BRINGING innovation to LIFE

STRATEGIC VISION

GenomeCanada

GLOBAL CHALLENGES ✦ GENOMIC SOLUTIONS

GenomeCanada

STRATEGIC VISION

Executive Summary

LIVING SYSTEMS ARE THE FOUNDATION of our health, our environment, and our economy. Unsurprisingly, understanding these systems has been a human preoccupation for centuries. Today, we possess knowledge and tools that allow us to see the details of this living world like never before. At the most fundamental level—the level where we can read and interpret the operating code of life—is genomics.

Genomics is a young science, emerging in the 1980s and 90s. Then, countries began investing heavily in scientists and technologies to benefit from the rapidly increasing ability to read DNA, most notably through the Human Genome Project. Canadian scientists, recognizing the need for a coordinated national effort, led the charge here, culminating in the creation in 2000 of Genome Canada.

From the beginning, Genome Canada embodied a distinct approach to genomics research. Unique among national genomics initiatives, Genome Canada supported both human and non-human research under the same umbrella. This meant that technologies and infrastructure developed for human health research could also be used to sequence salmon, spruce or canola. This approach has made Canada a world-leader in the application of genomics, particularly in forestry, fisheries, agriculture and energy.

Genome Canada also adopted a collaborative approach that coordinated efforts between the federal government and the provinces—a truly national project. Genome Canada works with six independent, provincially-supported Genome

STRATEGIC VISION

Centres to ensure Canadian genomics research has national breadth and regional depth, aligning research support through coordinated funding between national and provincial governments. Industry and other users represent a third partner, bringing challenges and opportunities to the table and taking research results and applying them in the real world.

For nearly two decades, Genome Canada has helped build the foundation for genomics research and application in Canada. Here, we outline a vision for the next phase of Genome Canada, a vision where **Canada is a world-leader in the application of genomics-based biosciences for human health, the environment and across the bioeconomy**. To achieve this vision, Genome Canada commits to **put genomics in the hands of those who will use it to create health, environmental and economic benefits for Canadians**.

To do this, we outline a series of strategies organized under **THREE MAIN OBJECTIVES**:

1. Drive high-impact research to benefit Canada
2. Deliver effective, purpose-fit programs that support our mission
3. Promote the responsible application of genomics in Canada

Many of the strategies we describe represent a continuity with Genome Canada's success,

a recommitment to the core of who we are. But this vision also reflects a changing landscape. Accordingly, we describe new and dedicated strategies for **mission-driven research, big data initiatives to handle enormous and complex genomic data sets, an explicit commitment to promoting equity, diversity and inclusion, and an enhanced commitment to genomics in society**.

We are in the early stages of a revolution in advanced biosciences. New areas like gene editing, synthetic biology and the application of artificial intelligence (AI) to big data sets are opening unimagined possibilities. At the same time, DNA sequencing is becoming faster and cheaper and moving increasingly towards application. Genome Canada is proud to have led Canada's genomics effort through the early days and is thrilled about what comes next. Together with our partners and researchers, we will continue to drive research and innovation in genomics and ensure Canada is a world leader in cutting-edge biosciences.

GenomeCanada

Today and Tomorrow

THIS IS AN EXHILARATING TIME for genomics and an exciting new era for Genome Canada. As the science explodes in multiple directions, we are building on our strong foundation of past achievements to meet new challenges and capitalize on new opportunities. We are the only national organization that focuses exclusively on harnessing the power and potential of genomics and related technologies to improve the lives of Canadians.

Although genomics is still a relatively young science, the underlying technology is more powerful and affordable than ever before. As our knowledge of living systems deepens, the impact of genomics' potential applications — across a range of sectors — is enormous. That's why Genome Canada is shifting a greater portion of our efforts to supporting more strategic and purpose-driven applied research — with line-of-sight to application and the potential to help solve societal challenges of both national and global importance.

Through the implementation of precision health, better diagnostics, and new therapies, genomics will help make Canadians healthier and increase the efficiency of the health care system. By driving innovation in the bioeconomy, genomics will improve productivity and support new products, making Canadians more prosperous. And through adaptation to and mitigation of climate change, improved techniques for managing pollution, and better management of natural systems, genomics will help create a cleaner, more sustainable environment.

To mark this new transformative era and our sharper focus on application, we have developed an ambitious Strategic Vision. This Vision is the product of a year-long consultation, analysis, and strategy development process engaging more than 300 individuals in the national and international genomics community. It attempts to capture the enthusiasm of our community and contains the blueprint for the exciting next chapter of Genome Canada.

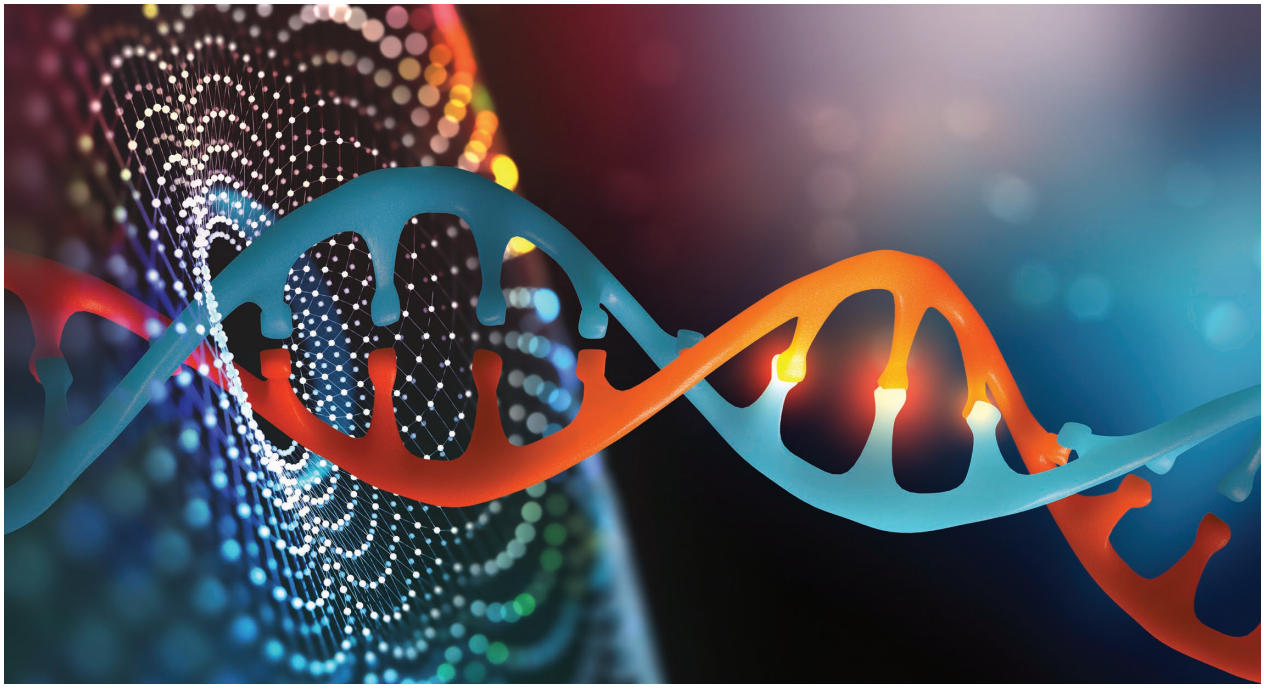
We are committed to building on our strengths by enhancing the best of our programs and practices, while launching new initiatives that maximize the benefits and impacts of promising opportunities. At the same time, we recognize the need to support the responsible uptake of genomics innovations by investigating and communicating about the potential societal implications of genomics research.

