December 12, 2023

Backgrounder

New genomics research delivers sustainable solutions to public health and food security challenges

Genome Canada is proud to announce the launch of eight new projects within its Genomic Applications Partnership Program (GAPP) that will mobilize cutting-edge genomics research and innovation to deliver real world impact for Canadians. The GAPP program leverages world-leading expertise and diversified partnerships to accelerate the translation of scientific knowledge into broad economic and societal benefits for Canada.

This announcement represents more than $11 million in federal support to cutting-edge genomics science and innovation funded by Genome Canada. Provincial governments, business and research partners are also investing another $30 million in co-funding, for a total investment of over $41 million.

The projects in this backgrounder are listed by the regional Genome Centre leading on the work, and within those groupings, alphabetically by project name.

Funded projects

GENOME BC

Title: Surveillance alert for fast epidemiology genomics and unified agile response to disease (SAFEGUARD) against respiratory viruses using wastewater surveillance
Academic Leaders/Institutions: Natalie Prystajecky/David McVea (University of British Columbia, BC Centre for Disease Control)
Receptor Leaders/Organizations: Dr. Bonnie Henry (BC Office of the Provincial Health Officer, Ministry of Health), Natalie Knox (National Microbiology Laboratory-Public Health Agency of Canada)
Genome Centre: Genome BC
Total Funding: $6,148,823

During the COVID-19 pandemic, wastewater surveillance (WWS) was used by public health organizations around the world, including Canada, as an early warning system to predict outbreaks, detect the emergence of variants of concern and discover novel variants. WWS can be conducted for a fraction of the cost of clinical surveillance and can improve surveillance data and public health responsiveness in underserved communities. In addition, WWS can be applied to a broad range of pathogens such as the Monkeypox virus, poliovirus and antimicrobial resistance.

Currently, WWS programs in Canada are mostly limited to detecting SARS-COV-2. The SAFEGUARD project will take WWS to the next level by developing a robust and comprehensive genomics based WWS program for several key respiratory viruses. SAFEGUARD will provide provincial and national public health agencies with population-scale surveillance data and modelling tools enabling rapid responses to pathogens of concern. The project will also develop a formal surveillance program evaluation along with a wastewater preparedness toolkit to rapidly develop and implement wastewater tests for emerging threats across Canada. The toolkit will guide method validation, laboratory and analytical training, data interpretation and provide resources to put the research findings into practical use. The three-year SAFEGUARD pilot study in BC will guide strategic plans for the development of a pan-Canadian Wastewater Network and serve as an innovative model for use internationally. Canadians will benefit from quicker responses to public health threats.

ONTARIO GENOMICS

Title: EpiSign international: Health system impact assessment and expanding clinical utilization of epi/genomic testing in rare diseases and beyond
Academic Leaders/Institution: Bekim Sadikovic (Lawson Health Research Institute; London Health Sciences Centre)
Receptor Leader/Organization: Rishi Porecha (Illumina Inc.)
Genome Centre: Ontario Genomics
Total Funding: $7,551,693

An estimated 1 in 15 children is born with a rare genetic disease. Since 75 per cent of the 4,000 diseases manifest in childhood, children affected by them occupy 25 per cent of pediatric hospital beds in Canada, with diagnostic assessments often exceeding $10,000 per child. Despite advances in genome sequencing, most people with rare disorders remain undiagnosed, resulting in a significant socioeconomic burden related to the so-called "diagnostic odyssey", impacting treatment, reproductive planning and access to specialized care services. In addition to genetics, a significant cause of birth and neurodevelopmental defects involves prenatal exposures to teratogenic toxins including lifestyle choices, drugs and pathogens. Toxic exposures are challenging to resolve due to the lack of genetic biomarkers that can be detected with standard molecular tests. In partnership with Canadian biotech start-up EpiSign Inc., London Health Sciences Centre's Dr. Bekim Sadikovic has developed the first technology, called EpiSign, that uses a patient's epigenome to diagnose both genetic and teratogenic disorders. EpiSign's proprietary and continuously evolving AI-based algorithms compare Illumina microarray-generated epigenetic DNA methylation profiles in a patient's blood to the EpiSign Knowledge Database, the largest, rare disorder DNA methylation database. This project will expand clinical adoption of EpiSign as a Tier I test, using new Illumina technology. The project will advance molecular diagnostics of rare disorders and enhance Canada's leadership in clinical epigenomics. Improved and earlier diagnosis will give patients better access to care options and support networks, while improving health equity and socioeconomic impacts on healthcare systems in Canada and internationally.

