



BC Life Sciences Update 2021: **Building on a foundation of innovation**

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Life Sciences British Columbia
Greater Vancouver Board of Trade



Table of Contents

Foreword	3
Introduction	4
Sector Overview	6
Definition and statistical approach:	8
Direct contribution of BC’s life sciences sector to the economy:	8
Impact of COVID-19	11
Surge in research funding and acceleration of adoption of innovation	13
International recognition	15
Moving from response to recovery	15
Recommendations	17
Stories	20
Made at Home. Trialed in the USA - A not uncommon BC life sciences story	20
BC at the Forefront - Nanomedicines	21
Leading a global pandemic response - How a BC company’s strategic pivot led to the Pfizer-BioNTech COVID-19 vaccine	24
Appendix	25
<i>A - Life Sciences in British Columbia: Sector Profile (June 2020)</i>	25
<i>B - Putting Innovation to Work for British Columbia: Growing B.C. Companies (Jan 2020)</i>	25
<i>C - Restart, Recover and Reimagine Prosperity for all Canadians - An Ambitious Growth Plan for Building a Digital, Sustainable and Innovative Economy. A Report from Canada’s Industry Strategy Council (Oct 2020)</i>	25

<i>D - 6th Annual Life Sciences BC Access to Innovation (Feb 2021)</i>	25
<i>E - BIV Life Sciences 2020. Innovation in Motion: A New Era (2020)</i>	25
<i>F - We must harness digital technology for 21st-century health care (iPolitics April 2021)</i>	25
<i>G – Degrees of Success (Canadian Council of Academies Jan 2021)</i>	25
<i>I – Canada’s Economic Strategy Tables: Health and Biosciences (Sept 2018)</i>	25

Foreword

March 31, 2021. This interim report has been commissioned by the Greater Vancouver Board of Trade and has been made possible by funding granted by Western Economic Diversification Canada of the Government of Canada. It is a point-in-time overview of BC’s life sciences sector based on a synthesis of existing data and consultations/engagement from BC’s life sciences community, including partner provincial and national life sciences and business organizations. Data is drawn from sources (see Appendix) including the following reports: *Life Sciences in British Columbia: Sector Profile* (June 2020) and *Putting Innovation to Work for British Columbia: Growing B.C. Companies* (January 2020); and *Restart, Recover, and Reimagine Prosperity for all Canadians – a report from Canada’s Industry Strategy Council* (October 2020), as well as consultations with Academic, Research and Industry leaders through one-on-ones, roundtables and Life Sciences BC conferences, e.g. *Career Connect Day & Access to Innovation 2021*. It should be noted, BC’s life sciences sector is in a dynamic phase that includes ongoing pandemic response, data gathering, and consultation with all levels of government. Updated data and refined recommendations for the sector are expected to be developed through the summer/fall of 2021. As data becomes available, it will be updated on the Life Sciences BC [website](#).

Introduction

“By building on our strengths, and investing in ideas and people, we can maneuver through current economic headwinds and ride global trends to a resilient, sustainable and prosperous future.” Dr. Alan Winter (former) BC Innovation Commissioner Putting Innovation to Work for British Columbia: Growing B.C. Companies (January 2020)

British Columbia is home to a thriving life sciences sector with a history of fostering top scientific talent and generating innovative discoveries and initiatives. Recognized globally, BC science is world renown in several fields including antibodies, genomics, and nano and precision medicines. But while lauded internationally for breakthrough advances, the sector has faced ongoing challenges in scaling and growth that support commercialization and uptake of made-in-BC treatments and technologies, and ultimately economic growth and transformation of health care delivery. Barriers to success include complex regulatory, reimbursement, and procurement processes that impede the adoption of innovations, and a lack of consistent growth capital and commercialization incentives to grow companies and attract the right type of talent to lead growth transformation and larger organizations.

The COVID-19 pandemic shone a spotlight on the breadth and capabilities of BC’s life sciences sector at home and abroad, especially the stunning impact locally produced innovation had in the areas of treatment and vaccine development. The pandemic also laid bare the crucial relationship between public health and the economy, and the role of the life sciences sector in working in partnership and collaboration with government, academia, industry, and other key stake holders to support the public health enterprise. The urgent need for response enabled an environment for these groups to come rapidly together in the areas of research, clinical trials, and manufacturing and procurement in ways that had not been done before and created an opportunity to lift some of these historical barriers to growth.

There have been several reports and documents leading into the pandemic, including [Life Sciences in British Columbia: Sector Profile \(June 2020\)](#); [Putting Innovation to Work for British Columbia: Growing B.C. Companies \(January 2020\)](#); [Restart, Recover and Reimagine Prosperity for all Canadians - An Ambitious Growth Plan for Building a Digital, Sustainable and Innovative Economy. A Report from Canada’s Industry Strategy Council.](#) The findings have highlighted the importance of BC’s (and Canada’s) life sciences sector to the economy and to health care, as well as recommendations to support development and acceleration. Now we have seen the

sector's essential role in the pandemic response and are looking to the future. Momentum must not be lost. With the ability to generate products, services, and solutions critical to public health and health care delivery, as well as high-paying jobs, there is no better sector to lead British Columbia's recovery, and ensure ongoing resiliency. Furthermore, with an emphasis on clean technology, the growth of this sector can assist BC in its goal of establishing the province as a globally competitive low-carbon jurisdiction. In short, it is more important than ever to address system barriers and provide support needed to move the sector forward.