Unlike a traditional strategic plan that is tied to a fixed time period, this Strategic Vision is dynamic and flexible. We will revisit it to respond to the changing needs of our community and emerging scientific and technological opportunities. We are confident that by pursuing and achieving this Vision, we will succeed in fully leveraging genomics for the benefit of all Canadians — now and for future generations.

Moura Quayle
Chair of the Board of Directors

Marc LePage,
President and CEO

Genomics and Beyond



INNOVATION TAKES TIME. From first discovery, to expansion of understanding, development of engineering, training of skilled talent, and building an ecosystem of tools and suppliers, it takes many years to go from the initial excitement of discovery to the transformation of an industry or sector. For example, foundational work on artificial intelligence was done in the 1980s but today is revolutionizing industries. Quantum computing was first imagined in the 1970s and is only now within reach of transformative impact.

Coined in 1986, "genomics" is the science related to the structure and sequence of DNA and the function of genes in all living things. In 2003, the first human genome was sequenced, allowing us to read the complete genetic blueprint for a human being. Since then, researchers have learned more and more about the "source code" for life, generating and analyzing petabytes of data, generating enormous new understanding of living systems and developing innovative tools and techniques for working with it.

Since these early days, costs for sequencing have dropped by 90%. AI-based computational techniques are unlocking new understanding in enormous genomic datasets. Tools for manipulating DNA (like CRISPR) are becoming economically viable and technically reliable. And a generation of researchers have grown up with the skills and understanding necessary to integrate these technologies into innovative companies. The transformative impact of genomics is starting to be realized.

But all of this is just the beginning. Classical genome sequencing is the foundation of a rapidly expanding bioscience revolution. We are moving beyond reading a single genome to being able to understand, edit and write DNA, and are unlocking whole new sub-

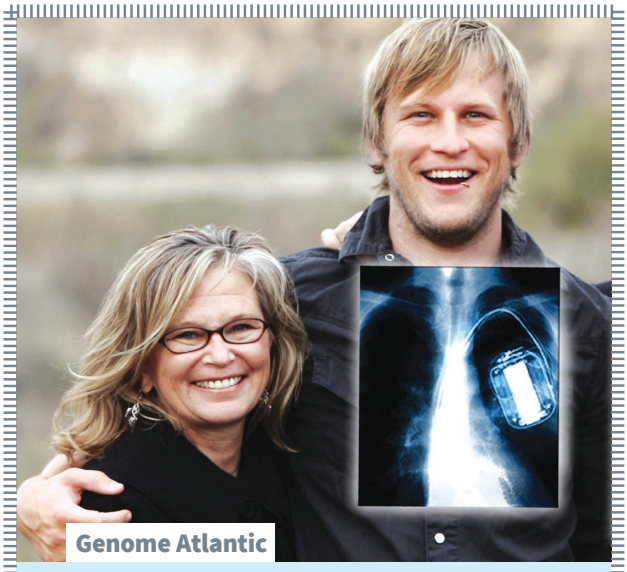
disciplines like synthetic biology, precision health, bioengineering, environmental DNA monitoring, and analysis of complex microbial communities. Genomics is evolving to include other molecular signatures—proteomics, metabolomics, epigenomics, glycomics—increasing understanding of living systems and the potential for innovation.

The technologies being driven by this revolution will transform society. New products and processes will drive advanced economies. New diagnostics and treatments will significantly improve peoples' health. New tools and green biotechnologies will improve the environment. These developments will create societal opportunities and challenges that go beyond technical or scientific developments.

Canada is poised to reap enormous benefit from these developments. As a leading bioeconomy, Canadian genomics research is benefitting diverse sectors like health, agriculture and agri-food, forestry, fisheries and aquaculture, the environment, energy and mining. Canada is a world leader in genomic research, with technical capacity and highly-skilled personnel working in research labs and industry across the country. Canada is also a world-leader in research into the implications of genomics in society, working to understand how disruptive knowledge and technology can be adopted effectively and responsibly.

We must not be complacent. Countries around the world are making enormous investments in biosciences to benefit their health and natural resource sectors. The advantage of abundant natural resources is at risk from countries that will innovate and stay at the fore of new biotechnologies.

Genome Canada is proud to have been a leader in laying the foundation for Canadian genomics and is committed to keeping Canada at the fore of the emerging revolution in biosciences, through a commitment to research, innovation, partnership and talent.



Atlantic Medical Genetic and Genomics Initiative

A team of researchers led by Professors Terry Lynn Young at Memorial University in Newfoundland and Mark Samuels at the University of Montreal successfully isolated the gene responsible for claiming the lives of seemingly healthy young men through sudden cardiac arrest. The multidisciplinary team uncovered the disease-causing gene TMEM43 and then spearheaded research to establish life-saving screening methods and preventative treatments for patients with TMEM43 mutations. Today, a simple blood test can diagnose those with the mutation and physicians worldwide now have the information to successfully treat hundreds of gene carriers with life-saving implantable cardioverter defibrillator (ICD) therapy based on this test alone. The discovery significantly lengthens the lifespan of those affected, adding 30-plus years to affected individuals.

GENOME TIMELINE

1950

Erwin Chargaff works out DNA pairing pattern of the bases A, C, G and T.

1953

James Watson, Francis Crick, Rosalind Franklin and Maurice Wilkins discover the double helix structure of DNA. Watson, Crick and Wilkins share the Nobel Prize in Physiology or Medicine in 1962.

1977

Frederick Sanger develops a DNA sequencing technique and sequences the first full genome – the virus phiX174. He won his second Nobel Prize in Chemistry for this work in 1980, sharing it with other pioneers of DNA sequencing Wally Gilbert and Paul Berg.

1978

Canadian Michael Smith develops the technique for oligonucleotide-directed site-directed mutagenesis, earning a share of the 1993 Nobel Prize in Chemistry with Kary Mullis.

