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# CONSULTATION PAPER:

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## DEVELOPING A PAN-CANADIAN GENOMICS STRATEGY



# Introduction

Genomics is the study of the entire genetic information of an organism encoded in DNA and other molecules, which includes the structure, function, evolution, mapping, and editing of genomes. Genomics, coupled with other disciplines (e.g., artificial intelligence, bioinformatics, and synthetic biology), has been identified as a key technology that is instrumental to responding to global and national challenges such as climate change, the implementation of precision health, pandemics, environmental protection, food and energy security, as well as economic recovery. Many have further recognized the significant role of genomics and its applications in helping Canada fight against the COVID 19 pandemic (e.g., COVID 19 variant tracking and sequencing, diagnostic devices, and mRNA vaccines and therapeutics).

Over the last 20 years, Canada has built world class strength in genomics research and is positioned to continue leading on genomics given its advantages of having a robust research ecosystem, strong public health care system, diverse ecosystems, and abundant natural resources and agri-food sectors. The Government of Canada has also played a significant role in supporting genomics research and development (R&D) across all stages of the innovation pipeline, from fundamental research to commercialization, through various initiatives.

The global interest in genomics R&D has increased substantially and can be seen through the significant investments and activities undertaken in other countries (e.g., the United States, the United Kingdom, and France). Despite Government of Canada investments in genomics related research, Canada continues to experience an innovation gap in bringing research knowledge into the commercialization and adoption phases. The genomics innovation pipeline can take more than a decade, with high front end costs and no guaranteed return on investment. Canadian firms, which are predominantly small and medium sized enterprises, may not have the capacity to propel genomics further toward commercialization and adoption, especially when market needs may be undetermined.

Overall, Canada is at risk of falling behind its peers, who are situating themselves to attract and generate genomics related talent, investments, innovations, and companies in the future. Canada's biotechnology<sup>i</sup> R&D intensity in the business sector (0.0537% in 2019) and its share of biotechnology patents (2.1% in 2018) are consistently at the lower end of the G7 countries<sup>ii</sup>. While the number of Canadian biotechnology firms (375 companies in 2001 to approximately 900 companies in 2020<sup>iii</sup>) and public offerings (\$735 million in equity in 2018 to over \$1.5 billion in 2020<sup>iv</sup>) have increased, the utilization rate of biotechnology across Canada's economy remains low (1.6% in 2017; 1.1% in 2019<sup>v</sup>). To ensure that Canada is able to compete alongside its peers and realize the scientific, commercial, socioeconomic and environmental benefits that could be generated, Canada should take advantage of the current global interest and leverage its own research excellence in genomics to better drive the commercialization and adoption of genomics technologies and innovations.

# Developing a Pan Canadian Genomics Strategy

The \$400 million Pan Canadian Genomics Strategy (PCGS) was announced in Budget 2021 to advance the commercialization and adoption of genomics and related technologies, strengthen Canada's global leadership, and position Canada for long term success in the global bioeconomy while enhancing coherence and coordination among the key players. The PCGS will contain the full suite of Government of Canada activities related to genomics, including investments in Genome Canada's new challenge driven approach, as well as other PCGS related initiatives, through the genomics ecosystem.

To support the refinement of the goals of the PCGS, the Government of Canada is seeking to engage with stakeholders to better understand the challenges and opportunities facing the Canadian genomics ecosystem on the path to the commercialization and adoption of genomics technologies and innovations into policy and practice. Through this consultation exercise, the Government of Canada is seeking input from stakeholders on the proposed thematic directions of the PCGS, as well as actions and interventions that could be considered in addressing opportunities and challenges. This consultation paper lays out a series of five themes, with questions for consideration.

## Canada's genomics landscape – opportunities and challenges

### CONTEXT

The Canadian genomics landscape is spread across the country, with various levels of expertise and collaboration shared between governments, industry, academia, and not for profit organizations. The distribution of Canada's genomics capabilities presents both opportunities for and challenges to the further development of genomics in this country. Examples of regional strengths in genomics include agriculture and agri-food in the Prairies, Ontario, and British Columbia (BC); fisheries and aquaculture in the Atlantic provinces, BC, and Quebec; and forestry in BC and Quebec.

As genomics and related fields continue to evolve, more can be done to enhance Canada's genomics landscape. This could include better coordination of support for genomics; addressing data sharing across jurisdictions; conducting population genomics in health; protecting the environment and driving sustainability; increasing downstream activities; as well as increasing private and public sector uptake of genomics.

### FOR CONSIDERATION

1. What are the specific opportunities, gaps, and challenges within Canada's genomics landscape related to adoption and commercialization? How can those be addressed, whether through the PCGS or other mechanisms?
2. Regions have developed specializations based on their industrial strengths and natural environment. What are the regional strengths in genomics in Canada? How can the PCGS help leverage regional expertise into a pan-Canadian approach to advance shared national priorities and Canada's position in the global bioeconomy?
3. How can stakeholders within the Canadian genomics ecosystem work better collectively to enhance the adoption/commercialization of genomics across Canada and globally?



4. What are the strengths and weaknesses of Canada's genomics-related infrastructure? What are the challenges and opportunities in accessing and using genomics-related infrastructure and tools across sectors and regions?

## Developing, retaining, and attracting talent

### CONTEXT

Adoption and commercialization of genomics technologies and innovations requires the capacity and expertise of highly qualified personnel (HQP). While Canada is recognized for its development of skills and talent in the R&D ecosystem, and benefits from a steady influx of skilled immigrants, it may continue to experience challenges with competing for and retaining top tier Canadian and global talent. In addition, as genomics and related disciplines are constantly evolving, HQP in Canada may also face obstacles in maintaining their expertise as new developments and trends emerge.

