c/w AARI, AFRI, ARC plans) • BioEnergy (c/w Energy Strategy and Environment) • Health (c/w Stewart and McLeod Reports, AHFMR, AIF, ACB) • Nutrition (c/w AARI, Health) • Environment and Climate Change (c/w ARC, AARI, AFRI, AIF, Environment, Energy) 	June 2007
	Coordinate and support Alberta's capacity development in cross-sectoral platform technologies including: <ul style="list-style-type: none"> • Functional Genomics and Proteomics (c/w AARI, ANPI*, GP) • Informatics (c/w iCORE and ICT Strategy...) • Biodiversity (c/w AARI, AFRI, Health) • Nanobiotechnology (c/w NINT**, ACB) 	Ongoing/Sustained
	*ANPI (partnership of GC, AHFMR, CFI, ASRA universities) **NINT is a unique partnership of funding and governance including NRC representing the Federal Government and ASRA representing the Provincial Government.	
	Establish a funding mechanism in conjunction with SIC to strengthen the resource base and strategic allocations for life sciences research (e.g., ASRIP)	October 2003
	Develop and implement a long-term life sciences infrastructure plan to support growth in research excellence.	March 2004
	i.e. HRIC's are a partnership of multiple Departments (Foundations, Treasury, Infrastructure, Learning, Health and Wellness, Innovation and Science) + partnerships with CFI, AHFMR, RHAs and a Private capital campaign)	

Goal	Action/Enabling Strategy	Time Line to Prioritization and/or Completion
Ensure a progressive and innovative business climate to foster and sustain industry innovation and growth in the life sciences	Stimulate investment in knowledge based Alberta life sciences businesses by extending existing and developing additional investment mechanisms	Ongoing/Sustained
	Increase intellectual exchange, collaboration and intellectual property within Alberta, nationally and internationally using the ICT (i.e. We//net) and Supernet pathways, resources and infrastructure	Ongoing/Sustained
	Establish a public/private partnership to develop and implement an aggressive, long-term marketing initiative to raise awareness of Alberta's life sciences research and industry capabilities	December 2003
Harmonize development of the life sciences with Albertan values and goals	Increase the magnitude and scope of life sciences education and engagement initiatives involving the public, government and industry	Ongoing/Sustained
	Increase the capacity to analyze impacts of new and existing life sciences technologies on quality of life through strengthened social sciences and humanities research, and an emphasis on bioethics and education	Ongoing/Sustained
	Monitor, evaluate and communicate medium (M) and long (L) term outcomes of life sciences development	M: 12/2003 L: 12/2003
Develop, attract and retain high quality people in the life sciences	Develop and implement a life sciences human resources plan in cooperation with industry, government and educational institutions	June 2004
	Encourage postsecondary institutions to review and revise their curricula as necessary to serve the emerging opportunities at the intersection of the sciences in biomanufacturing and the management of life sciences companies	December 2003
	Encourage postsecondary institutions to explore additional opportunities for co-op and internship programs for life sciences and business students	December 2003

Contributors - Accomplishing the goals of this strategy will require contributions from many organizations. The following is a partial list of these with abbreviations used in Table 1 :

Industry; Provincial Government Departments; municipal development agencies; the Federal Government; post-secondary institutions; AARI, Alberta Agriculture Research Institute; ACB, Alberta Cancer Board; AFRI, Alberta Forestry Research Institute; AIF, Alberta Ingenuity Fund; AHFMR, Alberta Heritage Foundation for Medical Research; ANPI, Alberta Network for Proteomics Innovation; ARC, Alberta Research Council; ASRA, Alberta Science and Research Authority; ASRIP, Alberta Science and Research Investments Program; BA, BioAlberta; CIHR, Canadian Institutes of Health Research; CFI, Canada Foundation for Innovation; CTI, Calgary Technologies Inc.; c/w, consistent with; FT, full time; GC/GP, Genome Canada/Genome Prairie; HRIC, Health Research Innovation Centre; IA, Innocentre Alberta, RSO, Research Services Office; LSA, Life Sciences Alliance; NRC, National Research Council; NINT, National Institute of Nanotechnology, RHAs, Regional Health Authorities; UTI, University Technologies International

REQUIRED INVESTMENT

Achieving Alberta's life sciences goals will require the concerted effort of all partners. As a measure of this effort, by 2020, Alberta will attract \$1.5 billion of annual investment in life sciences R&D and industry innovation. It is anticipated that this will come primarily from industry and federal departments and organizations.