1983

The polymerase chain reaction (PCR) is developed by Kary Mullis. He shares the 1993 Nobel Prize in Chemistry with Michael Smith.

1990

The Human Genome Project is launched, aiming to sequence 3 billion letters of the human genome in 15 years.

1995

The first bacterium genome sequence is completed (*Haemophilus influenza*).

1996

The first eukaryotic genome sequence is completed, (the yeast *Saccharomyces cerevisiae*).

The first cloned animal, Dolly the Sheep, is born at the Roslin Institute, Scotland.

2000

The full genome sequence of the model organism *Drosophila melanogaster* (fruit fly) is completed.

2002

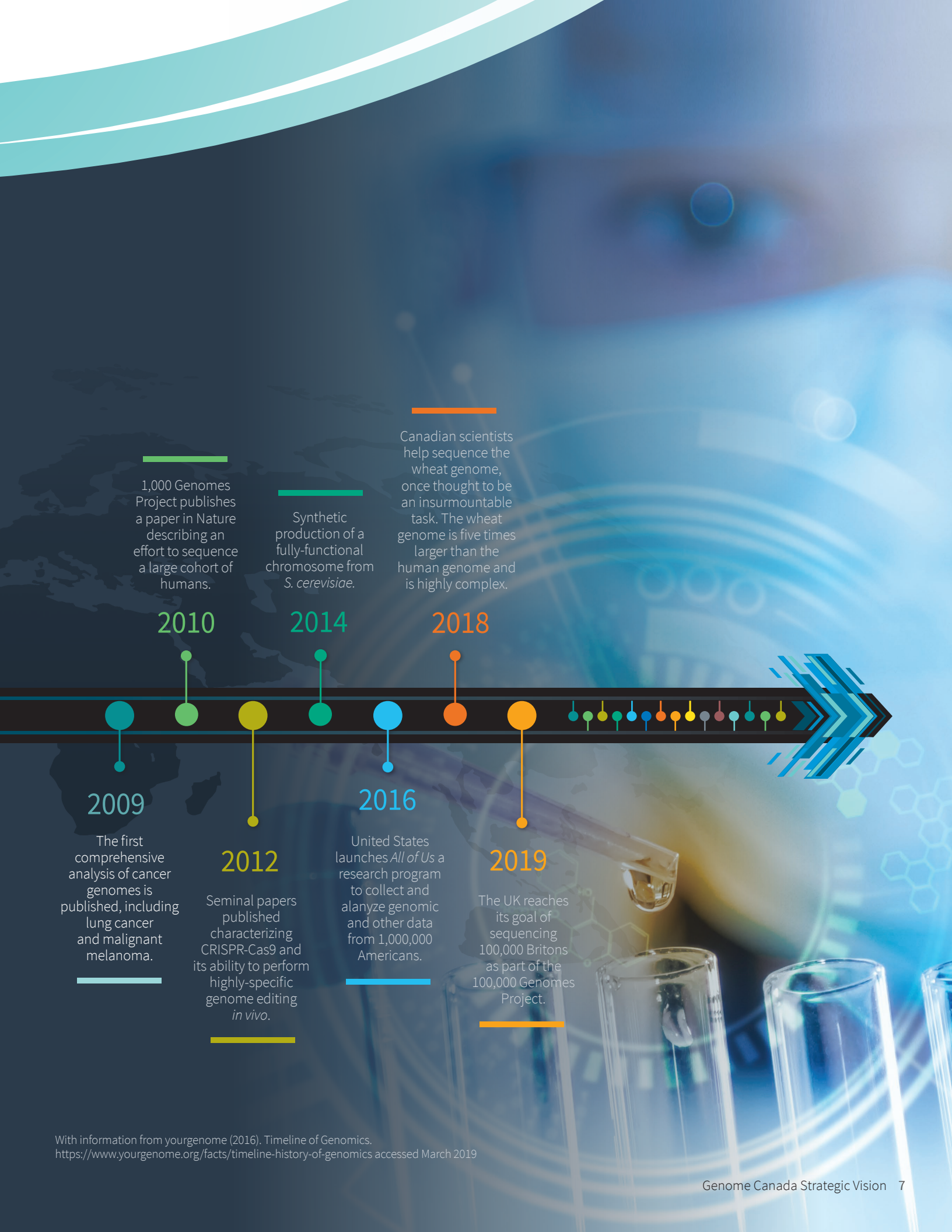
The mouse is the first mammal to have its full genome sequence completed. The mouse genome is 14 per cent smaller than the human genome, but over 95 per cent of the mouse genome is similar to ours.

2003

Human Genome Project is completed. The human genome is sequenced to 99.99 per cent accuracy, 2 years ahead of schedule and confirms humans have approximately 20,000–25,000 genes.

2008

Next-generation sequencing platforms result in dramatic drop in sequencing costs while increasing output 70-fold.



With information from yourgenome (2016). Timeline of Genomics.
https://www.yourgenome.org/facts/timeline-history-of-genomics accessed March 2019

LOOKING AHEAD

Sequencing the Wheat Genome

Genome Prairie

Wheat is the world's most widely cultivated crop, accounting for 20 per cent of all calories consumed throughout the world. The wheat genome is five times larger than the human genome and more complex. For over a decade, an international consortium of more than 200 scientists from 73 research institutions in 20 countries endeavoured to complete the genome sequence for bread wheat to help breeders develop improved varieties. But in 2018, Canadian researchers cracked the wheat genome: "Our research team at the University of Saskatchewan played a key role in the international consortium's success, a discovery that has the potential for disruptive innovation in wheat improvement," said Dr. Curtis Pozniak (ABOVE), researcher and wheat breeder at the university's Crop Development Centre. Pozniak leads Canada's contribution to the wheat genome initiative through the Canadian Triticum Applied Genomics (CTAG2) project, which includes a team of researchers from government and universities across the country.

Care4Rare – World-Leading Research into Childhood Rare Diseases

Canadian researchers have developed new expertise in understanding the underlying biology of rare childhood disorders. 264 rare disorders were submitted by geneticists from across Canada and selected for the Finding of Rare Disease Genes (FORGE) study. The research team has already solved 146 disorders, including identification of 67 novel genes that had never been associated with a rare disease before. “When we launched this project, we predicted we might explain, or solve, 50 disorders; we’ve almost tripled that goal,” Dr. Kym Boycott (FAR RIGHT), lead investigator of FORGE and clinician scientist at the Children’s Hospital of Eastern Ontario (CHEO). “This was a leadership opportunity for Canada. Our team’s rare disease expertise is now sought on an international stage – and it started with FORGE.” Now at the forefront of precision medicine. the FORGE project has rolled into an international research program called Care4Rare.

