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A Message from the Life Sciences Collaborative

THE PANDEMIC showed us first-hand why Ontario needs a strong life sciences sector. Over the last three years, we saw hospitals, innovators, industry and researchers rapidly pivot their work towards patient care, retooling industries to manufacture personal protective equipment (PPE) and to biomanufacturing treatments and therapeutics.

These experiences have further underscored the fact that the jurisdictions best prepared to face future shocks will be those with a life sciences ecosystem that is robust, resilient and self-sufficient – one that fuels discovery, conducts ground-breaking research and commercializes inventions to improve quality of life and drive economic development.

Ontario now has an opportunity to strengthen its life sciences ecosystem and is well-positioned to seize this moment.

If is why the Life Sciences Collaborative has come together – consisting of representation from industry, health care and academia – to demonstrate our willing partnership in helping Ontario take life sciences to the next level.

As key players in the sector, the Collaborative welcomes the Ontario government’s leadership in developing a provincial life sciences strategy and its critical investments in the sector.

Our report outlines how we can build on these commitments and work together to ensure Ontario remains a global leader in life sciences and improves its ranking among the top 10 life sciences jurisdictions in North America, according to InvestOntario.

The future economic prosperity and self-sufficiency of Ontario’s life sciences sector will be determined in large part by the steps we take now to leverage and expand the highly skilled talent and ground-breaking research and innovation that has been cultivated.

In order to build on the government’s life sciences strategy and take Ontario’s life sciences to the next level, the Life Sciences Collaborative is recommending:

1. Investment throughout the life sciences ecosystem, including in life sciences research and innovation, and support to expand enrolment in high-demand programs.

2. Strategic matching of federal dollars in biomanufacturing and life sciences to ensure Ontario does not fall behind what Quebec, B.C. and Alberta are leveraging.

3. Continued collaboration and conversation through Ontario’s new Life Sciences Council to ensure a range of perspectives that are as diverse as the Collaborative membership are reflected.

Together, we can harness our collective power in order to strengthen Ontario’s life sciences sector by ensuring a future of discovery, life-saving treatments and expanded biomanufacturing capacity that leads to job creation and improved outcomes for all Ontarians.

With the right ingredients, Ontario can capitalize on opportunities within life sciences to support our economic recovery, strengthen our pandemic preparedness and build a stronger Ontario for today and tomorrow.

– The Life Sciences Collaborative

With membership from:

Centre for Aging + Brain Health Innovation
Centre for the Commercialization of Regenerative Medicine
Clinical Trials Ontario
Life Sciences Ontario
Ontario Brain Institute
Ontario Chamber of Commerce
Ontario Genomics
Ontario Hospital Association
Ontario Institute for Cancer Research
Ontario’s Universities

With collaboration from: the Ontario Chamber of Commerce, Health Policy Council
Introduction

Over the last three years, we saw first-hand why Ontario needs a strong life sciences sector. We saw how hospitals, innovators, industry and researchers were able to rapidly pivot their work — diverting resources to patient care, retooling industries to manufacture personal protective equipment (PPE) and pivoting biomanufacturing to the development of vaccines and therapeutics.

Today, it remains clear that the jurisdictions best prepared to face future shocks will be those that develop highly skilled talent across life sciences and health care, while conducting research to find innovative solutions.

Now, with a spotlight on the life sciences sector, Ontario has the opportunity to build on efforts that had been accelerated during the pandemic. The province can seize this moment to continue to fuel a sector that saves lives, increases Ontario’s self-sufficiency and drives economic development.

An integrated ecosystem with collaboration between government, universities, industry and communities is fundamental for Ontario to maintain and improve its ranking among the top 10 life sciences jurisdictions in North America (according to InvestOntario), as well as to realize opportunities to develop, retain and attract talent; and drive research, innovation and commercialization.

Ontario’s universities, research-intensive hospitals, research institutes and industry are working together to harness our collective power in order to strengthen life sciences, help Ontario’s economic recovery and ensure future pandemic preparedness.

Further support and investment into Ontario’s life sciences ecosystem, while fostering space for innovation, is critical to ensuring stakeholders across the sector have the resources they need to continue to:

- **Build a dynamic research ecosystem:** Strong partnerships within the life sciences ecosystem are essential to continue to translate and mobilize knowledge, build Ontario’s supply chain resiliency and commercialize innovations that support the health of Ontarians and drive economic growth.

- **Drive a competitive economy:** More jurisdictions across Canada are prioritizing life sciences and ensuring they are receiving their fair share of federal funding. Ontario must leverage these opportunities to remain a leader in the life sciences sector, both locally and internationally.

- **Improve health care with innovative solutions:** Ontario’s life sciences ecosystem is vital to supporting the recovery of Ontario’s health-care system, improve patient outcomes and help innovations in health care and biomedical technology scale for the benefits of Ontarians.

- **Develop highly skilled talent:** Without highly skilled talent, the potential growth in the life sciences sector envisioned in recent federal and provincial strategies cannot be fully realized.

Ontario’s life sciences sector is well-poised to be a global leader. It is home to a myriad of players and encompasses interconnected fields that contribute to human, agricultural and environmental health – from bio-health, biopharmaceuticals and bioenergy to agri-biotechnologies, zoonotic diseases and biomanufacturing (see Appendix A for a full definition of life sciences).

Supporting advances in life sciences will transform Ontario, strengthening the health of our communities and helping solve some of the most urgent challenges society faces today, such as pandemics and climate change.

McKinsey & Company estimates that bio innovations could impact up to 60% of the physical inputs to the global economy – a market worth $2 to 4 trillion in 10-20 years. Fifty per cent of the benefit will occur in the health sector.