Title: Improving patient matching to therapy (PMATCH): Streamlining clinical trial criteria to guide precision oncology
Academic Leaders/Institution: Benjamin Haibe-Kains, Trevor Pugh (University of Toronto)
Receptor Leader/Organization: Janet Dancey (Canadian Cancer Clinical Trials Network, 3CTN)

Genome Centre: Ontario Genomics
Total Funding: $1,861,850

Clinical trials are a crucial element of the modern health system. Cancer patients in Canada, however, face substantial barriers to accessing state-of-the-art precision therapies. This is because matching patients to trials is an increasingly resource-intensive and time-consuming task. The disjointed nature of the digital infrastructure means that already overworked clinicians have to spend time parsing through complex eligibility criteria and clinical diagnostic data. The result is fewer patients are enrolled in trials for which they are eligible. The project will develop PMATCH, an innovative open-source software platform. PMATCH uses powerful machine learning techniques to search through complex clinical and genomic eligibility criteria along with the data generated by each patient during their cancer journey, e.g., blood tests, surgery, family history. Clinicians will be able to match their patients with the best clinical trials for each individual in near-real-time. PMATCH will also standardize the clinical and sequencing data and ensure their FAIRness (findability, accessibility, interoperability and reusability). Expected benefits of the PMATCH pilot include a 50 per cent increase in patients matched to precision medicine trials across Ontario, acceleration of the identification of actionable biomarkers, increased pharmaceutical support for academic clinical trials, and improved patient experience in trials.

GÉNOME QUÉBEC

Title: Developing the Canadian sheep production using genomics
Academic Leader/Institution: Claude Robert (Université Laval)
Receptor Leaders/Organizations: Johanne Cameron (Société des éleveurs de moutons de race pure du Québec, SEMRPQ), Frédéric Fortin (Centre d'expertise en production ovine du Québec, CEPOQ)
Genome Centre: Génome Québec
Total Funding: $2,202,619

The Canadian sheep industry is facing growing domestic demand with production levels only meeting 44 per cent of current demand. Imports from countries such as New Zealand and Australia help fill the gap. While other livestock producers in Canada have used genomics solutions to increase production, the ovine sector has not, despite the role of genomics in complementing elite ovine stock selection around the world. The program will establish routine estimation of genomic breeding values by establishing reference populations for the province's major breeds. This will be done through massive genotyping. The project will also develop complementary genomic-based tools to manage inbreeding, known genetic defects and detection of genomic aberrations, as well as to search for quantitative trait locations using genome-wide association studies. The genomic database will be developed within Genovalia, a newly established data centre at Université Laval, following the FAIR principles. Within three to five years, the expectation is increased demand and use of Quebec-bred elite rams, leading to greater profitability for sheep breeders. All tools developed will be available to sheep producers across Canada. If the increased production successfully meets 100 per cent of domestic demand, the market potential is estimated at nearly $900 million.

Title: Development of a novel cyclin K degrader of high-risk AML patients and associated genomic features
Academic Leader/Institution: Guy Sauvageau (Université de Montréal, UdeM)
Receptor Leader/Organization: Anne Marinier (RejuvenRx Inc.)
Genome Centre: Génome Québec

Total Funding: $6,061,850

More than 50K people in Canada, US and Europe are diagnosed every year with acute myeloid leukemia (AML). Their five-year overall survival rate is about 30 per cent, with relapses of the disease predicted within three years. There is an urgent need for accurate biomarkers to help identify optimal treatments for individuals and development of novel effective therapeutics for high-risk patients and those who cannot receive standard treatments. The project will focus on Cyclin K (CCNK), a protein-coding gene, as a novel target for AML. It builds on previous research conducted by the University of Montréal (UofM) Leucegene program. Researchers have identified UM511 as a proprietary molecule able to induce the degradation of CCNK. The project will optimize this novel compound, develop a biomarker based on chemo-genomics and perform synergy testing by combining the optimized compound with existing AML drugs. This project will generate important benefits for Canada. Université de Montréal researchers will work with RejuvenRx, an emerging biotech company focused on cancer therapeutics, to ultimately advance the new drug through clinical trials to its market launch. Within three to five years after the funding ends, an IND (Investigational New Drug) application will be submitted, and Phase I/II trials likely completed. Assuming positive results, the drug will lead to the creation of dozens of high-quality jobs, generation of Canadian IP, and, most importantly, significantly improved therapeutic outcomes and survival rates for certain AML patients.