Ontario Genomics, Genome Alberta, Genome British Columbia

PATRICK DOYLE, CP IMAGES

De-Risking Offshore Natural Resource Exploration in Atlantic Canada

Genome Atlantic, Genome Alberta

The energy industry has invested $37 billion in offshore development in Atlantic Canada over the past two decades, but little is known about what lies beneath an area called the Scotian Slope, which makes the search for drilling locations a long and expensive process. A partnership between the Nova Scotia Department of Energy and the University of Calgary’s Geomicrobiology Group is helping exploration companies to understand this challenging terrain. A teaspoon of sediment from the ocean floor contains about a billion bacteria, some of which consume hydrocarbons and can indicate the presence of sub-surface oil. “We’re using genomics to do a ‘census’ of the microorganisms in seabed sediment samples,” says Geomicrobiology Group leader Dr. Casey Hubert (LEFT). “The DNA tells us the composition of that population. A high proportion of specialized hydrocarbon-degrading bacteria could indicate an oil reservoir below. If the genomic, geophysical, chemical and seismic data all line up, it might be a hot spot for petroleum.”

New Methods in Prenatal Testing for Genetic Diseases

Génome Québec, Genome British Columbia

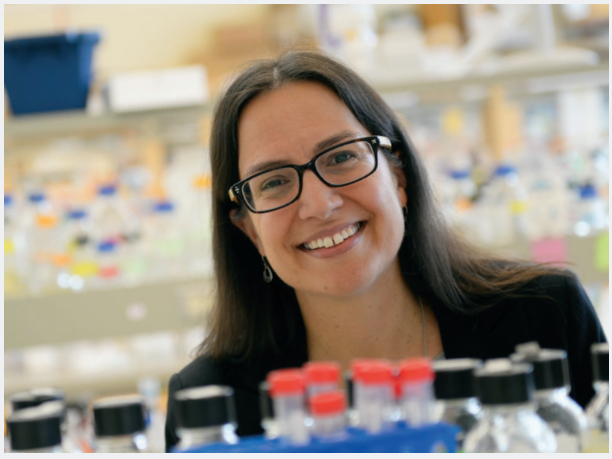
Every year in Canada, about 10,000 pregnant women undergo amniocentesis to screen for genetic abnormalities. This procedure represents a non-negligible risk and approximately 70 healthy fetuses are lost each year due to complications from the procedure. Recently, however, researchers have discovered that fetal DNA present in the mother's blood can be used to test for genetic abnormalities through a simple blood test. A team of researchers, co-led by Dr. François Rousseau of the University of Laval and Dr. Sylvie Langlois of the University of British Columbia, spearheaded the Personalized Genomics for Prenatal Aneuploidy Screening Using Maternal Blood (PEGASUS) project to develop the safest and most accurate genetic testing for fetuses and to explore associated ethical, legal and social questions. These include a concern that women may feel pressure to test, and the prospect of families facing an avalanche of complex genetic data, says PEGASUS researcher Dr. Vardit Ravitsky (LEFT), of the Université de Montréal. At the same time, NIPT could "revolutionize prenatal care," adds Dr. Ravitsky. If women are able to test in the first trimester, they will have more time to make an informed, early choice about the outcome of their pregnancy or to prepare for the birth of a child with special needs.

New Tool for the Rapid Detection of Bloodstream Infections and Antibiotic Susceptibility

Bloodstream infections are responsible for thousands of deaths in Canada each year, many of which could be treated by antibiotics if detected quickly enough. Unfortunately, testing for bloodstream infections is a costly and time-consuming process, with two to four days needed to identify the pathogen and measure its susceptibility to antibiotics. Better diagnostic tools are urgently needed. Dr. Ian Lewis (RIGHT) at the University of Calgary has teamed up with Calgary Lab Services to develop a metabolomics-based testing device that can identify pathogens and their antibiotic sensitivity in a few hours rather than days. Once in use, this device will reduce the time required to get a diagnosis while also reducing the cost of testing by more than 70% and should capture a significant portion of the $12 billion global marketplace for clinical microbiology testing.