The Life Sciences Collaborative welcomes the Ontario government’s development of our province’s first life sciences strategy in more than a decade, Taking Life Sciences to the Next Level, as well as the critical investments the province has made in the sector, including the launch of a $15-million early-stage innovation fund, targeting 85,000 jobs, attracting investment and reducing red tape.
In order to build on the government’s life sciences strategy and take Ontario’s life sciences to the next level, the Life Sciences Collaborative is recommending:

1. Investment throughout the life sciences ecosystem, including in life sciences research and innovation, and support to expand enrolment in high-demand programs.

2. Strategic matching of federal dollars in biomanufacturing and life sciences to ensure Ontario does not fall behind what Quebec, B.C. and Alberta are leveraging.

3. Continued collaboration and conversation through Ontario’s new Life Sciences Council to ensure a range of perspectives that are as diverse as the Collaborative membership are reflected.

The future economic prosperity and self-sufficiency of Ontario’s life sciences sector will be determined in large part by the steps we take now to leverage and expand the highly skilled talent and research cultivated.

Ensuring life sciences can continue to thrive in Ontario means ensuring a future of ground-breaking discovery, life-saving treatments and expanded biomanufacturing capacity that leads to job creation and improved outcomes for all Ontarians.

Ontario’s Life Sciences Sector

While the life sciences are often synonymous with human health, they are, in fact, much more encompassing. The life sciences sector in Ontario—and around the world—brings together science, R&D and technology-based products and services that contribute to human, agricultural and environmental/planetary health. The life sciences are interdisciplinary and interconnected, driven by organizations and companies contributing to biohealth (e.g. biopharmaceuticals, diagnostics), bioenergy (e.g. biomolecules, biofuels), bioindustry (e.g. biomaterials, sustainable development) and agri-biotechnologies (e.g. plant and animal genetics, food).

Accounts for 51% of Canada’s R&D spending.
Contributes ~$58B to Ontario’s GDP (top-11 highest contributor, above transportation, information and cultural industries, accommodation and food services, utilities, mining, oil and gas extraction) and $8.8B in taxes.
3rd highest number of companies across sectors in Ontario, above food & beverage, automotive, mining and aerospace sectors.
Employs -90K highly-skilled workers (Ranking 4th among N. American jurisdictions by life science employment) across more than 6,140 companies (Ranking 3rd among N. American jurisdictions by life science establishments).
1 in 13 Ontarians work in a job connected to the life sciences sector, sustaining over 191K jobs through direct, indirect and induced impacts.

Building a Dynamic Research Ecosystem

Translating research into health benefits and economic prosperity

Already established partnerships enabled industry, universities, hospitals and institutes to build on their work together and accelerate the creation of new knowledge over the last three years. By pivoting quickly, they translated this knowledge into the development of life-saving treatments, vaccines and PPE to help improve the health of Ontarians.

Ontario must now build on this biomanufacturing strength, knowledge and agility to further catapult the sector forward. In doing so, we can ensure our province is well-positioned to be a global leader in the development, commercialization and early adoption of innovative products, services and treatments.

IN ORDER TO IMPROVE THE OUTCOMES OF HEART bypass surgery, researchers at the University of Waterloo are using a natural material derived from seaweed. The new approach is helping promote vascular cell growth, prevent blood clots and improve the performance of synthetic vascular grafts used in heart bypass surgery.

Strong partnerships within the life sciences ecosystem have been essential to translating and mobilizing knowledge, building Ontario’s supply chain resiliency and commercializing innovations that support the health of Ontarians and drive economic growth.

ONTARIO’S RESEARCHERS ARE DRIVING INNOVATION through breakthrough discoveries that can have meaningful impacts in health care. Research conducted at the University Health Network by senior scientists from the Princess Margaret Cancer Centre and the University of Toronto has led to the launch of a new biotech firm, Adela, which focuses on the early detection of cancer and other high-morbidity, high-mortality conditions through a blood test. The firm recently attracted $60 million in financing to commercialize a new “liquid biopsy” technology.

To date, by working together, Ontario’s universities, research-intensive hospitals, research institutes and industry have greatly contributed to the provincial GDP, generating more than $27 billion in 2016 and placing life sciences among the top 11 contributors to Ontario’s GDP, according to Life Sciences Ontario (see Figure 1).
In addition, more than $56 billion has been generated in revenue for Ontario, with 64 per cent of this revenue driven by drugs and pharmaceuticals, 20 per cent by medical devices and equipment, 14 per cent by agricultural feedstock and chemicals and 2 per cent by research, testing and medical laboratories, according to Life Sciences Ontario (see Figure 2).
Leading-edge Infrastructure Supports Economic Development

Much of the work that results in health benefits and economic contributions to Ontario takes place in innovative spaces that fostered collaboration between stakeholders, allowing life sciences research and innovation to thrive.

From 2017-22, eight Ontario universities reported that more than 60 major infrastructure projects have been built on campuses to help foster life sciences research, innovation and talent development.

For example, OmniaBio Inc. recently launched a new biomanufacturing facility in Hamilton’s McMaster Innovation Park that will pioneer treatments for many forms of cancers, cardiovascular diseases, Parkinson’s disease and diabetes. The facility focuses on manufacturing leading edge treatments, discovered and researched here in Ontario and abroad.

In fact, OmniaBio, a scaling firm spun out of the Centre for Commercialization of Regenerative Medicine (CCRM), hosted by the University of Toronto, has attracted $100 million in investment to date and will grow to more than 500 people in Phase 1. The firm represents a new manufacturing sector enabled by the talent and collaborations among academic and industry stakeholders in order to develop, commercialize and adopt innovative health products and services.

In fact, private companies are frequently seeking access to specialized knowledge, research hubs and facilities within institutions and research-intensive hospitals to develop or test their innovations. In particular, many Ontario health-care start-ups have emerged from hospital-based research institutes and institutions where they began as academic endeavours.

These spaces are fundamental to attracting talent, fueling research and ensuring companies can expand operations and retain start-ups in Ontario.

Through partnership and collaboration, life sciences research, knowledge and innovation have and will continue to be translated into real economic benefits for our province.