This report is intended to serve as the start of a roadmap that will help BC's life sciences sector capitalize on the opportunities to grow. It provides an overview of the sector, the impact of pandemic response, and sector barriers and recommendations needed to move forward. Sources include the above-mentioned reports, as well as roundtables and one-on-one consultations with life science leaders over the course of 2020/21.

Sector Overview

Life sciences has been one of BC's fastest growing sectors - the 2020 COVID-19 pandemic and rapid search for health-related solutions accelerated change and growth for the sector. While a full 2020 data set is not yet available, BC's life sciences companies were at the forefront of developing innovative products, services, and solutions to address the impact of COVID-19, while attracting record levels of investment and increasing employment through job creation. As we are seeing, this trend is continuing in 2021 with BC life sciences companies projecting continued growth.

While most of the sector is made up of small-to-mid-size companies, BC is home to Canada's largest biotech company, **STEMCELL Technologies**; Canada's largest medical device design, development, and contract manufacturing company, **Starfish Medical**; and to the three largest biotech companies in Canada, with greater than \$1B in market capitalization: **AbCellera**, **Biologics**, **Aurinia Pharmaceuticals**, and **Zymeworks Inc.** With respect to market capital, a **record breaking \$2B was raised in 2020**. (Figure 1 source Novateur)



Even prior to the defining year of 2020, BC's life sciences sector was experiencing dynamic growth. Based on 2018 data from the [Life Sciences in British Columbia Sector Report \(Appendix A\)](#), the sector has produced a highly skilled work force earning above average salaries with revenue growth rate, GDP, and salary growth rate above national average. At six percent growth in 2018, it was already one of the fastest growing sectors of the BC economy with approximately 2,057 companies and 18,000 employees.

In terms of geography, most of British Columbia's life sciences businesses are in major city centres with proximity to academic institutions and research hospitals. Sixty-six percent are in the Lower Mainland/Southwest region, followed by the Vancouver Island/Coast and the Thompson-Okanagan regions with fourteen and eleven percent, respectively.

Approximately eight percent of life sciences businesses are in outlying regions of the province. Though the hub of activity is centred in the metro Vancouver area, strong networks of connections flow throughout the province. These connections are fostered by many initiatives and collaborations including the work of post-secondary institutions; provincial and federal research funding organizations and accelerator mechanisms; industry; and sector-based organizations such as Life Sciences BC.

The present success of BC's life sciences sector is anchored in strong historic investments in world class science that have created a robust and globally recognized talent base resulting in world class science and leading research centres and institutes. The sector is supported by growing clusters of excellence in cross-cutting technologies, particularly

quantum computing and virtual, augmented, and mixed reality (VR, AR, MR); as well as (aforementioned) ecosystem supports of industry organizations; accelerators; government supported research funding agencies and economic development initiatives; universities and research hospitals; and other organizations that coordinate specific activities such as clinical trials.

While there is much to be proud of and encouraged by, **there is overwhelming consensus the timing to build a larger life science cluster in B.C. is NOW.** Given the momentum experienced due to COVID-19 response initiatives, continued rapid growth is anticipated, and this sector is tracking to become increasingly

Sector Strengths

BC life sciences sector strengths as identified by consultations with sector leaders and past reports include:

- World leading science in key fields -
 - Lipid Nanoparticles
 - Antibodies
 - Genomics
 - Oncology
 - Precision Medicine
 - Vaccine R & D
 - Medtech/Medical device design
- Highly trained, multidisciplinary talent base
- Company development and launch
- Foundational assets: research-focused post-secondary institutions/research hospitals with multiple campuses
- Cross sector multidisciplinary ecosystem collaboration between academia, private sector, and increasingly government
- Global collaboration & partnerships
- Clean technology/low carbon

important to the BC and Canadian economy. A three-to-five-year growth strategy will help secure the sector as an innovative and sustainable engine of the BC economy for the long-term.

Definition and statistical approach:

Unless otherwise stated, for consistency of data, the sector definition and statistical profile presented are based on the BC government's June 2020 [Life Sciences in British Columbia Sector Report \(Appendix A\)](#), which uses the North American Industry Classification System (NAICS) to gather and classify key statistical data such as business counts, employment, wages, revenue, gross domestic product (GDP), and the trade of goods and services. The data gathered in the report is based on three main groups of NAICS sector/subsector codes: 1. *Research, Testing and Medical Laboratories* 2. *Medical Devices and Equipment* 3. *Drugs and Pharmaceutical*.