Title: Nano-enabled biostimulant for sustainable agriculture: Optimizing scale-up parameters through genomic approaches for commercialization
Academic Leader/Institution: Saji George (McGill University)
Receptor Leader/Organization: Jamil Samsatly (BioSun Products Inc.)
Genome Centre: Génome Québec
Total Funding: $978,637

Feeding an estimated global population of 9.1 billion people in 2050 requires raising overall food production by 70 per cent between 2005/07 and 2050. The increasing global demand for food forces the agriculture sector to heavily use fertilizers and pesticides for increasing crop protection and productivity. Since this use is unsustainable and irreparably damages the environment and humans, there is a demand for developing cost-efficient, high-performing and eco-friendly biostimulants. Worth around US$393 million in 2020, the North American biostimulant market is estimated to be growing annually by 11.29 per cent and will surpass US$4 billion by 2025. This project will use -omics technologies to lower manufacturing costs and drive commercialization of BioSun's innovative biostimulant, based on newly identified biologically active compounds (lipopeptides) from *Bacillus velenzensis* strain OB9 encapsulated in halloysite nanoclay (nOB9). When tested in yellow beans and tomatoes, the Canadian-made biostimulant prototype showed improved productivity under field conditions. The aim is to introduce this new product to the Canadian market, starting with Québec and Ontario, ultimately helping to lower Canada's carbon footprint and increasing its share of global agri-markets.

Title: Predict to prevent: A novel genomic-derived score to improve the prognosis of type 2 (T2) diabetes patients at high risk of complications
Academic Leader/Institution: Pavel Hamet (Université de Montréal)
Receptor Leader/Organization: Johanne Tremblay (OPTITHERA), Laurent Amram (ELNA Medical)
Genome Centre: Génome Québec
Total Funding: $13,289,585

T2 diabetes (T2D) is a public health challenge that affects 10 per cent of Canadians, with treatment costs of $30 billion in 2019. People with T2D have an increased risk of developing serious health complications. Globally, cardiovascular diseases (CVD) account for one-third to half of all diabetes-related deaths. Despite overwhelming evidence showing the crucial role of blood pressure (BP) and glycemic control in T2D management, many patients do not reach recommended BP and glucose targets. This places them at a high risk for complications. The researchers, in collaboration with OPTITHERA, have used clinical and genomic information from over 4,100 Type 2 diabetes patients followed for 10 years and AI to develop the first genomic test to predict the risk of CVD—including myocardial infarction, stroke and renal complications—in T2D patients. This will bring early and personalized disease management for patients at high risk of complications and reduce overtreatment of low-risk individuals. The team has already demonstrated the benefit of testing on renal complications of T2D, delaying dialysis, lowering healthcare costs and improving patient quality of life. Building on this previous work, this project is a unique opportunity to generate prospective real-world evidence from over 3,000 T2D patients to support clinical use, adoption and diffusion of this proprietary genomic test. It will expand the test to various ethnic groups; scale up the analytical process to make the test automated, robust and secure; and use an electronic medical record platform to make results available. Health economic studies will demonstrate its cost-effectiveness. The ultimate aim is to successfully commercialize this innovative Canadian test.

GENOME ATLANTIC

Title: Triploid mussel genomics program
Academic Leader/Institution: Ramon Filgueira (Dalhousie University)
Receptor Leader/Organization: Tiago Hori (Atlantic Aqua Farms, AAF)
Genome Centre: Genome Atlantic, Génome Québec
Total Funding: $3,486,131

Aquaculture is a viable option to enhance the production of sustainable protein sources for human consumption. Its average global emissions are estimated as ~10X lower than from beef production and ~0.5X from poultry. Mussel aquaculture is one of the most important industries in Prince Edward Island (P.E.I.), generating annual revenues of over $60 million and supplying 50 per cent of mussels consumed in North America. Shellfish aquaculture has lower GHGs than salmon and shrimp aquaculture. Triploid shellfish, especially oysters, are widely used in the US, France, U.K. and New Zealand. Currently, no companies are using triploid mussels in Canada. Due to their sterility, triploids (with three sets of chromosomes) grow faster and are more resilient than their diploid (two sets) counterparts. However, triploidization can cause reduced resistance to heat stress. The project will use genomic solutions to optimize the production of robust triploid strains of mussels that perform well in PEI's estuaries. Increased efficiency will allow PEI and AAF, the largest mussel grower/processor in North America with over 4,500 acres of water leases, to expand production without increasing their water lease footprint. It will also increase provincial revenues without creating conflicts over use of the marine space. Establishing genomic-driven biotechnology approaches will further Canadian leadership in aquaculture innovation and create high-skilled jobs in Atlantic Canada. Expanding shellfish production to replace other protein sources will help Canada meets its net-zero target by 2050 and help ensure food security.