Commercializing research for the benefit of Ontario

Ontario’s life sciences stakeholders will continue to work together to support the discovery and commercialization of Ontario-made ideas, while ensuring we foster a culture that encourages multinationals to establish headquarters in Ontario for the benefit of Ontarians.

By focusing on both homegrown inventions, as well as attracting companies to Ontario, the province can ensure communities throughout Ontario feel the positive impacts of commercialization. These impacts lead to job creation in local economies and industry partnerships between researchers and businesses, both big and small, that help in local distribution and supply chain optimization.

University researchers, for example, continue to make ground-breaking discoveries, partnering with industry to mobilize ideas and translate discovery into tangible products and services, while taking proactive steps to protect sensitive data and national security objectives.

From 2017-2022, more than 720 start-up companies were created in life sciences across 10 universities in Ontario, including more than 290 research-based start-up companies and more than 300 student originated start-up companies, according to Council of Ontario Universities (COU) data.
Much of this work is done through Technology Transfer Offices (TTOs) on campuses that provide legal and market research expertise to researchers; match mentors and management teams to start-up companies; provide database access; and share best practices. TTOs help bolster knowledge translation and identify commercially viable researcher IP, securing funding and de-risking IP for private-sector investment.

From 2017-2022, eight Ontario universities, generated nearly $141 million in licensing revenue, according to COU data. In addition, equity and grant financing for start-ups equaled $2 billion during this same timeframe.

Similarly, organizations, including the Ontario Brain Institute (OBI), the Ontario Institute for Cancer Research (OICR), Ontario Genomics, Toronto Innovation Acceleration Partners (TIAP) and the Centre for Aging + Brain Health Innovation (CABHI), offer mentorship and partnership opportunities, as well as financial and commercialization support, to researchers in hospitals, postsecondary institutions, care delivery organizations and start-ups to strengthen and scale their innovations. Support ranges across the health-care sector, including both the physical and digital health-care spaces.

In fact, through CABHI’s Spark program, point-of-care staff (workers, managers and researchers) and caregivers have the opportunity to receive funding to transform grassroots ideas into real-world applications – developing, testing and scaling these ideas over a 12-month period.

In 2021-22 alone, Ontario Genomics created or maintained more than 750 jobs. In fact, since 2000, the institute has contributed $1.8 billion to Ontario’s GDP (between 2013 and 2018), collaborated with more than 500 partners, supported more than 300 projects and has been awarded more than 300 patents, according to Ontario Genomics data.

**WITH SUPPORT FROM THE ONTARIO INSTITUTE FOR CANCER RESEARCH AND FACIT**, the commercialization of a Lakehead University researcher’s work has resulted in the launch of a spin-off company, Radialis Medical, and the creation of a new innovation, the PET mammography, to detect breast cancer with greater accuracy and less discomfort. The innovation is now being used for different applications, such as prostate cancer. Recently granted FDA approval allows the company to market this device in the United States.

**THE ONTARIO INSTITUTE FOR CANCER RESEARCH (OICR) and FACIT**, OICR’s commercialization subsidiary, support more than 1,300 highly skilled jobs in STEM fields. Since 2005, OICR and FACIT-supported researchers and start-ups have attracted an additional $1.6 billion in funding to Ontario to advance their innovations. In 2021-22 alone, OICR collaborated with more than 500 partners in 30 countries around the world and 74 new products, practices or services were developed, evaluated, introduced into practice or adopted as the result of OICR support, according to OICR data.

In addition, Ontario’s research-intensive hospitals have expertise and infrastructure in place to support strong partnerships with Ontario companies and system partners that can help companies and start-ups expand their operations, boosting their commercialization capacity.

Beyond generating commercialization revenue, these innovations also result in improvements to health-care delivery and outcomes, helping ease the pressures on the health-care system.

Since 2017-18, Ontario’s research-intensive hospitals have generated nearly 1,400 intellectual property disclosures and $162 million in commercialization revenue from more than 680 products, according to the Ontario Hospital Association (OHA) data.
WITH INITIAL SEED FUNDING FROM BAYER AG AND Versant Ventures, BlueRock Therapeutics, a company co-founded by researchers from the University Health Network (UHN) and University of Toronto, develops stem cell therapies for neurology, cardiology and immunology with a special focus on Parkinson’s disease in regenerative medicine. More than 7 million people worldwide with Parkinson’s disease could benefit from the therapy, which has the potential to reverse degenerative disease and restore motor function. In 2019, the firm was wholly acquired by Bayer AG and valued at around USD $1 billion.

Ontario’s universities, hospitals, research institutions and industry will continue to work together to foster strong collaborations that fuel the full spectrum of research from discovery to commercialization and secure investment.

However, the path to commercialization is still particularly arduous for life sciences products, where, despite the outcomes outlined above, securing capital can be challenging.

With its cost-intensive and lengthy payback periods, the sector can be especially risky for early-stage technologies and inventions. For example, in BIOTECanada’s 2018 Biotechnology Sector data survey, access to capital was identified as the top issue facing the biotechnology sector by the majority of survey respondents (57 per cent), according to Life Sciences Ontario.

Without sufficient funding, often times, innovations and ideas are scaled elsewhere to secure the support needed to commercialize, while new medicines are not always available or accessible to Ontario patients. When it comes to access to new treatments, Ontarians wait an average of 22 months after Health Canada’s regulatory approval to gain public access to innovative medicines.

In particular, the funding gap is noticeable at the earliest stages of commercialization, when the path to the market is the longest and most risky.

Support for early-stage innovations, such as the $15 million invested by government through the Life Sciences Innovation Fund, will help prevent companies created in Ontario from leaving for other jurisdictions where they can obtain capital and sell their products.

THE FLONERGIA AIRLIFT PUMP WAS ENGINEERED AND prototyped in the University of Guelph’s Multiphase Flow and Energy Lab. With support from the Gryphon’s Leading to the Accelerated Adoption of Innovative Research program, the pump was commercialized for the agriculture, aquaculture, aquaponics, hydroponics, vertical farming and water/wastewater industries. These pumps now perform as well as or better than conventional pumps, while reducing operating costs and cutting energy consumption by 50-70%.