Direct contribution of BC's life sciences sector to the economy:

Sector size and growth:

- **BC is home to the fastest growing life sciences sector in Canada, and one of the fastest growing sectors in BC**
- In 2018 the sector grew 6%, exceeding Canada's life sciences GDP growth of 1% and exceeding BC's industrial aggregate GDP growth of 2.7% for the same period
- Approximately 2,050 companies, of which 1,120 have employees. Of these:
 - ~58% are in the Research, Testing and Medical Laboratories industry group
 - ~31% are in the Medical Devices and Equipment industry group
 - ~12% are in the Drug and Pharmaceuticals industry group

High-paying knowledge-based job growth: Zymeworks Inc
2015 – 71 staff
2020 – 369 staff
2021 ~ 400 staff

Employment and wages:

- In 2020, the sector employed approximately 18,000 people, up from 17,000 in 2018, which at the time represented 0.7% of the province's total employment
- In 2018, the sector paid just under \$1.2 billion in total wages, up 10.7% from 2017. This exceeded the national wage growth rate of 8.8% in the sector and ranked the highest in the country

Revenue, GDP, Exports:

- In 2018:
 - Revenues in British Columbia's life sciences sector were approximately \$5.4 billion, up 5.6% from 2017 and third in the country behind Ontario (\$49.4 billion) and Quebec (\$24.4 billion). British Columbia's growth rate was above the national growth rate of 5.0%
 - GDP in British Columbia's life sciences sector was just over \$1.6 billion, up 5.7% from 2017, exceeding Canada's life sciences GDP growth, and industrial aggregate GDP growth, which was 2.7% for the same period
 - Exports of ~ \$484 million in life sciences goods and services were sent to international destinations, which was approximately 7% of the Canadian total in this sector. British Columbia is:
 - the second largest exporter of medical instruments after Ontario with 39% of export value share. The largest market for British Columbia medical devices and equipment is the U.S. (\$88 million or 93% of all British Columbia's medical instruments exports)
 - the main exporter of ultraviolet and infrared ray equipment in Canada with 83% of Canada's total exports
 - the number one exporter of artificial body parts with 81% of Canada's export value share

Talent Development:

- Talent development is a key pillar of sector success and the number of BC students enrolled in life sciences-related baccalaureate and graduate programs has grown 13% in recent years, with approximately 22,500 students (2017/18)
 - Biological and Biomedical Sciences programs had the largest proportion of enrolments in each of the five years reported
- While science talent has been recognized as a sector strength, it is identified by sector leaders that BC needs to do more to build and attract entrepreneurial academics and senior business leaders with the ability to help develop high-growth scale-ups and future anchor companies ([Appendix B](#))

Clinical Trials (2020 data):

- ~ 1,300 clinical trials at 100 sites (considered a high proportion of all clinical trials conducted in Canada)

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- Majority are in oncology and rare disease – BC attracts more oncology clinical trials than any other province
 - 56% industry funded
 - 32% post-secondary/grant funded
 - 10% International (National Institutes of Health/Other)
 - ~900 investigators
 - ~25 COVID-19 trials
 - Supported by Clinical Trials BC – independent, non-profit unit of [BC's Academic Health Science Network](#)

Assets:

- A strong science talent-base, world class research, and robust, collaborative ecosystem are foundational assets of BC's life sciences sector. Research is conducted and innovation produced by both the private sector and research teams based at post-secondary institutions and their affiliated research hospitals institutes, and centres. BC is also home to adMare BioInnovations, which plays a critical role in the life sciences sector supporting drug discovery and scaling companies, including training leaders in how to drive large-scale growth.
 - A list of BC's key research assets as well as research support organizations and supporting regional initiatives are detailed in Appendix A [Life Sciences in British Columbia Sector Report](#)
- A uniqueness of BC's life sciences ecosystem, highlighted by sector leaders, is the convergence and integration of disciplines within and across life sciences, tech, and innovation sectors that are leading to the creation of novel technology platforms generating solutions for human health, (e.g., AbCellera Biologics, which brought together AI, genomics, and computation to develop an innovation focusing on platform and process vs a single biologic).
 - This type of cross-discipline collaboration/integration is enabled across BC's research, academic, and private sectors through multidisciplinary post-secondary programs, such as UBC School of Biomedical Engineering and SFU's non-departmentalized Faculty of Health Sciences, and funders such as Michael Smith Foundation for Health Research and Genome BC. Canada's Digital Supercluster plays a role in the ecosystem through co-funding collaborative projects to advance digital innovation
 - BC bench strength across non-life sciences innovation sectors includes:
 - Quantum computing (DWAVE, Fujitsu, Amazon, IBM, Microsoft)

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- AR/VR/MR (over 200 companies in BC making it one of the world's largest hubs)

System barriers:

While BC's life sciences sector has been growing, a shift of policy/process barriers that can come at little cost will unleash rapid acceleration of the sector. While the sector excels at scientific research and discovery, it has struggled to commercialize and scale up companies. BC's life sciences leaders have identified long-standing key barriers, including:

- Inconsistency of consistent growth capital and commercialization incentives to create and scale companies
- Complex regulatory, tax, and procurement policies and processes that impede the adoption of innovation
 - Uncompetitive taxation that provides disincentive for companies to keep IP in Canada and attract top global talent
 - Procurement policies do not support the health system to buy local innovation and enable growth
- Shortage of wet-lab space and manufacturing capabilities
- Scarcity of executive-level talent that will enable the sector's growth and competitiveness
- Inconsistency of coordinated collaboration across levels of government, academia, research, and industry in efforts to scale companies and adopt innovation
- Lack of coordinated data strategy to advance research and health innovation

“We are at a watershed moment for what can happen in biotech here in B.C.”
Dr. Carl Hanson, CEO AbCellera – Life Sciences BC Access to Innovation Feb 2021

Impact of COVID-19

At a BC ecosystem level, pandemic response helped identify and catalyze key sector strengths in innovation, nimbleness, and adaptability – from developing vaccines and anti-viral therapies, to pivoting to manufacture ventilators, screening tools and tests, to creating digital health tools such as the COVID-19 app and technologies that enabled virtual health visits, and finally donating critically needed supplies,

equipment, and human resources. It also highlighted core system barriers and challenges, including the lack of connection between those who produce new therapies, products, and technology and those in the system who use it; patients/public, clinicians, and policy/health system decision makers. While it is too early to understand the full impact on BC's life sciences ecosystem, this unprecedented time of change brought growth and opportunity and identified how the private and public sector can work better together. It also amplified the understanding of the importance of life sciences and the role the sector plays in supporting public health and the economy.

We saw during COVID-19:

- an unprecedented increase in research funding, and that BC scientists and companies can rapidly pivot to address societal need and create lifesaving technologies
- adoption of innovation can be greatly accelerated by changes to procurement and the regulatory environment and through supports to SMEs to scale up
- the ability of BC bio and medical tech companies to respond to the pandemic on a global scale, and the recognition of international capital for BC's world leading science and differentiated companies that have quality platforms and deep pipelines

These themes will be further explored in the following section.

Surge in research funding and acceleration of adoption of innovation

When the pandemic was officially declared, governments worldwide were quick to act with significant investments in research aimed at responding to and ending the pandemic. Canada was no exception. In March 2020, the federal government announced investments of ~\$300M in funding for research on

Over 500 COVID-19 related research projects are underway in BC – including:

- Starling Minds and UBC received backing from Genome BC and the Digital Supercluster to create a new digital app for healthcare workers who may be experiencing stress, anxiety, trauma, and depression because of frontline work
- UBC and St. Paul’s Hospital researchers received support from CIHR to examine whether familiar blood pressure drugs can help in the treatment of COVID-19
- UBC and VGH researchers received support from the Michael Smith Foundation for Health Research to study respiratory outcomes following COVID-19 Infection

medical countermeasures against COVID-19. This was later augmented by the [national medical research strategy](#) which brought the investment to ~\$1B in new medical countermeasures to better understand COVID-19, and develop the infrastructure needed to fight the pandemic. In British Columbia, millions in additional research funds also flowed from agencies such as Genome BC, the Michael Smith Foundation for Health Research, and private and public organizations and foundations, both domestic and international.

By November 2020, a conservative accounting revealed more than 500 COVID-19 wide-ranging research projects from vaccine development to understanding mental health impacts, valued at approximately \$200M, underway involving BC researchers. (Source: [BC’s Research Response to COVID-19, BC COVID-19 Research Advisory Committee](#)).

This **historically unparalleled level of research funding injected into the system** was aimed at rapidly developing therapies, products, and services in support of the public health response to the pandemic. This large-scale funding investment will also be foundational in delivering ongoing discoveries related to COVID-19 – and far beyond – helping

seed the development of new biotech and medtech companies, as well as new solutions and services that can be directly taken up by the public health system.

(It is also important to acknowledge while a historic amount of funding was injected into the system, there was also reduced funding and process slowdowns in some non-COVID-19 health research areas, particularly where

patients were unable to continue in clinical trials, and where researchers were unable to access labs/ research environments for a period of time, and/or were unable to pivot their work to take advantage of new funding.)

Additionally, government and public organizations at federal and provincial levels supported the life sciences sector business specific pandemic response through key mechanisms such as direct funding for promising products and therapies; “challenge programs” for SMEs and supply chain and manufacturing; data initiatives; rapid update of digital tools; and emergency use authorization legislation that fast-tracked solutions to the system. Below provides examples but not a complete list of these initiatives.