Genome Alberta

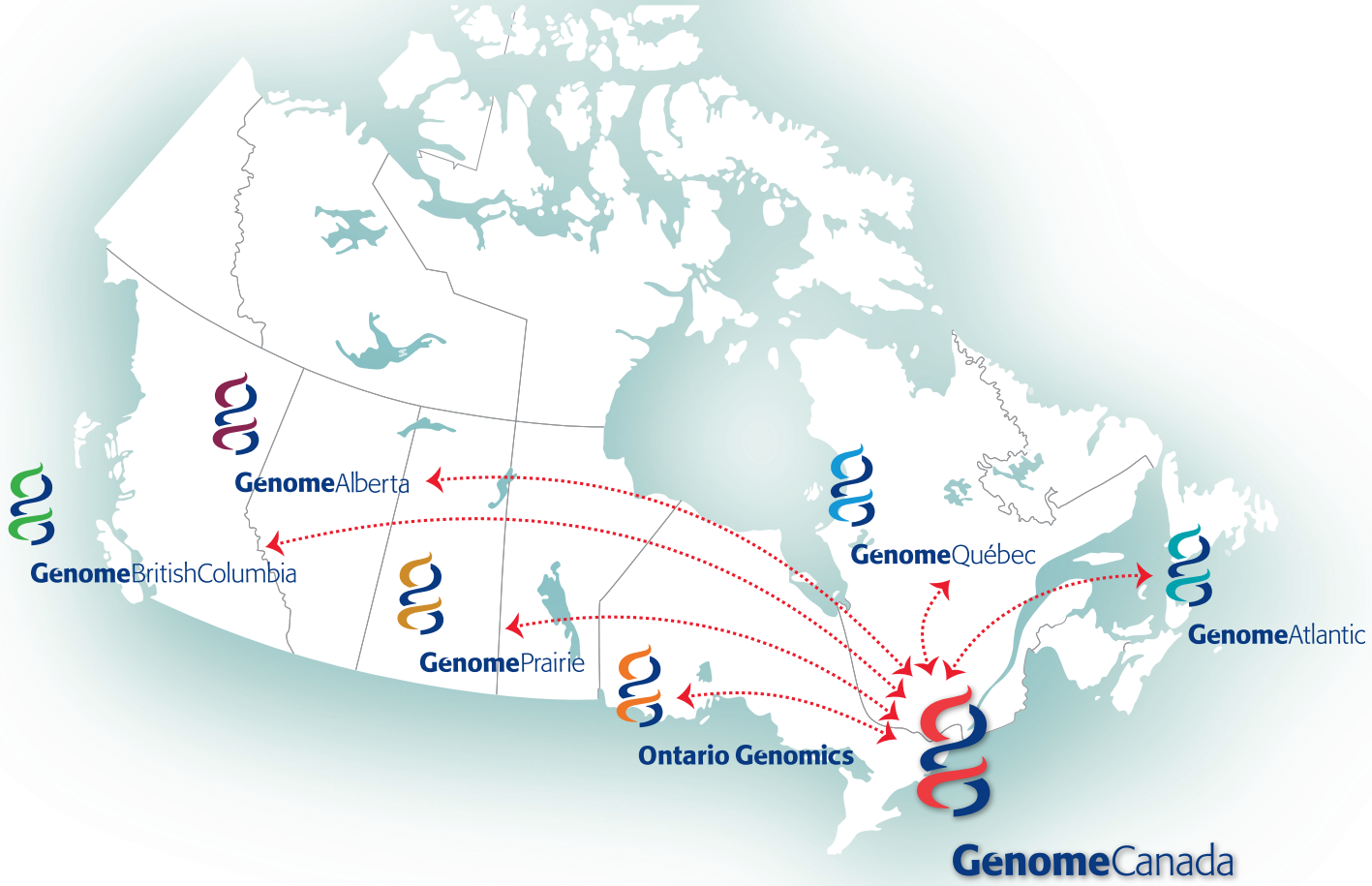
Silent Genomes: Genetic Diseases



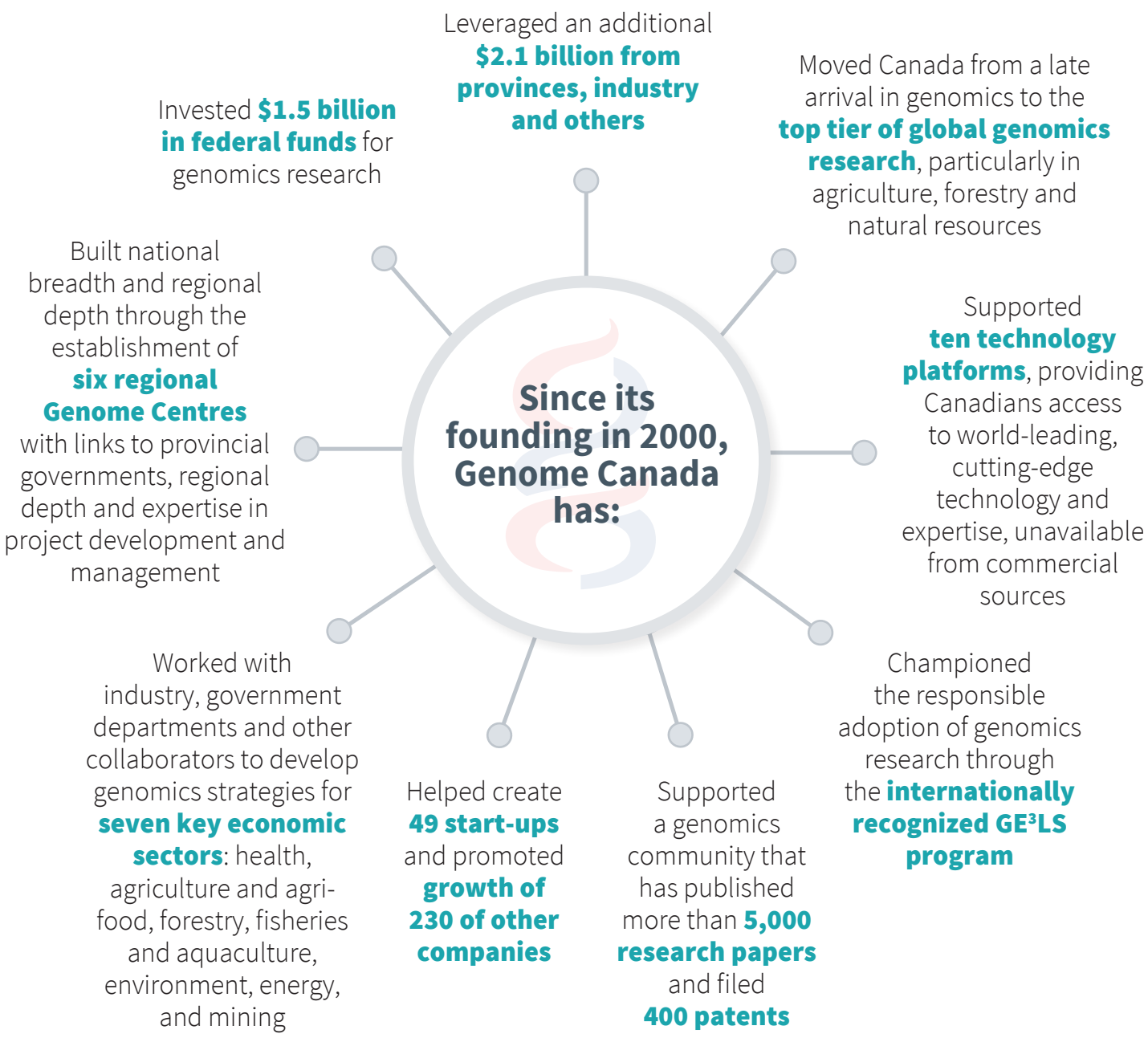
Precision health enables diagnosis and treatment to be tailored to individuals based on a patient's unique genetic makeup. Traditionally, it has been hard for people in Indigenous communities to gain access to precision health care. Now a team of British Columbia-based researchers, led by Drs. Laura Arbour, Nadine Caron (LEFT) and Wyeth Wasserman, is working to narrow the gap. The team is creating a system within which Indigenous people can oversee their own genetic data to improve diagnoses and health outcomes related to genetic disease.

"The Indigenous Peoples of Canada face unique health challenges, inequities, and barriers to health care and typically have poorer health outcomes than non-Indigenous groups. While leading-edge genomic technologies are becoming routinely available to other Canadians, Indigenous people often have little or no access to these technologies, increasing the health disparity gap. Silent Genomes is a game-changing effort to address this inequity, by bringing life-changing genomic diagnosis to children while ensuring Indigenous-led governance over biological samples and health data."
— Laura Arbour, Nadine R. Caron, Wyeth W. Wasserman

Genome Canada:
Leading the Canadian Genomics Enterprise



Genome Canada provides national leadership to a unique and cooperative Canadian genomics enterprise with six genome centres. The Genome Centres work closely with their provincial governments and regional partners and engage with industry, the public and other stakeholders. This collaborative delivery model aligns federal priorities with provincial opportunities and support and combines national breadth with hands-on regional knowledge and expertise. Genome Canada is proud to lead a truly national enterprise that builds on the regional strengths across Canada.