But more can be done to support the considerable costs and time associated with getting a product from ideation to market readiness.

Attracting capital to support the commercialization of research in Ontario will need an all hands-on-deck approach to ensure Ontario can compete globally for research dollars, talent and investment. In addition, by working with Intellectual Property Ontario (IPON), universities, industry and government can support the commercialization of research without adding red tape or financial barriers.

A thriving life sciences ecosystem requires continued investment to support the full spectrum of research and biomanufacturing. Only with investment can Ontario’s life sciences sector truly seize opportunities for discovery, clinical trials and commercialization, while ensuring innovators can take the risks needed to build companies, create jobs and improve access to new products and services for all Ontarians.

“There is a wide-spread need for increased funding, lab capacity, and access to infrastructure and equipment to support R&D and the commercialization of genomics technologies.”

– What We Heard: Pan-Canadian Genomics Strategy, May-June 2022

RECOGNIZING THE NEED FOR TRANSFORMATIVE solutions in an evolving health-care landscape, the University of Waterloo’s incubator, Velocity, is launching Velocity Health – a globally competitive platform that connects health innovators and helps start-ups commercialize health technology.
Driving a Competitive Economy

Invention and innovation that attracts investment

Ontario's industry, universities, hospitals and research institutions are working to build a dynamic life sciences ecosystem that drives investment, attracts global attention and makes Ontario more competitive.

These efforts are attracting more companies to our province. For example, Toronto became the sixth Johnson & Johnson Innovation – JLABS site and the first to be located outside of the U.S. Now North America's largest urban innovation hub, JLABS @ Toronto brings together researchers, investors, government and entrepreneurs with the common goal of advancing health-care innovation.

TO PROTECT INDIVIDUAL PATIENT INFORMATION while preserving data usability, a researcher at the University of Ottawa developed a software called the Privacy Analytics Risk Assessment Tool (PARAT). This digitized solution strips out key data elements that could be used to connect individual records to patients. Based on this research, the researcher has founded a spin-off company, Privacy Analytics Inc. (acquired by IMS Health, now IQVIA, in 2016) and launched the PARAT solution commercially, which continues to provide anonymization services to companies around the globe.

These private-sector sources continue to invest in Ontario's life sciences ecosystem. In 2021-22, total industry investment in Ontario's research-intensive hospitals represented more than $211 million of the $1.82 billion research-intensive hospitals received in total from all revenue sources, including federal and provincial grants.

Between 2016-17 and 2021-22, research-intensive hospitals attracted private-sector investment totaling $1.44 billion from industry investments in clinical trials and basic science. In addition, over the past five years, universities attracted $3.5 billion from private-sector sources for life sciences research conducted at affiliate hospitals, including funding from business enterprises, individuals, as well as foundations and non-profits.

CONAVI MEDICAL INC., A TORONTO-BASED COMPANY founded in 2007 by physicians and scientists at Sunnybrook Research Institute, has attracted more than $20 million to support the commercialization of its Novasight Hybrid integrated intravascular imaging system. The system is the first and only clinical system that combines ultrasound and optical imaging to help interventional cardiologists conduct minimally invasive heart procedures, visualize disease and deploy stents to open arteries to restore blood flow to the heart. At the end of 2021, Conavi Medical announced that it had entered into agreements for more than $20 million in funding to prepare the Novasight Hybrid System for market.
A well-coordinated, funded and collaborative ecosystem will continue to attract investments and create the conditions that enable companies to scale and grow.

Innovative Medicines Canada represents more than 50 innovative pharmaceutical companies across Canada that are driving the discovery and development of new medicines and helping improve access to treatments. These companies support more than 50,000 jobs, contribute an estimated $1 billion in research and development and generate approximately $8.5 billion in economic activity for Ontario.

Further support will fully unlock the sector’s potential and ensure life sciences in Ontario remains a place where life-changing discoveries are made, ground-breaking inventions are manufactured, high-quality clinical trials are conducted and innovative companies are built, transforming research and ideas into products and services that the world wants to buy.

Kitchener-based Nicoya Lifesciences began as a start-up with five employees that has now grown to 100 employees. The company developed a molecule sensor that can be used to monitor and analyze proteins, antibodies, nucleic acids and small molecules, and has broad-ranging applications from medical diagnostics to industrial sensing. Due to investments from Ontario Genomics, the company is beginning to commercialize a new sensor chip technology for food quality monitoring, as well as for the proteomics and genomics industry.

Leveling the playing field with other jurisdictions

Canada’s research and development (R&D) spending as a percentage of GDP and productivity growth currently lag behind G7 countries, as well as the average for the Organisation for Economic Co-operation and Development (OECD). In fact, the OECD estimates that among OECD countries, Canada will have the slowest GDP per capita growth from 2020 to 2030 and from 2030 to 2060.

When it comes to access to new medicines, Canada ranks last in the G7 and 19 out of 20 when compared to peer OECD countries in the time it takes for public patients to access new medicines.

While many OECD countries have improved their R&D intensity since 2005, both Canada’s, and Ontario’s in particular, have declined, according to Life Sciences Ontario (see Figure 3).

**Figure 3: R&D intensity of OECD countries**

When specifically comparing university research funding across Canada, Ontario falls behind other provinces.

What’s more, jurisdictions across the country are prioritizing life sciences and ensuring they are receiving their fair share of federal funding (see Figure 4). Alberta, for example, recently committed to spending $81.5 million to grow its pharmaceutical and life sciences sector, which includes up to $55.1 million for new vaccine and drug development and manufacturing, contingent upon federal funding.

Similarly, Quebec has invested $205 million in a Life Sciences Strategy with the explicit goal of becoming one of North America’s top five life sciences hubs by 2027. The province has also put in place policies, such as the BAP-15 policy, which guarantees that the Quebec government will cover the cost of the brand for 15 years for publicly insured patients, even if a generic competitor enters the market before then.