- Direct federal funding of BC innovation, includes:
 - \$175M in BC Biotech AbCellera (May 2020) to expand efforts related to antibodies for use in drugs to treat COVID-19 and to build technology and manufacturing infrastructure for antibodies therapies against future pandemic threats
 - \$633,000 for BC bioLytical Labs (May 2020); toward development of a one-minute COVID test
 - \$50M for Precision Nanosystems (PNI) toward a new biomanufacturing facility in Metro Vancouver (2020/21)
- ISED/NRC programs supporting SMEs and supply chain/manufacturing includes:
 - COVID-19 Challenges Procurement Program – support for near-to-market solutions from SMEs that required financial support to refine and sell their product or solution. For example, Kelowna based Metabolic Insights received \$300,000 to adapt an existing device that detects insulin levels in saliva to detect the presence of the viral protein of SARS-CoV-2 in a small sample of saliva, providing results in 15 minutes
 - Call to Suppliers to help combat COVID-19 by providing products including ventilators and test kits
 - Pandemic Response Challenge Program to build teams to address challenges requiring further research and development for solutions
- Regulatory changes supporting acceleration of adoption of innovation, includes:
 - Regulatory changes that enabled the rapid adoption of digital health tools
 - Optimization of data banks of COVID-related information for ease of access.
 - In October 2020, the Public Health Agency of Canada implemented a National COVID-19 Public Health Data Portal to support the collection, sharing, and management of COVID data, and is working with the federal, provincial, and

territorial partners and stakeholders to develop a pan-Canadian Health Data Strategy

- o Emergency Use Authorization that enabled rapid procurement processes and access to patient and markets

International recognition

BC life sciences innovation has been at the forefront of global COVID-19 responses, and BC as a major international biotech player should not be surprising news. While COVID-19 helped some BC life sciences companies become household names, BC and Canada have been major players in global markets, biotech companies, and as global partners for the last several years. According to a recent article in [Globe and Mail Report on Business “Just say ehhhh: When it comes to the lucrative U.S. drug “discovery market, Canadians are everywhere” March 25, 2021](#) **“The world of biotechnology and health care, and frankly Wall Street itself, is built with Canadians.”** The markets have also taken note with two billion dollars raised in 2020. This is not a one-off. While BC is now home to three life sciences companies with over \$1B each in market capital, there are several more on their way.

Virtually every COVID vaccine and candidate in late-stage clinical development was consulted, initiated, developed, or manufactured by Vancouver community members.

Vaccine Development:

- Acuitas Therapeutics developed an mRNA delivery platform for the world's first FDA approved COVID -19 vaccine made by Pfizer- BioNTech. Prior to the COVID-19 pandemic, Acuitas & BioNTech had been partnering to utilize Acuitas's expertise in mRNA to advance the development of mRNA cancer vaccines.
- Precision Nanosystems (PNI) PNI offers proprietary technology platforms and comprehensive expertise to enable researchers to translate disease biology insights into non-viral genetic medicines. In Oct 2020, PNI received a commitment of up to \$18.2 million in support from the Government of Canada under the Innovation, Science and Economic Development's (ISED) Strategic Innovation Fund (SIF) to develop a COVID-19 vaccine.

Therapeutic Development:

- AbCellera and Eli Lilly's bamlanivimab was the first monoclonal antibody therapy for COVID-19 authorized for emergency use by the U.S. FDA. They have advanced a second antibody into clinical trials, LY-CoV1404, that has been shown in the lab to neutralize SARS-CoV-2 variants of concern.
- Symvivo is collaborating with Merck to develop an oral COVID -19 therapeutic similar to that used to treat polio. It is the first oral COVID-19 vaccine in trial.

License Agreement:

- ImmunoPrecise Antibodies Ltd. recently announced preliminary, preclinical study results using a SARS-CoV-2 hamster model, treatment with IPA's TATX-03 resulted in complete clearance of detectable replication-competent virus from the lungs and throat of SARS-CoV-2 infected animals.
- Genevant Sciences in license agreement for COVID-19 Vaccine with Gritstone Oncology, Inc. to license Genevant's LNP technology to develop and commercialize self-amplifying RNA (SAM) vaccines against SARS-CoV-2, the virus that causes COVID-19.

Products:

- Evonik Laboratories is increasing the supply security in the short-term expansion of its specialty lipids production which are essential for mRNA-based COVID-19 vaccines which includes the supply security of the Pfizer-BioNTech COVID-19 vaccine.
- STEMCELL Technologies develops specialty cell culture media, cell isolation systems and accessory products for life science research, including COVID-19.
- VanRx Pharmasystems (now part of Cytiva) makes robotic aseptic filling machines to fill vials, syringes, and cartridges with reduced risk and increased speed to patients. VanRx currently works with multiple global companies who leverage their products and services. They are expanding and are building out a 400,000 sq ft. facility in the lower mainland. Amongst VanRx's clients is Moderna, one of the leading COVID-19 vaccine producers, to whom it is supplying aseptic filling work cells.

Moving from response to recovery

As we transition from COVID-19 urgent response to management, recovery, and future response, it is imperative the landscape changes resulting from BC and Canada's COVID-19 response must not be lost. In fact, the removal of barriers impeding growth and adoption of innovation must be accelerated. BC's life science sector is ready to work with all

levels of government and key stakeholders to address existing barriers, including access to data, an uncompetitive tax and regulatory environment, and system process impediments such as ethics review, clinical trial access, procurement, knowledge transfer and uptake of innovation. These changes, as outlined in recommendations below, will help bring about the changes needed and level of ambition for our system to drive economic growth and support a sustainable health care system, and position BC for success.

