SUBMISSION

Presented to the Expert Committee on the update of the

Québec Strategy for Research and Innovation

By

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Thank you to all for your contribution.

Genomics – Time to take stock…

The updated version of the *Québec Strategy for Research and Innovation* (QSRI) must continue to recognize genomics as one of the most promising multidisciplinary innovation sectors for the future of the Québec economy and the well-being of its citizens.

Since 2000, Canada has bridged the gap with the rest of the world in the area of genomics research. This was mainly achieved through the creation of Genome Canada and its Québec counterpart, Génome Québec (2001). During this period, thanks to Génome Québec, $400 million were invested in the field of genomics in Québec, with $120 million coming from the Québec Government, $155 million from Genome Canada, $67 million from the private sector and $58 million from other sources. Thanks to the Génome Québec business model based on co-funding, investments in Québec have more than tripled, allowing for the funding of large-scale projects, a fundamental driver of competitiveness in genomics. Through its structuring role and the strength of its organization, Génome Québec has allowed Québec to showcase its leadership on the international scene.

The QSRI clearly recognizes the strategic importance of this discipline and the promise it holds for the future of the Québec economy. This position must be maintained. The funds invested in this area to date have resulted in inventions, which have already generated economic benefits. To see the full results of our efforts, however, we must stay abreast of the global technological revolution in the health sciences sector.

Sustained investments in genomics are critical to furthering socio-economic development and maintaining our competitive edge in this strategic sector. Countries around the world have chosen this path. In Ontario, for example, a $100-million fund dedicated to genomics was recently created. British Columbia has invested $85 million in a business plan worth $340 million for 2010-2015. In the United States, investments in research have recently increased by US$15 billion. Europe is no exception to this trend with the European Union dedicating, in one year alone (2006), US$468 million to a single program in genomics (the Seventh Framework Program). Finally, Singapore has earmarked some US$2.1 billion for the medical sciences sector.

Québec's decision to focus on genomics over the past 10 years has required vision. The return on its investments is already obvious and will only grow over the next three to five years. Our long-term commitment requires dedication, but it will yield formidable results, both on the economic and social fronts.

Our assets

By keeping pace, Québec has developed expertise in genomics that has translated into tangible clinical and environmental applications and major socio-economic benefits. These efforts have enabled us to provide a most enviable critical mass for the sector and make our mark among innovative leaders, both crucial elements if we hope to remain at the vanguard of innovation. To that end, we have access to valuable assets, such as:

- A dozen universities and university hospital centres equipped with cutting-edge genomics research centres;
- A pool of over 600 talented researchers specialized in various genomics fields like complex diseases (diabetes, cardiovascular and infectious diseases, cancer, etc.), pharmacogenomics, forestry, agriculture, aquaculture, ecosystems and bio-fuels;
- Over 12 pharmaceutical companies and clinical research organizations conducting studies in Québec, thus promoting the application of discoveries in genomics to the clinical setting;
- A favourable context to study the consequences of the founder effect on the genetic baggage of Quebecers of French origin.

Genomics is ripe with potential for the future of health care, sustainable development and the management of energy and natural resources. In fact, even if genomics were to reach only half of its objectives, its research would generate massive improvements in the quality of life of people around the world.

Human health

With the development of personalized medicine, the field of human health stands to benefit most from genomics research. With the aging of the population, the variable efficacy of drugs from patient to patient and the skyrocketing cost of healthcare, genomics provides a most innovative solution. The shift from a curative approach in medicine to an increasingly preventive one is already underway. Given the need to manage the rising costs of health services, this transition represents a significant advantage. Achievements in this area include:

- Major progress in the development of diagnostic tools, genomics having led to the discovery of the underlying causes of many complex diseases;
- The creation of targeted drugs and diagnostic tests to treat various cancers. Researchers from the Université de Montréal and the Montreal Heart Institute are currently developing cardiovascular medications customized to patients;
- The development of cutting-edge screening tools for certain forms of cancer. For example, Alethia Biotherapeutics, a recipient of seed money from Génome Québec, has built an impressive portfolio of new therapeutic targets. These accomplishments have given way to two funding agreements and several partnerships. One of these agreements with a multinational corporation involves the development of one of the world's first diagnostic markers for the early detection of ovarian cancer;

- The sequencing of bacteria like *C. difficile*. Researcher at McGill University have gained internationally recognized expertise in this field, having sequenced over 40 new organisms;
- The sequencing of the H1N1 virus genome by a research team from Winnipeg and the development of a vaccine for this virus by Medicago, a Québec-based company. This type of rapid progress was unthinkable a few short years ago;
- The identification of a predisposition marker for diabetes by a team of researchers at McGill University;
- The launch of several technological centres leading to the creation of critical masses of expertise specific to each site (CHUQ, Chicoutimi CSSS, MHI, McGill, UDM, UDS);
- Implementation of P^3G, an international consortium that is headquartered in Montreal and brings together some 45 member countries;
- The launch of CARTaGENE, a project that involves the creation of a databank of biological samples taken from 20,000 Quebecers. This resource will help researchers better understand disease and transform medicine as we know it.