In addition, B.C. has invested $76 million into Genome BC to lead genomics research and applications.

In the 2022 federal budget, the government announced Canada’s Biomanufacturing and Life Sciences Strategy aimed at rebuilding Canada’s domestic biomanufacturing capacity, while encouraging the creation of life-changing innovations. The Strategy is supported by $750 million over four years in competitive funding for Biomedical Research ($250 million) and Bioscience Research Infrastructure ($500 million).

Stakeholders in the sector are and will continue to leverage these funds. For example, the Canada First Research Excellence Fund (CFREF) has resulted in leading-edge research in regenerative medicine and food security.
Ontario’s commitments outlined in its life sciences strategy, such as targeting 85,000 jobs, attracting investment, reducing red tape and investing in the early-stage innovation fund are critical to bolstering the life sciences sector.

Strategic investments in bio-manufacturing and life sciences will further drive the sector forward, maximizing Ontario’s share of federal investments, as well as enhancing our province’s competitiveness and leadership by maintaining a level playing field with other jurisdictions.

LIFE SCIENCES IS BEING PRIORITIZED ON A GLOBAL scale with matching funding from local governments. Canadian philanthropist Geoffrey Cumming recently provided $250 million to the University of Melbourne to establish a new pandemic preparedness centre, which will invest in developing treatments that can fight infectious diseases. The state of Victoria will provide matching funding of $75 million over 10 years to support the centre.

These investments will result in a life sciences sector that continues to build domestic capacity, attract and retain talent, improve quality of life for Ontarians and ensure start-ups and companies created in Ontario can scale at home.

RNA DIAGNOSTICS EMERGED FROM WORK conducted by Laurentian University and Health Sciences North Research Institute. The company develops personalized medical technologies that enable physicians to assess whether a patient’s cancer treatment is effective within weeks, ensuring course of treatments can be adapted early. Currently, an international clinical trial to validate the technology for use in breast cancer is underway in six countries across North America and Europe.
How the Life Sciences Ecosystem is Continuing to Drive Health Care Innovation in Ontario
As the pandemic and its impacts demonstrated, Ontario’s health-care system faces ever-increasing challenges, demonstrating that we need a strong talent pipeline of highly skilled health-care workers and innovative solutions to ensure future pandemic preparedness.

Ontario’s life sciences ecosystem will play a critical role in helping rebuild Ontario’s health-care system, improve patient outcomes and help innovations in health care and biomedical technology scale for the benefits of Ontarians.

At the forefront of a rejuvenated health-care system are researchers, innovators and entrepreneurs who are developing novel technologies and products targeted at helping Ontarians live healthier lives.

In addition to innovative prevention and wellness tools, Ontario’s research-intensive hospitals, in partnership with key stakeholders, are developing new approaches to virtual care and digital health, early detection biomarkers and ground-breaking treatments to support health system recovery.

Ultimately, this will result in an Ontario that is healthier, more prosperous and more self-reliant in addressing the current and future threats to the health and well-being of Ontarians.

Together, Ontario’s universities, hospitals, research institutions and industry will continue to help the province’s health-care system by energizing research in new treatments, drug discovery and advanced technologies.

Ontario is Canada’s leading clinical trials sector with 4,600+ active clinical trials in Ontario; two times the number of active clinical trials per capital compared to the U.S. and a 160% increase in clinical trials over the past decade, according to Clinical Trials Ontario.

Curiosity-driven research that fuels medical breakthroughs

Ontario has a history of ground-breaking fundamental health research that continues to fuel future scientific and technological breakthroughs. Such breakthroughs and inventions in life sciences include innovations in blood-forming stem cells, the discovery of insulin, cancer stem cells in leukemia, early-onset Alzheimer’s disease, radiation treatment for cancer, the external cardiac pacemaker and the identification of genes for cystic fibrosis.

Collaborations between industry, research-intensive hospitals and Ontario’s universities continue to develop breakthroughs, solving some of the country’s and world’s biggest health dilemmas. For example, teams of researchers across Canada in hospitals and universities are coordinating efforts to address sepsis, a leading cause of death and a high-cost illness for health systems, representing an annual cost of $1 billion to Ontario’s health-care system, alone.
SUCCESS STORIES: Making an impact across health care

Through work conducted at the hospital-based Lawson Health Research Institute in London, Ontario, and Western University, researchers have discovered a protein that is now in development to become a new pharmaceutical to treat sepsis. Development of this discovery involved years-long collaboration among scientists, hospitals and the university and private sectors. The path towards the commercialization of this breakthrough is being facilitated through WORLDDiscoveries—a business development arm of London research institutes with private-sector linkages—and will lead to very significant health benefits for patients.

Research conducted at Ontario’s hospital-based research institutes is improving the manufacturing process for vaccines and other biological therapies. Virica Biotech, based on research conducted at the Ottawa Hospital Research Institute and the University of Ottawa, has pioneered a new product category of Viral Sensitizers (VSE), which improves production processes to deliver high yields at lower cost and bolster products to enhance their therapeutic effects.

Genome-wide sequencing has transformed our ability to diagnose rare diseases. However, the process to receive a diagnosis currently has significant challenges. To address these challenges, the Children’s Hospital of Eastern Ontario (CHEO) and The Hospital for Sick Children (SickKids), in collaboration with the Ministry of Health, developed and is delivering an optimized clinical genome-wide sequencing service as a two-year pilot for individuals with rare diseases that is equitable, accessible, sustainable and Ontario-made. The pilot project will provide genome-wide sequencing to 650 families from CHEO and SickKids, and will enable robust assessment of diagnostic utility, cost effectiveness and timeliness of genome sequencing to inform policy and delivery of genome-based diagnostics for rare disease.