### FOR CONSIDERATION

1. What are the main opportunities and challenges in developing, retaining, and attracting genomics-related talent in Canada?
2. Where are there potential needs for specialized training within specific sectors or areas to enhance the adoption and commercialization of genomics within the economy?
3. What can be done to ensure that, as Canada's genomics ecosystem grows, it is increasingly representative of our diversity and ensures equity and inclusion?

## Optimizing the management, standardization, and utilization of genomics data

### CONTEXT

As genomics continues to generate vast amounts of data, maximizing its impacts requires the ability to store, access, exchange, integrate, and manage genomics data across different information systems, devices, and applications in a coordinated and standardized manner, within and across organizational, regional, and international boundaries.

Deploying and integrating other emerging technologies (e.g., artificial intelligence and advanced data analytics) presents opportunities for genomics data. Canada's genomics ecosystem will need to be agile to keep pace with international trends, in terms of both technological advancements and data standards and protocols, including privacy and security concerns, to take full advantage of the genomic data available to enable the commercialization and adoption of genomics.

### FOR CONSIDERATION

1. What are the strengths and weaknesses of Canada's genomics-related data infrastructure? To what extent does it support the current data needs of stakeholders?
2. What are the greatest opportunities and challenges in optimizing the management, standardization, and utilization of genomics data in the Canadian and international context?
3. How can stakeholders within the Canadian genomics ecosystem better support the development or application of data standards, sharing, and management?



4. Given significant advancements in technology development, including the reduction of costs and time for sequencing and processing genomic samples in the last two decades, what can the Government of Canada do to further leverage and optimize the use of genomics data?

## Driving the commercialization and use of Canadian genomics technologies and innovations

### CONTEXT

Genomics R&D in Canada continues to face barriers in transitioning into the commercialization and adoption phase. Genomics is complex and costly, especially in the initial stages, and requires access to cutting edge infrastructure and processes. To further de risk and drive genomics based technologies and innovations for commercialization and use, government support (both federal and provincial/territorial) has been necessary in combination with other sources of research expertise, infrastructure, and capital from the private sector. Canada also faces limited receptor capacity due to the traditionally low gross domestic spending on R&D, lack of larger sized enterprises, and limited access to capital in comparison to other countries.

Awareness among potential end users is also a challenge. Many areas with potential for commercialization and adoption, including in Canada's traditional sectors such as agriculture, forestry, oceans, and mining, and in environmental protection, may be unaware of the benefits of integrating genomics based research and technologies into their innovation processes. To increase understanding and address public misconceptions of genomics and related sciences, which are often complex and fast evolving areas, further efforts may be needed to bring greater awareness and knowledge to potential end users.

### FOR CONSIDERATION

1. What are the greatest opportunities and challenges in commercializing genomics technologies and innovations in the Canadian context?
2. How can the PCGS help maximize the socioeconomic and environmental benefits for Canada from the commercialization and use of genomics technologies and innovations within Canada and internationally?
3. How can stakeholders within the Canadian genomics ecosystem better align support to drive the commercialization and use of genomics technologies and innovations? How could federal and provincial/territorial government facilities be leveraged?
4. What should the Government of Canada and the Canadian genomics ecosystem focus on to better support the commercialization, adoption, and utilization of genomics technologies and innovations?

## Adoption of genomics in key sectors – health, environment, clean tech, food and natural resources

### CONTEXT

While health remains the dominant focus of genomics in Canada and internationally, Canada benefits from a multi sectoral approach that applies genomics R&D in natural resources (e.g., forestry, energy, and mining), food (e.g., agriculture/agri-food and aquaculture/fisheries), clean tech and environmental protection. Fostering

the adoption and uptake of genomics in policy and practice in Canada is critical to supporting future transformative breakthroughs within sectors of strategic importance.

## FOR CONSIDERATION

1. How can the Canadian genomics ecosystem work together better, including through policy and program supports, to ensure that, as genomics technologies and innovations come to fruition, they are adopted by key sectors and the general public within Canada?
2. Which key sectors are ready and/or offer the greatest potential for the adoption of genomics? What are the next steps needed to achieve this potential?
3. Which key sectors are not yet as ready, and what needs to be done to get them there?

## Conclusion

An inclusive national strategy that outlines Canada's approach to supporting genomics commercialization and adoption, through collaboration across sectors and regions, will further position Canada as a leader in genomics technologies and innovations, leading to increased socioeconomic and environmental outcomes for Canadians.

In conclusion, we ask stakeholders to consider the following: What should Canada's top priority be for the PCGS?

We would like to thank all participants of the PCGS consultation for their time and contribution. The feedback and comments provided will ultimately help inform and shape the PCGS to improve the lives of Canadians, give Canada a competitive edge in genomics and related fields, and stimulate economic growth.

Following the consultations, we will be analyzing the feedback received to inform the final strategy. A summary of what was heard during the stakeholder engagement process will also be prepared and shared with stakeholders. If there are considerations that have not yet been addressed or if there are elements that could be explored further, stakeholders are invited to submit their input through the web portal at <https://ised-isde.canada.ca/site/genomics/en>.

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<sup>i</sup> Genomics-related companies underpin a significant section of the Canadian biotechnology sector.

<sup>ii</sup> OECD, *Key biotechnology indicators*, <http://oe.cd/kbi>; 2018 and 2019. (Japan and the UK are excluded in the OECD database for some of the biotechnology data.)

<sup>iii</sup> BIOTECCanada, *Canadian Biotechnology: Solving For Today. Building For Tomorrow*, 2020.

<sup>iv</sup> BIOTECCanada, *Canadian Biotechnology: Solving For Today. Building For Tomorrow*, 2020.

<sup>v</sup> Statistics Canada, *Use of advanced or emerging technologies, by industry and enterprise size*, 2019.