In other words, the impact of genomics on human health is real, far-reaching and immediate. It is now possible to intervene sooner and better in terms of the risk factors, diagnosis and treatment of diseases, leading to improved patient care and lowered patient management costs for the healthcare system (see graph in Appendix I).

Forestry

Genomics will help the forest industry make the most of raw materials and recover their full value through bio-refining and the production of bio-fuels and other products. Researchers at Université Laval are currently designing innovative solutions that are contributing to the sustainable development of forests. The genomics tools they have built will help to preserve genetic resources and identify new species of trees. Advances made by the Arborea project since 2002 have led to the discovery of new instruments to conserve and optimize natural genetic diversity in order to improve the productivity and value of softwood species.

In the current context of renewal in the forest industry, the quality of resources plays an even more important role for Canada's economy, particularly with regard to improving our carbon emission track record. Québec innovation in this sector should make it possible to reduce the impact of global warming, a phenomenon that could compromise the health of ecosystems and reduce their benefits to human beings. It should also be noted that the forest industry creates some 189,000 direct and indirect jobs and its activities represent 3 percent of Québec's GDP.

Bio-fuels and bio-products

At Concordia University, a team of researchers is using genomics to identify, analyze and develop fungus enzymes to be used as catalysts in the production of bio-fuels and other organic- or chemical-based products. Large-scale bio-refineries will soon be able to convert bio-mass into bio-fuel and bio-chemical products. The market for industrial enzymes could reach US$3.8 billion by 2010.

Our challenges – Staying competitive, turning knowledge into action

Genomics is now recognized internationally as having the potential to resolve many of our pressing social, environmental and economic issues. To stay in the race, Québec must, like the rest of the world, continue to invest in this sector. Failure to do so would mean falling behind and losing the fruit of our labours.

Together we have built competitive teams and cutting-edge infrastructures. At Université Laval, for instance, a research team has created diagnostic tests that reduced from 72 hours to 1 hour the time needed to identify certain microbes and viruses, leading to improved patient care. Five of these tests are currently used in hospitals. In addition, manufacturing the vaccines has created 350 jobs at Becton Dickinson, a world leader in the diagnostics field that elected to set up its plant in Quebec City's technopark.

Genomics has already served to stimulate our economy. Every effort must be made to retain our top talent, translate our inventions into action and export our knowledge and discoveries to other markets. In this context, the recruitment, training and retention of experts is a top priority, especially in areas such as bio-informatics and applied bio-statistics in genomics; these skills are in high demand and are needed to process the mass quantity of data produced.

As it stands, there are 68 disclosures from the 36 projects funded by Génome Québec (many currently underway) and the results of some of these projects are already being applied in commercial production. These innovations are made possible by our investments. According to a report by the Council of Canadian Academies, 80 percent of Canadian researchers do not have their inventions patented. If we are seeking to have this knowledge integrated into the medical, forestry, environmental and agri-food sectors, we must ensure that universities and researchers obtain more support in the active management, transfer and commercialization of their research.

In the interest of all Quebecers and because it promotes the accelerated development of prevention, diagnostic and treatment strategies and the identification of new therapeutic targets, genomics must remain a clearly stated priority in the updated version of the QSRI. By strengthening research capacity, developing local talent, stimulating the private sector and creating infrastructure suited to an array of long-term research projects, Génome Québec remains an important catalyst for this innovation sector.

RECOMMENDATIONS

In your view, what are the priorities in the area of R&D and innovation that will ensure Québec's development over the next three to five years?

1. Continue to increase funding of genomics research to:
    a. Attract new outside investments to Québec in this sector;
    b. Strengthen existing research teams by recruiting young, forward-looking researchers and top talent;
    c. Launch competitions for large-scale research projects, particularly in human health.
2. Support excellence in genomics and fully leverage investments made in Québec by supporting the Génome Québec business model.

3. Ensure that Québec remain competitive in genomics research in Canada and support international partnerships, where Québec could play a leadership role.

In your view, which measures of the current strategy are most effective and worth maintaining?

1. The major investments in genomics over the last eight years, which must be actively sustained.
2. The five-year tax holiday for foreign researchers recruited by Québec, an initiative that must continue.
3. The tax credit promoting pre-competitive research by private partnerships, which must be maintained.

What other actions or measures could the Québec Government implement to improve the Québec innovation system?

1. Given the major shortage of experts specialized in bio-informatics and applied bio-statistics in genomics, establish a grant program for graduate students (master's, doctorate, post-doctorate) specific to this field
2. Promote the transfer of knowledge developed by Québec researchers on the financial and regulatory front, to medical, forestry, environmental, agri-food.
3. Make expenses associated with protecting and maintaining intellectual property eligible for the R&D tax credit.

APPENDIX I

Genomics holds much promise for human health.

Thanks to genomics, it is now possible to intervene more effectively in terms of the predispositions, diagnosis and treatment of diseases, leading to improved patient care and lowered patient management costs for the healthcare system.