Now, more than ever, we need skilled people building lifesaving products, right here at home – BC Premier, John Horgan. Access to Innovation 2021

Recommendations

“BC has historically been ‘hewers of wood and drawers of water.’ We are now allowing our most valuable 21st century resource – the intellectual capacity to improve human health and ameliorate suffering – to also be exported for others to develop into high value products elsewhere. We must now decide; not now, not anymore.” BC Life Sciences sector leader, Access to Innovation 2021

COVID 19 put a spotlight on the strengths of BC's life sciences ecosystem and provided an opportunity to show the value of this sector. BC companies rapidly responded to urgent need on a local, national, and global scale. The public health care system moved swiftly and decisively to uptake locally produced products, solutions, and services. Global markets and capital recognized the world leading science that is developed in BC. While other vital sectors were shedding jobs, the life science sector was adding them. As BC recovers from the pandemic, a continued emphasis on protecting public health, creating resiliency, and growing the economy – particularly in low-carbon sectors – is needed, and there is **no greater opportunity than the BC life sciences sector, which creates well-paying jobs in the knowledge sector by producing products and services aimed directly at curing disease and supporting strong**

public health and effective health care delivery. Good public policy that supports innovation, talent, and entrepreneurship will help drive this opportunity by assisting our home-grown companies in scaling businesses and increasing commercialization and by supporting the uptake of BC products and therapies into our provincial and national health care system.

The following high-level recommendations are aimed at supporting changes to remove system barriers. They are a result of past consultations with BC's and Canada's life sciences ecosystem and are documented in referenced reports (see Appendices), as well as roundtables and one-on-one consultations with life science leaders over the course of 2020/21.

- Talent
 - Enhance investment in talent to attract, develop, and retain scientific leaders with a focus on C-suite leadership that will support commercialization and company growth
- Capital:
 - A dedicated life sciences fund to support the VC market, early-stage growth, and incubator organizations, which will accelerate and scale up the next wave of SMEs that will stay in B.C. and grow to be anchor companies
- Regulatory & Tax Policies:
 - Implement modernized streamlined regulatory processes that are aligned globally and harmonized to ensure regulatory capacity to draw the next generation of technologies into use for and by British Columbians and Canadians
 - Implement competitive tax policies that attract and retain investment and ensure retention of intellectual property in B.C. and Canada
- Value-based Procurement:
 - Implement streamlined value-based health procurement and sourcing strategies to create resilience of domestic capabilities through ensuring local innovation is considered and prioritized for adoption.
- Data:
 - Invest in a coordinated, comprehensive strategy to provide faster, streamlined access to data and facilitate and create data-driven advances in research, innovation, and health outcomes

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- Infrastructure:
 - Continue to invest in research and increase investment in critical infrastructure, particularly lab space and manufacturing

These recommendations represent **the beginning** of a future roadmap that will be needed to capitalize on the opportunities for the sector. Over the coming months and years, these will be further refined and developed in consultation with industry experts and support the continued efforts of Life Sciences BC.

Stories

Made at Home. Trialed in the USA - A not uncommon BC life sciences story

The story of Response Biomedical is not dissimilar to other BC life sciences companies – an innovative product meets a health care need and leads to improved patient outcomes. Manufacturing is scaled-up, 34% revenue growth achieved in 2020 and new markets are added – just not in Canada. For Response, global success has never translated into Canadian sales. Response provides a platform for point-of-care diagnostics for a suite of life-threatening illnesses through the detection of proteins in blood samples or nasal swabs. These proteins are read by a fluorescent-based instrument providing results in approximately 15 minutes (test-dependent). In BC and most jurisdictions in Canada, this point-of-care testing has not been widely adopted.

“We have never sold in our own market because of the complexity of regulations,” says Dr. Barb Kinnaird, Chief Executive Officer. “As a small to mid-sized company, Response has focused on being able to get our products into the markets where there is demand, and we have not had the resources available to tackle the regulatory environment and historical ways of doing things here at home.”

The onset of COVID-19 provided an opportunity for Response to add a COVID-19 Antigen test to its infectious disease suite that includes Influenza A + B and RSV. The company received funding from Next Generation Manufacturing Canada (NGen) to purchase manufacturing equipment, develop the assay, and scale up manufacturing capacity. This was followed by additional support from the National Research Council of Canada Industrial Research Assistance Program (NRC IRAP).

Response Biomedical Corp.

Founded: 1991

CEO: Dr. Barb Kinnaird

Location: Vancouver, BC

Number of employees: 65 employees (43 in 2019)

Diagnostic testing solutions for use in cardiovascular, infectious disease, sepsis, women’s health, arbovirus and biodefense. Using the RAMP platform to provide point-of-care lab-quality results within minutes that medical teams can trust, while reducing total cost of care.

Opportunity: COVID-19 provided an opportunity for Vancouver-based Response Biomedical to add to its suite of point-of-care infectious disease diagnostics tests and help improve pandemic-related health services and patient outcomes globally with a “Made-in Canada” solution geared for British Columbians and Canadians.