Through regenerative medicine, a team of researchers from Algoma University has discovered a way to regenerate frog limbs after they have been lost, while minimizing the pain associated with limb loss. The strong biological connection between frogs and humans makes this technology promising and, with further research, it could lead to ground-breaking developments in the field of regenerative medicine.

With lung cancer being the leading cause of cancer-related death in North America and the world, a Brock University epidemiologist has developed a lung cancer prediction model to assist in the early detection of the disease when it is most curable. By identifying patients at high risk earlier, the discovery can reduce lung cancer death by as much as 20 per cent.

A new health technology partnership between Carleton University, Ottawa Hospital Research Institute and the Division of Orthopedic Surgery has resulted in the establishment of a laboratory to improve orthopedic implants and surgical repairs. This three-way partnership will utilize a robotic arm to evaluate materials and techniques used in implants, improving their performance. The device is designed to reproduce the motions and forces of real-life joints and to test innovative orthopedic procedures and implants for treating these injuries to better understand how injuries occur.
Researchers work at the intersection of basic and applied research to translate knowledge into products and technologies to help advance societal health and well-being. At McMaster University, a team of scientists have designed two next-generation COVID-19 vaccines which are delivered by inhaling aerosol and designed to combat variants. These are two of the very few COVID-19 vaccines being developed in Canada, with Phase 1 of the clinical trials recently approved by Health Canada.

Researchers at Nipissing University are contributing to the recovery of the region following the pandemic, including studies that are exploring the impact of COVID-19 on children's health-related behaviours, as well as the impacts the pandemic had on the life and care of adults living with intellectual and developmental disabilities.

In order to effectively communicate information about COVID-19, fourth-year graphic design students at OCAD University developed effective visual communication techniques. These students focused their projects on the impacts of COVID-19 on social, financial and/or mental health, supporting a new study on trends in data visualization of COVID-19 information in two Canadian daily newspapers.

An innovative technology solution is being developed by students at Ontario Tech University that uses artificial intelligence (AI) to help health-care professionals analyze a patient’s balance quickly and accurately. The project involves embedding computerized sensors into shoe insoles in order to assess static and dynamic balance abilities. As a result, a piece of AI software is applied to the data so that individual patient scores for balance and risk of falling can be generated.

Research done in partnership with the Lawson Health Research Institute, the London Health Sciences Centre and Ontario Genomics has the potential to provide patients with rare diseases an improved quality of life through early and definitive diagnoses. The team is working to validate EpiSign, a diagnostic test that uses machine learning to analyze data and diagnose rare diseases. Once validated, EpiSign could be used broadly as a bioinformatics services, where tertiary genetic centres can engage with their patients locally.

A critical factor in survival rates of breast cancer is early detection and treatment. To help improve the early detection and monitoring of breast cancer, a team of researchers at Queen's University have developed a new, more sensitive detection method using a blood test that senses the presence of circulating tumour DNA in the blood called mDETECT.

The long-term symptoms and effects of COVID-19 will remain for many years. Researchers at Western University are using functional MRI and inhaled xenon gas to demonstrate that these debilitating symptoms are caused by microscopic abnormalities that affect how oxygen is exchanged between the lungs and the red blood cells. Conducted in partnership with London Health Sciences Centre, St. Joseph’s Health Care London, Lakehead University, McMaster University, Toronto Metropolitan University and Sick Kids Hospital, the research is the first to show a potential cause of long-term COVID symptoms. By understanding the cause, individuals responsible for patient care have been able to target treatment for these patients.

In a world-first discovery, a virologist at Wilfrid Laurier University has found that a nucleic acid produced by viruses can be used to target and shut down the spread of disease in healthy and cancerous cells. Until now, this strategy has only been known to work for invertebrates and plants. The discovery has the potential to change the way we treat a wide variety of ailments, from cancer to lower back pain to viruses, including coronaviruses, such as SARS-CoV-2.
Researchers at the University of Windsor have come together to explore a novel potential treatment for an aggressive type of brain cancer. By studying the use of nanoparticles to target and treat glioblastoma (GBM), researchers observed a decrease in CD44 receptor protein levels—a marker for tumour-initiating cells and a driver of several aggressive aspects of glioblastoma like invasiveness, proliferation, resistance to cell death. Through this discovery, researchers were able to get rid of the very molecule responsible for so many of those aggressive characteristics of glioblastoma.

A study, involving researchers from York University and Sunnybrook Health Sciences Centre, combines state-of-the-art imaging techniques with sophisticated machine learning using artificial intelligence, resulting in a methodology that could allow clinicians to predict—before or soon after treatment begins—how well individual breast-cancer patients will respond to chemotherapy. The research can allow doctors to tailor treatments for patients, which can greatly improve the effects of chemotherapy in the future.

Atrial fibrillation (AF) is the most common cardiac arrhythmia in the world and is associated with increased risk of stroke, cognitive impairment, dementia, paralysis and heart failure. However, there are currently no established biomarkers to guide the management of AF. A partnership between the University of Ottawa, Roche Diagnostics International Ltd. and Ontario Genomics is working to develop a diagnostic biomarker panel to allow for the early detection of AF and predict the risk of complications, resulting in improved care, treatments and outcomes for patients. In addition, improved decision-making in AF management is expected to save more than $200 million annually in health-care costs in Canada.
Training, retaining and attracting talent

As outlined previously, industry, research hospitals, research institutes and universities have worked together to attract investment and fuel growth within the sector.

However, without the right mix of talent, the potential growth that recent federal and provincial strategies will bring to the sector cannot be fully realized.

Ontario’s life sciences sector needs a strong talent pipeline – the next generation of highly skilled scientists, innovators and entrepreneurs to propel the sector forward and increase its self-sufficiency.

Amidst a changing landscape where Canadian companies are growing at a rapid pace, it is now more important than ever to build on these recent investments by ensuring Ontario has the programs, initiatives and partnerships it needs to train, retain and attract the critical talent that can leverage these investments.

“As people who have the ability to take a drug or a product all the way through development and to the market — that’s where there is a real deficiency in Canada.”