Since its founding in 2000, Genome Canada has:
Invested $1.5 billion in federal funds for genomics research
Leveraged an additional $2.1 billion from provinces, industry and others
Moved Canada from a late arrival in genomics to the top tier of global genomics research, particularly in agriculture, forestry and natural resources
Built national breadth and regional depth through the establishment of six regional Genome Centres with links to provincial governments, regional depth and expertise in project development and management
Supported ten technology platforms, providing Canadians access to world-leading, cutting-edge technology and expertise, unavailable from commercial sources
Worked with industry, government departments and other collaborators to develop genomics strategies for seven key economic sectors: health, agriculture and agri-food, forestry, fisheries and aquaculture, environment, energy, and mining
Helped create 49 start-ups and promoted growth of 230 of other companies
Supported a genomics community that has published more than 5,000 research papers and filed 400 patents
Championed the responsible adoption of genomics research through the internationally recognized GE³LS program

Charting Our Future:
Canada and the Biosciences Revolution

OUR WORLD FACES MAJOR CHALLENGES — climate change, chronic and acute health issues, global population growth, and increasing food and energy demand. Significantly, our biggest challenges are not driven by the digital flow of zeros and ones or the inanimate physical objects around us; rather, they involve the natural world: human health and disease, biodiversity and impact of climate change, food security, green energy. These challenges require comprehensive, coordinated solutions with science at their core.

Thankfully, we are in the early stages of a never-before seen revolution in the biosciences that is opening up the living world. Globally, we have built a foundation in genomics – knowledge, technology, skills and infrastructure – that is spurring applications and technologies that were unimaginable a few years ago. Synthetic biology, gene editing, environmental DNA monitoring, microbiome population analyses, novel diagnostics, and especially big data/AI techniques: the pace of genomics discovery and application is increasing ever more rapidly with commensurate potential for impact.

Countries with strong genomic scientific, technological, and entrepreneurial ability will develop solutions to these challenges, leading to improved lives at home and globally. They will also reap significant economic returns in the world's growing

bioeconomy, projected to be worth $1 trillion globally by 2030, according to the OECD. Canada is uniquely positioned to seize this opportunity given our great natural resources and life sciences footprint coupled with a strong genomics research enterprise.

Genome Canada is excited to be driving Canada's genomics strategy. With a strong reputation for research and technology excellence, a new focus on mission- and purpose-driven research, and a strong network of national and international partners, Genome Canada is driving creative solutions to complex Canadian and global issues. We have spent our first 19 years building a Canadian foundation in genomics and working with international partners to push the science and technology to where we are today. We are justifiably proud of our accomplishments. But the most exciting work is yet to come.

Genome Canada is animated by a vision of how rapidly emerging biosciences and technologies can transform the lives of Canadians, while contributing significantly to global challenges through partnership and cooperation. **We envision**:

> Canada as a world-leader in the application of genomics-based biosciences for human health, the environment and across the bioeconomy.

To accomplish this, Genome Canada delivers a portfolio of programs and initiatives with different objectives and outcomes. Across the board, though, they are driven by **Genome Canada's mission**:

> To put genomics in the hands of those who will use it to create health, environmental, and economic benefits for Canadians.

This Strategic Vision document is meant to capture our mission and translate it into a set of objectives and strategies. It reflects conversations with Canada's genomics research and user communities, international partners, and government stakeholders about the future of Canadian genomics: our greatest opportunities and risks, integration with other initiatives and activities, and how Genome Canada can optimize its support. This vision is not time-limited; we consider it evergreen and will revisit it regularly to adapt to the rapid evolution of the science and to seize opportunities and strategic directions as they arise. Our vision is translated into three objectives and a set of strategies.

Objective 1: Drive High-Impact Research to Benefit Canada

Genome Canada is proud of the work our researchers have done over the last 19 years. Canada's genomics capacity is strong, the technology has advanced significantly, and genomics is being applied to key sectors. Genomics is moving outward from the lab and into the hands of those who are using it.

Now is the time to intensify our focus on the application of genomics and emerging sub-disciplines and technologies— in the clinic, in the field, and in industry. That way, we can work collaboratively with researchers, industry, the healthcare sector, governments, and others to maximize its benefits by solving real-world problems, growing Canada's economy, and improving the quality of life of its citizens.

WE WILL ACHIEVE THIS OBJECTIVE BY:

1. **Supporting large-scale, interdisciplinary research with line-of-sight to application**: All our projects are driven by a specific purpose or application. We will strengthen our support of purpose-driven, large-scale research by engaging upfront with potential users from a range of industries and not-for-profits representing the health, agriculture, fisheries and aquaculture, natural resources and the environment sectors. We will do so with the understanding that different industries and users require different approaches depending on where they fall on the fundamental-to-applied research spectrum.

2. **Funding strategic mission-driven research that addresses key societal challenges**: Genome Canada will support and coordinate bold mission-driven initiatives that tap into Canada's existing strengths in genomics and increase its capacity to respond to societal challenges. These missions will

Genome British Columbia, Génome Québec

Protecting Canadian Forests from Invasive Species

Invasive species pose a significant threat to Canadian forests, tree farms and nurseries, with increasing numbers of trees of all ages succumbing to invasive pests. Traditional techniques used to isolate and identify pathogens take weeks to perform, time during which unidentified pathogens may slip by undetected. Paramount in efficiently preventing and managing disease is the identification of infectious agents and their origin. Dr. Richard Hamelin from the University of British Columbia has developed genomic tools that allow for the real-time identification of pathogens in plants and trees. The project is already making waves in the forest sector and is expected to generate significant economic benefits through the reduction of losses to forest diseases. Within the first year, the project ran approximately 10,000 tests on samples for several end users, including provincial governments and municipalities.

tackle specific, strategic issues where genomics can play a transformative role. This new direction for Genome Canada will provide exciting opportunities for Canada to play a leading role in emerging issues, particularly those with significant impact for Canadians. We will work with governments and the community to focus and coordinate efforts on issues where genomics' potential for impact is greatest.

3. **Driving national and international genomic big data initiatives**: Genome Canada will support the development of national data platforms and tools to interpret, manage, govern, store and share genomics data in a secure and equitable manner. These will include, for example, platforms in the health sector to promote clinical genomics and the future of a learning health care system for Canadians, and platforms in the agri-food sector to augment Canadian economic competitiveness and innovation. We will also work to develop and adapt machine learning/AI algorithms for use on these large genomic data sets. Finally, we will participate in key international data initiatives, such as DivSeek and the Global Alliance for Genomics and Health, to ensure that Canadian data policies are aligned with international standards.