Roadblocks: A complex regulatory environment and clinical trial requirements have been barriers in accessing local patient population for clinical validation

“What we needed was support from the local community in order to do clinical validation to support regulatory submissions for Health Canada.” Dr. Barb Kinnaird, CEO Response Biomedical

With its technology and expertise, the company was quickly able to develop a quality product assay, but with mRNA PCR testing as the gold standard, Health Canada regulations demanded robust clinical validation, comparing the antigen test to the PCR, as part of the regulatory process. Response tried to undertake the clinical validation here at home but has been unable to do so.

“It is difficult to undertake clinical trials in Canada, at the best of times” says Dr. Kinnaird. “We went through both the usual, and COVID recommended channels, but with the entire health and life sciences community stretched for capacity, there was no response. Finally, we had to initiate our clinical trials in the U.S. with an independent CRO managing the trials which is expensive. We would have vastly preferred to do this BC-led research locally, which also would have kept the Canadian investment in research dollars here.”

While the company collects its clinical performance data and prepares the Health Canada application for the RAMP COVID-19 test, they feel fortunate to be partnering with the Greater Toronto Airports Authority on COVID-19 point-of-need testing research. The program, which started March 1, is supported in part by funding from NRC IRAP and is a research study involving several Canadian healthcare companies including LuminUltra's rapid PCR test (Fredericton) and data integration by Fionet Rapid Response Group (Toronto).

BC at the Forefront - Nanomedicines

Companies in the Vancouver area are global leaders in the nanomedicine field having developed six of the twelve systemically administered nanomedicines that have received regulatory approval by the US Food and Drug Administration (FDA) and/or the European Medicines Agency (EMA) (Table 1).

In addition, two Vancouver-based companies have developed instrumentation to synthesize these nanomedicines, these companies distribute apparatus for bench and clinical scale manufacturing

worldwide. In short, Vancouver has become a globally dominant commercial hub for nanomedicines with companies focused both on developing the nanomedicines of the future, and the techniques to make those medicines.

Table 1. Nanomedicines that have received regulatory approval from the FDA or EMA. Drugs developed in collaboration with Vancouver-based LNP companies are highlighted in blue

Name	Encapsulated Drug	Indication	Year Approved	Company (contributing Canadian company highlighted)
AmBisome	amphotericin B	Fungal infections	1997 (USA)	Gilead
Doxil/Caelyx	doxorubicin	Ovarian cancer Breast cancer	1999 (USA) 2003 (Europe)	J&J
DaunoXome	daunorubicin	Kaposi's sarcoma	1996 (USA)	Galen
Amphotec	amphotericin B	Invasive aspergillosis	1996 (USA)	Intermune
Abelcet*	amphotericin B	Aspergillosis	1995 (USA)	Canadian Liposome Co., licensed to Enzon
Myocet*	doxorubicin	Breast cancer	2000 (Europe)	Canadian Liposome Co., licensed to Cephalon
Visudyne *	verteporphin	Macular degeneration	2000 (USA)	QLT
Marqibo*	vincristine	Leukemia (ALL)	2012 (USA)	Inex Pharma, licensed to Spectrum
Onyvite	topotecan	Pancreatic cancer	2015 (USA)	Ipsen
Vyxeos*	cytarabine	Leukemia (AML)	2017 (USA)	Celator, licensed to Jazz Pharma
Onpatro*	TTR siRNA	hATTR amyloidosis	2018 (USA, EU)	Acuitas, licensed to Alnylam
Tozinameran*	SARS-CoV-2 mRNA	COVID-19 vaccine	2020 (UK, Can, US)	Acuitas, licensed to Pfizer/BioNTech

BC leading technologies include lipid nanoparticle

(LNP) and protein-based macromolecular therapeutics such as monoclonal antibodies (mAb) used in the treatment of COVID-19 and mRNA based COVID-19 vaccines. It is not an understatement to say these platforms and therapeutics are leading efforts globally to create a new generation of pharmaceuticals.

LNP nanomedicines promise to revolutionize the field of medicine by enabling gene therapies that have the potential to treat most, if not all, diseases. As we saw with the case of COVID-19, this technology allowed for a rapid response in vaccine creation. Vaccines based on mRNA have been the most promising pandemic response solutions because they can be developed quickly (in principle within a month of knowing the genetic sequence of the pathogen), are extraordinarily potent (two teaspoons of mRNA can potentially be enough to immunize a million people), and do not require complex manufacturing facilities.