– Richard Bozzato, Senior Advisor, Health Sector, MaRS

Ontario’s universities, research hospitals, research institutes and industry are vital contributors to developing Ontario’s highly skilled workforce in biommanufacturing, agri-food and more. By working in partnership, we are helping inject this talent into a fast-growing life sciences sector.

As of 2017, when taking into account the full scope of life sciences, the sector employed more than 500,000 workers in Ontario in nearly 90,000 companies, which means one in 13 Ontarians employed works in a job connected to the life sciences sector, according to Life Sciences Ontario.

These efforts have helped secure Ontario’s position in the top five of North American jurisdictions when it comes to life sciences employment and the top three for life sciences companies, according to Life Sciences Ontario’s Accelerating Prosperity: The Life Sciences Sector in Ontario (see Figure 5).
A survey of eight Ontario universities found that more than 70,000 workers helped drive life sciences in the university sector from 2017-22, including clinical care workers, researchers, veterinarian technicians and data scientists, according to COU data.

More than just developing talent, partnerships between stakeholders are ensuring this talent remains in Ontario and continues to be critical in bolstering our province’s global competitiveness. Recent investments in Ontario’s life sciences sector due to its highly skilled talent include:

- **Hoffmann La Roche Limited (Roche Canada)** investment of $500 million over five years in 500 highly skilled and specialized full-time positions in Ontario.

- **Sanofi investment of $79 million a year in research and development in Ontario** to leverage leading scientists in the province and create 300 high-quality jobs. This critical investment will push Ontario to become a leading producer of flu vaccines, and potentially others, reducing our reliance on others.

- **Merck Canada investment of $3 million in the University of Toronto’s Centre for Vaccine Preventable Diseases** to help researchers understand the decision-making of individuals and communities surrounding immunizations. The investment will bolster the centre’s continuing education training initiatives to help health providers improve their understanding of the science behind vaccines.

- **AstraZeneca investment of 500 highly skilled scientific and high-tech jobs to the Greater Toronto Area** to lead global clinical studies in areas, such as breast, lung and prostate cancer, COVID-19 and chronic kidney disease. The investment also includes the creation of a new Alexion, AstraZeneca Rare Disease Development Hub.

**Meeting the growing demand for talent**

The need for highly skilled talent in life sciences is only expected to grow.

A recent report by Stokes Economics, *Ontario Future Labour Force Needs Study*, examined labour market projections in Ontario within a range of fast-growing sectors. In particular, the report found that, over the next 10 years, Ontario will need more than 233,000 jobs in STEM and nearly 148,000 jobs in health care that will require a university degree.

These projections include thousands of job openings in life sciences, such as more than 2,500 biologists and
related scientists, more than 300 agricultural representatives, consultants and specialists, more than 1,300 veterinarians and more than 5,300 pharmacists.

Due to growing student, research and market demands, since 2010, Ontario’s universities have significantly increased STEM enrolment by more than 68 per cent and nearly 38 per cent in health programs, according to COU enrolment data (see Figure 6).

In fact, more than 614,000 students enrolled in undergraduate programs in life sciences at Ontario’s universities from 2017-22, while more than 100,000 students enrolled in graduate life sciences programs, according to COU enrolment data (see Figure 7), including in programs such as biochemistry, agri-food and epidemiology and public health (see Appendix B for a full list of life sciences university programs).

Figure 6: University enrolment growth by program area

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<td>Math. &amp; Physical Sci., +107.9%</td>
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<td>Engineering &amp; Applied Sci., +63.2%</td>
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<td>Health Professions, +35.1%</td>
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<td>Agri. &amp; Bio. Sci., +35.2%</td>
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<td>Social Sci. incl. Business, +19.4%</td>
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<td>Education, +5.9%</td>
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<td>Fine &amp; Applied Arts, +0.4%</td>
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<td>General Arts &amp; Sci., -9.8%</td>
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<td>Humanities, -24.5%</td>
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Source: Council of Ontario Universities, March 2023

Ontario Genomics-funded projects created 20,000 jobs between 2013 and 2018 – 50% of which were outside of the Greater Toronto Area, and most were in the health and agricultural sectors, according to data collected by Ontario Genomics.

Figure 7: Fall headcounts for life science programs at Ontario universities, 2018-19 to 2022-23

<table>
<thead>
<tr>
<th>Year</th>
<th>Undergraduate</th>
<th>Graduate</th>
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<tbody>
<tr>
<td>2018-19</td>
<td>20,873</td>
<td>118,961</td>
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<tr>
<td>2019-20</td>
<td>21,593</td>
<td>121,482</td>
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<tr>
<td>2020-21</td>
<td>22,184</td>
<td>127,109</td>
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<tr>
<td>2021-22</td>
<td>22,783</td>
<td>130,125</td>
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<tr>
<td>2022-23</td>
<td>22,984</td>
<td>130,761</td>
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Nearly 25,000 workers were engaged in the hospital-based research workforce in 2021-22, including clinical researchers, researchers, postdoctoral fellows, graduate and undergraduate students and other research staff, according to OHA data.

A workforce equipped with the skills and experiences to drive the sector forward will ensure life sciences in Ontario continues to increase its ability to compete globally, attract new investments, fuel economic growth and improve quality of life for Ontarians.

As key stakeholders across the sector, the Life Sciences Collaborative will continue to help meet this growing labour market need, growing and retaining talent that is helping discover life-changing medicines, create innovative technologies and advance ground-breaking research in digital health, agriculture and artificial intelligence.

Strategic investments and supports in the life sciences sector in Ontario, including removing red tape and barriers to further program expansion, will ensure our province can meet the growing demand for highly skilled talent – ultimately building out Ontario’s capacity to be self-sufficient and cementing the province as a global leader in life sciences.

Providing innovative training and learning opportunities

Ontario’s universities, research hospitals, research institutes and industry will continue to fuel the life sciences talent pipeline through innovative programming, work-integrated learning opportunities and entrepreneurship programs.