Génome Québec

Improving Cheesemaking for Industry and Consumers

Professor Steve Labrie of Université Laval and Agropur, the largest dairy cooperative in Canada and a leading dairy processor in North America, teamed up to improve the highly complex process of cheesemaking. A sub-optimal ripening process can lead to product returns, significant production delays and compromised shelf life, which negatively impact profitability. To address these problems, Agropur is using genomics to produce competitive products in greater quantities and ensure better revenues for the members of the cooperative. "With this research program, we will be able to develop a new genetic tool very rapidly to help us better control production, limit losses and make high quality cheeses with a longer shelf life and fewer returns," Michel Pouliot, Vice-President, Research and Development at Agropur, explains.

Ontario Genomics

Precision Health for Pediatric Inflammatory Bowel Disease

Canada has one of the highest rates of inflammatory bowel disease (IBD) in the world, with more than 10,000 cases diagnosed in Canada each year. This disease causes significant suffering and serious health issues and costs the Canadian economy approximately $2.8 billion annually. Drs. David Mack and Alain Stintzi at the Children's Hospital of Eastern Ontario (CHEO) and University of Ottawa have partnered with Toronto-based startup Biotagenics to develop simple and quick tests to optimize personalized treatment plans based on patient genomic data. These tests build on earlier work that has identified and characterized the gut microbes that change during IBD treatment, helping clinicians fine-tune treatments for these chronic diseases.

4. **Developing and providing access to leading-edge technologies**: Genome Canada will continue to ensure researchers have access to technology platforms. We will develop and deliver the next generation of tools and technologies such as synthetic biology, gene editing, and artificial intelligence. Where appropriate we will work with the Canada Foundation for Innovation and others to coordinate efforts to meet technology needs.

5. **Advancing Canada's role in international genomics research**: From its beginnings, genomics has been a collaborative international enterprise. This continues today with major global efforts underway that require coordinated national participation. Genome Canada will continue to represent Canada and support Canadian researchers in initiatives like the International Rare Disease Research Consortium, the International Wheat Genome Sequencing Consortium, the International Barcode of Life and the Structural Genomics Consortium. We firmly believe that countries directly involved in the research itself derive greater benefit than those who are simply consumers of the research products.

6. **Supporting research on the implications of genomics in society**: Genome Canada supports the interaction between genomics and society through GE^{3}LS research, which stands for genomics and its ethical, environmental, economic, legal and social aspects. GE^{3}LS research provides stakeholders with the insights needed to anticipate the impacts of scientific advances in genomics, avoid pitfalls, cultivate success, and ultimately, contribute to Canada's leadership in the 21st century bioeconomy. Genome Canada will investigate factors that may help or hinder the acceptance and uptake of genomics research. The aim is to facilitate the translation of genomics research and ensure its responsible development and use. We will use a variety of methods, such as integrating GE^{3}LS research into large-scale research projects, conducting and supporting stand-alone GE^{3}LS research projects, and developing collaborative teams, networks and partnerships to build capacity.

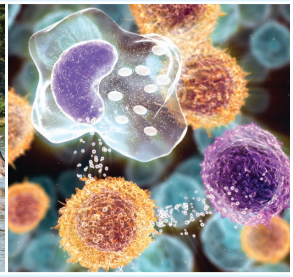
Examples of Mission-Driven Research Projects

- **National implementation of precision health for Canadians**. Genome Canada is currently piloting a mission-driven initiative to implement precision health for rare disease patients, paving the way for the broad roll-out of precision health for other diseases such as cancer, cardiovascular disease, and ALS. The mission includes peer-reviewed research into clinical implementation, data governance, and ethics, and a steering committee looking at how to coordinate efforts across provincial boundaries.

- **Cataloguing biodiversity in the north: The Boreal forest and Arctic**. This initiative will establish a baseline for biodiversity in climate-sensitive Canadian ecosystems in Northern Canada. Working with local partners and Canadian facilities, we will use this baseline to monitor climate change and help identify avenues for mitigation and adaptation.







- **The genomics of cannabis – health and plant biology**. Canada recently became the first OECD country to legalize the recreational use of marijuana. This has given Canada first-mover advantage to perform research and innovation on plant biology, commercial production, medicinal IP, and health impact. Genome Canada is working with leading Canadian producers to identify initiatives that will cement Canada's place at the fore of this rapidly growing sector.

- **A climate-adapted bioeconomy**. Canada is already a world leader in genomics and molecular biology in agriculture, forestry and fisheries, and the environment. The application and adoption of genomics capabilities in these key Canadian sectors will make Canada a leading global bioeconomy, particularly in the context of a changing climate.

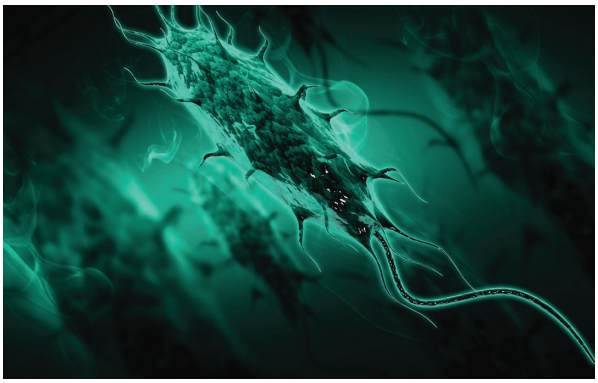
- **Anti-microbial resistance (AMR)**. AMR poses an increasingly serious threat to public health, livestock, and the environment. Canada's Pan-Canadian Framework on AMR and AMU (antimicrobial use) features research and innovation as one of its pillars. Genomics is at the core of AMR research, and is well-suited to tackle major challenges due to advances in studying the microbiome and the creation of tools for monitoring and discovery.

Objective 2:
Deliver Effective, Purpose-Fit Programs that Support our Mission

Genome Canada is proud of the work our researchers have done over the last 19 years. Canada's genomics capacity is strong, the technology has advanced significantly, and genomics is being applied to key sectors. Genomics is moving outward from the lab and into the hands of those who are using it.

We play a key role in Canada's research and innovation ecosystem by acting as connective tissue between fundamental, investigator-led research supported by the granting councils and industry-led government innovation supported through innovation programs. We also coordinate our programs with provincial and regional initiatives and investments through the national network of regional Genome Centres. This innovative model has resulted in collective action on genomics and shared costing for national research projects and has promoted alignment and cooperation across Canada.

Genome Canada is recognized world-wide as an innovative leader in genomics research; nonetheless, we recognize that to remain relevant and effective



we must continually evolve and adapt. Any changes we make must be based on demand and impact. Programming must be nimble enough to respond to changing user needs as genomics moves aggressively into the realm of application. Now that a generation of Canadian scientists is experienced in performing and managing large-scale genomics science, different programs will be required. We also need to attract and support a more diverse and equitable population of researchers that accurately reflects Canadian society and provide young investigators with opportunities for success.