These made-in-BC research breakthroughs did not just happen overnight. It began more than 40 years ago with top research talent initially located at UBC who moved academic-based discoveries into commercialization via spin-offs that evolved into several small and mid-sized companies. Global partnerships and collaborations enabled the development of new treatments for a variety of diseases, including cancer. When the pandemic hit, BC-based companies in this space were positioned to play a remarkable role in the global response. These include:

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- Acuitas Therapeutics which developed the LNP delivery systems that enable messenger RNA (mRNA) COVID-19 vaccines from Pfizer-BioNTech and CureVac.
 - Precision NanoSystems which developed microfluidic mixing technology for synthesizing LNP systems and is supplying manufacturing apparatus to more than 50 biopharmaceutical companies worldwide. Over 15 PNI clients are developing/manufacturing LNP-based COVID-19 vaccines utilizing PNI's platform technologies.
 - Evonik Canada which is manufacturing clinical supplies (Phase 1/2 studies) for a number of LNP-based vaccines at its Vancouver site. Note Evonik Canada resulted from the 2016 acquisition by Evonik Industries (Germany) of Northern Lipids Inc. (NLI) based in Vancouver. NLI worked with over 100 pharmaceutical companies to develop LNP formulations and also supply equipment to synthesize LNP systems. Evonik Canada is maintaining and expanding on this base.
 - GeneVant Sciences Corporation which has partnerships with Takeda, Sarepta and Gritstone to develop LNP mRNA therapeutics and Covid -19 vaccines.
 - AbCellera which created a platform to identify antibodies that can be developed into new therapies. In the case of COVID-19, a monoclonal antibody (mAb) developed in collaboration with Lilly.
 - VanRx which is supplying its aseptic filling workcells to Moderna, one of the leading Covid-19 vaccine producers that is also developing an LNP mRNA vaccine.

The role of these BC companies in the global response to Covid-19 reflects the ability to move discovery from the academic lab to small-and-medium-sized start ups and create global partnerships and collaborations. These achievements are significant, and they have created an enormous opportunity for BC to take full advantage of the breakthrough technology invented here.

The scale of what can be done is spectacular, as established companies are currently only scratching the surface of the therapeutic opportunities. Gene therapies are causing a revolution in medicine, and the economic benefits are enormous. For example, the Vancouver-based companies listed above currently employ approximately 800 people. If they can continue to be retained in Canada, these companies will grow at least five-fold over the next five years, employing BC talent in highly paid, innovative, sustainable careers. There is also the potential to incentivise drug companies to conduct drug discovery and development in BC, which will amplify growth and opportunity. It is also worth noting BC's research and

life sciences community has a growing track record of fostering equity, diversity, and inclusion in both developing talent at home and recruiting bright minds from around the world.

Leading a global pandemic response - How a BC company's strategic pivot led to the Pfizer-BioNTech COVID-19 vaccine

Founded in 2009, Vancouver-based Acuitas Therapeutics is a private biotechnology company with 30 employees. Acuitas specializes in the development of lipid nanoparticle (LNP) delivery systems for nucleic acid therapeutics, particularly messenger RNA (mRNA).

Messenger RNA allows the body to make new proteins to treat disease or to generate an immune response (vaccines). However, mRNA is rapidly broken down once administered and, on its own, is not able to get into cells where it needs to work. By encapsulating mRNA inside LNP carriers, the Acuitas LNP protects the mRNA and efficiently delivers it inside cells.

Before the current COVID-19 pandemic began, Acuitas had been working with several biotechnology partners, including BioNTech and CureVac, to develop new therapeutics and vaccines. In 2019, Acuitas had been working on a rabies vaccine with CureVac. The initial clinical results for this rabies vaccine were released in January 2020 and showed a strong immune response at very low doses of the vaccine.

Recognizing the importance of this clinical study, and as concerns over COVID-19 and a global pandemic grew, Acuitas engaged separately with CureVac and BioNTech (and their partner Pfizer) to develop COVID-19 vaccines. Initially, this involved generating the mRNA-LNP formulations for preclinical studies of candidate vaccines and supporting the safety studies. The most daunting challenge was then to scale up synthesis and manufacture of proprietary lipids and the final vaccine product to allow commercial manufacture of billions of doses. These initiatives were successful, with the **Pfizer-BioNTech vaccine being administered to hundreds of millions of people around the world to help control and end the pandemic**, and the CureVac vaccine is currently completing late-stage clinical studies.

To support its partners, Acuitas has expanded considerably over the last couple of years, with a 30% increase in employees between 2018 and 2020 and additional hiring planned for 2021.

Appendix

A - Life Sciences in British Columbia: Sector Profile (June 2020)

B - Putting Innovation to Work for British Columbia: Growing B.C. Companies (Jan 2020)

C - Restart, Recover and Reimagine Prosperity for all Canadians - An Ambitious Growth Plan for Building a Digital, Sustainable and Innovative Economy. A Report from Canada's Industry Strategy Council (Oct 2020)

D - 6th Annual Life Sciences BC Access to Innovation (Feb 2021)

E - BIV Life Sciences 2020. Innovation in Motion: A New Era (2020)

F - We must harness digital technology for 21st-century health care (iPolitics April 2021)

G - Degrees of Success (Canadian Council of Academies Jan 2021)

H - Canadian Biotechnology: Solving for Today. Building for Tomorrow (Sept 2020)

I - [Canada's Economic Strategy Tables: Health and Biosciences \(Sept 2018\)](#)