To achieve this investment goal, the Government of Alberta will also need to make significant investments into the Life Sciences Strategy framework areas (leadership, platform technologies, business development, high quality people and public engagement) and also into applications research. This applications research will be in areas of opportunity such as bioproducts and biomaterials, bioenergy, health, nutrition, environment, and climate change life sciences that are emerging from the traditional sectors of agriculture, health, forestry and environment.

During the next five years, implementing the central elements of the Life Sciences Strategy will require \$270 million in new investment. The Government of Alberta's portion of this will be \$85 million with the remainder coming from leveraged federal and industry funds. Additional contributions for applications research in new areas of opportunity and sectoral research will rely even more heavily on funds leveraged from industry and federal sources.

IMPLEMENTATION

The Life Sciences Strategy will be implemented by the Alberta Life Sciences Alliance. The Alliance will move Alberta toward its vision of a vibrant bioeconomy through five distinct and well-coordinated actions and initiatives:

1. Establishing an International Council on Life Sciences to validate strategic directions and provide leadership toward enhancing the competitiveness of Alberta's life sciences industry.
2. Developing and implementing a long-term life sciences infrastructure plan to support growth in research excellence.
3. Tasking an industry-supported organization to lead industry development through initiatives in business climate enhancement, public awareness, workforce planning, and intellectual exchange and collaboration.
4. Establishing a public/private partnership to develop and implement an aggressive, long-term marketing initiative to raise awareness of Alberta's life sciences capabilities.
5. Establishing Alberta's leadership in strategic research areas by:
 - Continuing to develop capacity in platform technologies of genomics, proteomics, bioinformatics, and nanotechnology.
 - Creating five Life Sciences Research Networks of Excellence in Biomaterials, Biomedical, Bioenergy, Health, and Environment.



APPENDIX I: THE LANGUAGE OF LIFE SCIENCES

Biochemistry is the study of the chemistry taking place in living organisms, especially the structure and function of their chemical components, such as proteins, carbohydrates, lipids and nucleic acids, and small molecules present in cells.

Bioinformatics is the use of computing science to manage, understand, and use the data from biochemistry, molecular biology, and other facets of biological research.

Biomaterials are organically-derived manufactured products, although the term usually implies that it is a non-traditional product such as biodiesel or plastics made from straw.

Biotechnology is the use of living organisms or parts of organisms to create products and processes.

One section of biotechnology is the directed use of organisms by humans for production. The first application of biotechnology was probably the making of bread by using yeast about 5,000 years ago.

Today, biotechnology usually means the use of genetically altered microorganisms such as *E. coli* or yeast for producing substances like insulin or antibiotics. It can also refer to transgenic plants such as Bt corn or Roundup Ready® canola.

Cell biology is the study of the physiological properties of cells and their interaction with each other and their environment, on the microscopic and the molecular level. Cell biology researches both single-celled organisms like bacteria and specialized cells in multicellular organisms like humans and animals.

DNA makes up genes. A person has between 30,000 and 40,000 genes that reside in 46 chromosomes, 22 matching pairs and the sex chromosomes X and Y.

Functional foods are foods or food ingredients that have been modified to provide a health benefit beyond the traditional nutrients they contain.

Gene refers to a sequence of DNA nucleotides that has two functions. Parts of it encode the constitution of protein molecules. Other parts of it regulate the production of protein molecules. Genes, along with environmental factors, as well as random molecular and cellular movements, play a crucial role in the production of organisms as well as in the reproduction of genes themselves.