WE WILL ACHIEVE THIS OBJECTIVE BY:

1. **Developing and delivering relevant, purpose-fit programs focused on research excellence and impact**: At Genome Canada, we continually strive to develop programs that promote and support research excellence. We achieve excellence by selecting the projects with the greatest potential for impact and success through our international peer-review panels of experts from a variety of disciplines. We are aware that the commitment

to excellence and accountability for large-scale investments can sometimes lead to administrative burdens for applicants. Going forward, we will simplify our programming and processes to make them nimble and responsive to user needs and commitments — while all the time maintaining excellence.

2. **Embedding equity, diversity, and inclusion in everything we do**: Genome Canada is committed to providing the entire pool of qualified Canadian researchers — particularly those in the early stages of their careers — with equitable opportunities to participate in our funding programs. A diversity of ideas strengthens the effectiveness of our governance, resources and research. In our own hiring process, peer-review system, and governing bodies, we will remove the barriers faced by underrepresented groups, including women, racialized and ethnic minorities, Indigenous peoples, people with disabilities and people who identify as LGBTQ2+. Our commitment will be rooted in a new Action Plan on Equity, Diversity, and Inclusion that will guide our work, programs, and partnerships.

3. **Strengthening the impact of the research and innovation ecosystem through collaboration and coordination**: The interdisciplinary nature of genomics means that no institution or organization can succeed working in isolation — particularly in Canada with its division of responsibilities between local, provincial, and federal governments. Further, Genome Canada understands that research and innovation are collaborative processes that require the shared talents and resources of diverse partners. To

Genome Prairie

Identifying Adaptable Lentil Crops

A team of researchers led by Drs. Kirstin Bett and Albert Vandenberg of the University of Saskatchewan is working to determine the genetics underlying the ability for lentils to grow well in different environments. In partnership with world-leading genomic big data company NRGene, the researchers have already successfully sequenced two wild lentil genomes – the largest legume genomes ever assembled. This project is expected to result in an increase in productivity and export revenues while ensuring Canada's continued dominance in research, production and marketing of this important global crop.

that end, Genome Canada works with partners in industry and the not-for-profit sector as well as with relevant agencies and departments of the federal and provincial governments. We convene cross-sector discussions in the formation of sector strategies for genomics or for the development of mission-driven initiatives. Genome Canada will continue to build partnerships and collaborations, seeking new participants and users, in order to maximize the impact of our research.

4. **Leading a national genomics enterprise that recognizes Canada's economic and geographic diversity**: Genome Canada is a cooperative and collaborative network with six regional Genome Centres, providing national leadership to a network with the ability to respond to regional and local opportunities. This 'national breadth and regional depth' helps build regional capacity, take advantage of particular opportunities and advance regional priorities. We will continue to leverage federal investments with co-funding by provinces and other partners at a greater than 1:1 ratio, demonstrating the broad, collaborative support for initiatives.

5. **Strength through our people**: The greatest strength of any organization is its people. Genome Canada commits to providing competitive salaries and comprehensive benefit packages to attract and retain exceptional talent. We recognize that employee engagement and their well-being are necessary in achieving Genome Canada's strategic vision. We will support and respect our people, address their concerns in a timely manner, communicate openly and involve them in our pursuit of success, so that they're inspired and are equipped to perform to the best of their abilities.

6. **Demonstrating accountability and continually improving programs through robust metrics and measurements**: The development and deployment of robust performance measurement and evaluation processes (PM&E) will underlie our commitment to demonstrating accountability and transparency through evidence-based information that informs decision-making; will ensure programs continue to be highly relevant and effective; and will enable the communication of the impact of investments to stakeholders.

Objective 3:
Promote the Responsible Application of Genomics in Canada

IN OPENING UP THE OPERATING software of life, genomics continues to create enormous potential for good, accompanied by significant challenges. Public optimism and excitement for genomics is often tempered by concerns and uncertainty, and outstanding questions remain around ethics, governance, and use. Policy-makers face challenges when they are presented with new questions and issues related to genomics and, for example, gene editing, genetic discrimination, novel biological products, and new therapies and diagnostics.

A key question for Genome Canada is how to more effectively support productive, evidence-informed conversations in Canada around these new technologies and the opportunities and challenges they represent. Certainly, the GE^{3}LS research we are already supporting provides a strong base of information, but the science, its applications, and therefore its impacts are evolving rapidly. We remain committed to exploring the implications of genomics in society — how to maximize its potential responsibly while minimizing any risks or negative impacts.

WE WILL ACHIEVE THIS OBJECTIVE BY:

1. **Supporting research on the implications of genomics in society**: As described under Objective 1, above, GE^{3}LS research provides essential insight into how genomics impacts society and contributes to its responsible application.

2. **Working with stakeholders to develop and implement genomic strategies**: Genome Canada will educate stakeholders and potential users on the potential applications of genomics, to understand barriers or concerns, and work together to develop coordinated strategies for genomics research and uptake. These strategies will be co-developed with other partners and will inform program development.

3. **Communicating trusted information about genomics to stakeholders**: Genome Canada will aim to increase awareness and understanding of genomics and its impacts by expanding our communications and outreach

activities to stakeholders. We will also support the regional Genome Centres, our researchers, and other members of the community in their outreach, including through partnerships with the media and joint education initiatives. By doing so, we can multiply the effectiveness and reach.

4. **Contributing to a national dialogue on the intersection of genomics and policy**: Genomics and its application create numerous implications for policy. Genome Canada will seize the opportunity to become a trusted voice of authority on genomics, its applications, and its implications for society. Through our Genomics in Society initiative, we will share evidence-based information, including the results of GE^{3}LS research, and make it accessible to the Canadian public. We will also participate in broader policy discussions on the innovation economy, digital and data developments, health and environmental issues, among others, and share our genomics knowledge and evidence base with policy-makers.

Genome Atlantic

Improving the Health of Aquaculture

In the past 20 years, aquaculture production in Canada has more than doubled to close to $3.1 billion in economic activity a year. However, the health of farmed salmon in Canada is perpetually threatened by infectious diseases. Researchers from Memorial University and the University of Prince Edward Island, along with aquaculture industry leaders EWOS/Cargill are using genomics to help the aquafeed industry improve the health of farmed salmon and protect them against disease by monitoring the impact of new feed. Dr. Matthew Rise of Memorial University and Dr. Richard Taylor of Cargill Aqua Nutrition are developing methods to identify and validate salmon genes related to growth in biomarker gene sets. From each individual fish sample, enough genetic data can be analyzed to classify the performance of a new feed. The genomic tools developed through this project allows EWOS/Cargill to determine right down to the cellular level how fish are impacted by the feed.

GenomeCanada

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