From bio-engineering, epidemiology and public health administration to food science, veterinary medicine and fisheries, life sciences programs, or programs that incorporate life sciences components, at universities and in partnership with hospitals and industry are all-encompassing, helping fuel the talent pipeline.

THE VETERINARY CAPACITY PROGRAM (VCP) AT THE University of Guelph enables students to work at a veterinary practice with supervision and mentorship from practicing veterinarians. The training opportunity equips students with hands-on skills that prepare them for career growth.

These learners move on to become the health-care workers, biomedical engineers and agricultural specialists who will fuel growth in life sciences, ensuring new discoveries can not only have immediate impact on the everyday lives of Ontarians, but also ensure the province can be at the forefront of the next revolution.

A PARTNERSHIP BETWEEN CARLETON UNIVERSITY and Turnstone provides students with opportunities for work-integrated learning, job shadowing and mentorship. Students, graduates and researchers work closely together to conduct research in immunology, microbiology, biotechnology and bioinformatics, generating insights into cancer therapies and chronic disease.

In addition to innovative programming, work-integrated learning opportunities provided through partnerships between stakeholders are ensuring learners continue to translate their knowledge to real world applications.
For example, a five-year partnership between an Ontario university, Mitacs and Fusion Pharmaceutical has created a unique teaching environment for graduate students seeking experience using radiopharmaceuticals to detect and treat cancer. In launching the Fusion Pharmaceuticals Training Program, the university provides graduate students with the expertise, specialty labs and instrumentation necessary to bolster training in the development and testing of cancer-related research.

TORONTO METROPOLITAN UNIVERSITY’S NURSING simulation lab is increasing capacity for learning by preparing students for the real world through simulation and gamification, allowing students to practice interactions with patients, undergo in-depth clinical examinations and gain access to nursing station equipment.

In addition, Ontario’s research-intensive hospitals, in close connection with universities and medical schools, are major training grounds for science that attracts and retains top talent.

Between 2017-22, nine Ontario universities reported that more than 2,300 students participated in research internships in partnership with industry related to life sciences, provided by programs through Mitacs, the Vector Institute and others, according to data collected by COU. During this timeframe, more than 1,000 students across all Ontario universities participated in Mitacs-specific research internships.

IN RESPONSE TO THE FAST-GROWING FIELD OF digital health data, Queen’s University is helping prepare students for careers in digital health. In collaboration with government and industry stakeholders, the university’s health data analytics program provides graduate students with training and research in medical informatics through work-integrated learning, practicums, mentorship and competency-based training.

TRENT UNIVERSITY’S NEWLY LAUNCHED PROGRAM, Bachelor of Science in Health and Behaviour, gives students a unique opportunity to examine the complex area of health and behaviour encompassing mental and physical well-being. During a 12-week placement in a community setting, students gain first-hand experience in health promotion or population health.

Clinical trials in Ontario are hubs for health research talent, employing 22,000+ researchers and staff in academic hospitals and 63,500 STEM graduates, annually, as well as creating 30,000+ jobs in drugs and pharmaceuticals and 26,000+ jobs in medical devices, according to Clinical Trials Ontario.
Conclusion

Ontario has an opportunity to strengthen its life sciences ecosystem and is well-positioned to seize this moment.

Together, as key players in the life sciences sector, the Life Sciences Collaborative welcomes the government’s leadership in developing a provincial life sciences strategy.

Cementing Ontario’s place as a global leader can be achieved through investments in life sciences research and innovation, expanding enrolment in high-demand programs, as well as strategic matching of federal dollars in biomanufacturing and life sciences.

By working together, we can continue to ensure Ontario has a highly skilled life sciences workforce, the resources to drive ground-breaking research and transform these ideas into products and services, as well as the spaces and leading-edge infrastructure to fuel innovation.

With the right ingredients, Ontario can capitalize on opportunities within life sciences, growing the sector to support our economic recovery, strengthen our pandemic preparedness and build a stronger Ontario for today and tomorrow.
Appendix

A. Defining Life Sciences

“The life sciences sector in Ontario – and around the world – brings together science, R&D and technology-based products and services that contribute to human, agricultural and environmental/planetary health. The life sciences are interdisciplinary and interconnected, driven by organizations and companies contributing to biohealth (e.g. biopharmaceuticals, diagnostics), bioenergy (e.g. biomolecules, biofuels), bioindustry (e.g. biomaterials, sustainable development) and agri-biotechnologies (e.g. plant and animal genetics, food).” – Definition outlined in Life Sciences Ontario’s 2021 report, Leading the Way Toward Recovery, Resilience and Prosperity: Roadmap for an Integrated Life Sciences Ecosystem in Ontario

B. List of University Courses Categorized as Life Sciences

› Agriculture
› Anatomy
› Animal Science
› Anthropology
› Archaeology
› Aural and Oral Rehabilitation
› Basic Sciences
› Biochemistry
› Biology
› Biomedical engineering
› Biophysics
› Botany
› Chemistry
› Dental Specialties
› Dentistry (Professional Programme)
› Embryology
› Endocrinology
› Epidemiology and Public Health
› Fisheries and Wildlife
› Food Science and Nutrition
› Forestry
› Genetics
› Geology and Related
› Health Administration
› Health Professions and Occupations
› Household Science and Related
› Immunology
› Man/Environment Studies
› Medical biophysics
› Medical Specialties
› Medical Technology
› Medicine (Professional Programme)
› Microbiology
› Neurology
› Neuroscience
› Nursing
› Occupational Therapy
› Oceanography and Waters Studies
› Optometry
› Pathology
› Pharmacology
› Pharmacy
› Physical Therapy
› Physiology
› Plant Science
› Psychiatry
› Psychology
› Rehabilitation
› Surgical Specialties
› Toxicology
› Veterinary Medicine
› Veterinary Medicine Specialties
› Veterinary Sciences
› Zoology