Genetically-modified foods are more accurately referred to as biotechnology-derived foods. These products are commonly termed genetically-modified foods, but this is misleading since conventional methods of microbial, crop and animal improvement also produce genetic modifications.

Genetics is that branch of science that relates to the study of genes, and their role in biological inheritance. Applied genetics is called genomics.

Genome refers to the complete set of all an organism's genes. It can also refer to the entire sequence of an organism's chromosomal DNA.

Genomics is the study of an organism's genome in its entirety. This field developed rapidly in the 1990s with the initiation of genome projects for several species. The genomes of a number of animal and plant species have been sequenced and the draft of the Human Genome Project was completed in early 2001.

Human genetic engineering means changing the genes in a living human cell. Some diseases are caused by defective genes. If there were a way to fix those genes, a cure could result.

Scientists change the genes in living cells by putting the desired "new" gene into a virus-like organism that gets into the target cells and inserts the new gene.

Nanotechnology is manufacturing at the molecular level. It has the potential to revolutionize electronics, computing and information technologies, engineered materials, robotics, genomics, health care, biotechnology and clean energy production.

Proteomics is an attempt to examine an organism's complete set of proteins and their interactions. Proteomics is more complicated than genomics. The genome is a constant entity; the proteome is constantly changing through its interactions with the genome. An organism has different protein expression in different parts of its body and in different stages of its life cycle.

With completion of a rough draft of the human genome, many researchers are now attempting to identify the function of ~35,000 genes and how the proteins derived from these genes interact.

Stem cells are cells capable of developing into a variety of types of cells. Some stem cells are found in the adult body while others are found in very early embryos. Stem cells can potentially be used to generate "therapeutic tissues" or "spare organs."

The application of stem cell technology to human diseases is controversial. Some support the use of adult stem cells for this purpose but oppose the use of embryonic stem cells, because they oppose the destruction or manipulation of human embryos.

Phytochemicals are specific food components that may expand the role of diet in disease prevention and treatment. Phytochemicals found in vegetables such as broccoli have been shown to trigger enzyme systems that block or suppress cellular DNA damage and reduce tumor size in animals.

Synchrotron light is an extremely bright combination of infrared, visible, ultraviolet and X-ray light. Synchrotron X-rays are millions of times more powerful than a medical X-ray. However, they can be trained on a spot smaller than a grain of oil sand. Synchrotron X-rays allow for experiments that would be impossible to perform any other way.

Transgenics is the transfer of a gene or genes from one organism to a different organism.

Xenotransplantation involves transplanting animal organs into human beings.



APPENDIX II: LIFE SCIENCES ACTIVITY IN ALBERTA

There is a growing life sciences industry in Alberta which is being nurtured by both the public and private sectors. Public sector organizations include:

Agriculture Canada, Lacombe Research Centre

Agriculture Canada, Lethbridge Research Centre

Alberta Agricultural Research Institute

Alberta Agriculture, Food and Rural Development

Alberta Cancer Board

Alberta Forest Genetics Resources Council

Alberta Forestry Research Institute

Alberta Heritage Foundation for Medical Research

Alberta Informatics Circle of Research Excellence (iCORE)

Alberta Ingenuity Fund

Alberta Network for Proteomics Innovation

Alberta Research Council

Alberta Synchrotron Institute

BioAlberta and member companies

Bioinformatics and Biocomputing Group

Bovine Genome Project

Canadian Bacterial Diseases Network

Canadian Protein Engineering Network

Foothills Model Forest

Institute of Biomolecular Design

Multi-Media Advanced Computational Infrastructure

National High Field Nuclear Magnetic Resonance Centre

Sustainable Forest Management Network

Veterinary Infectious Diseases Organization

Western Boreal Aspen Cooperative

BioAlberta has more than 90 member organizations. They are acting in many areas including:

- diagnosis and treatment of cancer
- prevention and treatment of infectious diseases
- therapeutic drug research and development
- molecular genetics for protein-based pharmaceuticals
- lab on a chip technology
- functional foods and nutraceuticals
- bioinformatics tools.



Alberta Science and
Research Authority

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