Innovation, Science and Economic Development Canada

Innovation, Sciences et Développement économique Canada

Canada

Evaluation of Innovation, Science and Economic Development (ISED) Canada's funding to the Centre for Drug Research and Development (CDRD)

Audit and Evaluation Branch

REPORT

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Table of Contents

Key Definitions

Life sciences refers to branches of science that study life processes and living organisms such as human beings, animals, plants and microbes. It includes a myriad of scientific fields ranging from biology, genomics and medicine, to bioinformatics, oncology and agricultural science.[1]

Drugs, as defined by the Government of Canada, are any substances or mixtures of substances manufactured, sold or represented for use in the diagnosis, treatment, mitigation or prevention of diseases, disorders or abnormal physical states, or their symptoms, in human beings or animals.[2]

Translational research in the context of drug R&D refers to the *bench-to-bedside* (i.e., laboratory to the patient) process whereby knowledge from basic research is applied to the treatment and prevention of disease, playing a critical role in the creation and commercialization of new treatments and medicines that reach patients and populations.[3]

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of nature and the underlying foundations of phenomena and observable facts, without any particular application or use in view.[4]

Commercialization is the process of managing something for financial gain. In the context of drug development, translational research is required to turn the idea or invention into a product or service that can be sold by a company.[5]

Background

- History and Evolution of the CDRD
- Overview of CDRD Programming
- Summary of CDRD Program Model

History and Evolution of the CDRD

The Centre for Drug Research and Development (CDRD) is a not-for-profit organization that works in partnership with academia, industry, and government to support drug R&D projects and advance health innovation.

Today, the CDRD, through adMare BioInnovations, continues to support the advancement of drug R&D projects towards commercialization.

2019-20: The CDRD joined with the NEOMED Institute and Accel-Rx to form adMare BioInnovations, a new pan-Canadian organization that supports the health innovation ecosystem.

2019-20: The CDRD entered into its second funding agreement with ISED, which provided the CDRD with $48 million over three years, beginning in 2019-20.

2017-18: The CECR funding program ended and the CDRD entered into its first funding agreement with ISED, which provided the CDRD with $32 million over two years, beginning in 2017-18.

2008-09: The CDRD was established as a national Centre of Excellence for Commercialization and Research (CECR).

Overview of CDRD Programming

The drug development continuum consists of five stages of development and reaching the final stage of drug adoption can often take decades.

CDRD

1 **Basic health research and pre-discovery**
(academic institutions)

2 **Drug discovery development and pre-clinical**
(new/existing companies, incubators, accelerators, and related organizations)

3 **Clinical trials**
(new and existing companies, regulatory bodies)

4 **Drug approval and market launch**
(regulatory bodies, global biotech/pharmaceutical industry)

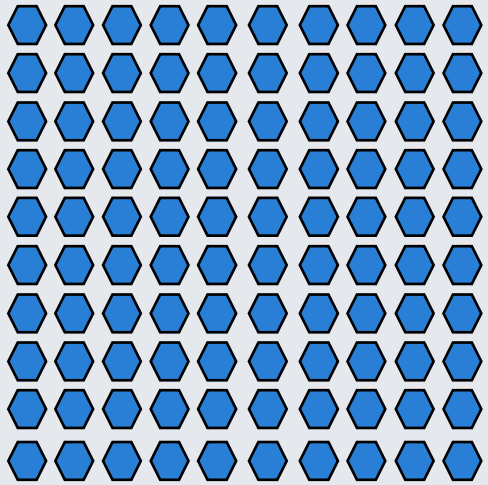
5 **Drug adoption**
(health care system)

Over the evaluation period, the CDRD's activities were primarily focused on supporting drug R&D projects with commercial potential and providing training programs in order to develop a pool of industry-ready talent.

Overview of CDRD Programming

To filter and identify which drug R&D projects from academia and industry to support with expertise, specialized infrastructure, and capital, the CDRD used a four-step process that continually assessed the scientific and commercial potential of new and ongoing project opportunities.[6]

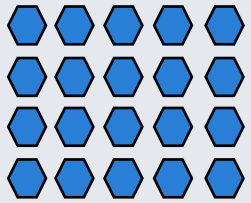
Filter more than 100 projects



1

Selection
Identify and assess the potential of a drug R&D project.

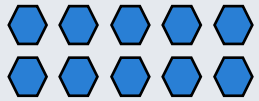
Filter up to 20 projects



2

Incubation
Replicate and validate key project data to enable the design of a robust experiment that could define commercial potential.

Filter up to 10 projects



3

Determination
Execute the robust experiment.

Filter less than 5 projects

4

Acceleration
Make a significant commitment to a drug R&D project with the goal of maximizing the commercial advancement and value to the CDRD.

To maximize potential commercial returns from its R&D opportunities, the CDRD focused on launching new companies and supporting existing ones.

Overview of CDRD Programming

To increase the talent pool of industry-ready, highly qualified personnel, the CDRD offered a variety of training programs through its Academy over the evaluation period.

Undergraduate Institute

A 4 to 12-month work-term for undergraduate students interested in life sciences and biotechnology. Students have access to on-the-job work experience and bio-innovation e-learning modules.

Post-graduate Institute

A 24-month postdoctoral fellowship program targeting scientists who wish to deepen their experience in commercial bioinnovation. It provides on-the-job and customized learning and development.

BioInnovation Scientist (BIS) Program

The BIS program was launched under adMare BioInnovations and builds on the success of the CDRD's Post-graduate Institute. It targets scientists who wish to develop valuable skills in commercial bioinnovation. BIS was designed to be delivered online.

Executive Institute

This program is focused on equipping up to 20 executive-level life sciences professionals annually to scale high growth companies into strong multi-product anchors. It was launched in 2018-19 by the CDRD and continues under adMare BioInnovations. The program is delivered in collaboration with the Centre for Creative Leadership, a not-for-profit specializing in executive-level training.

We@CDRD Institute

An ongoing professional development program to ensure that the CDRD team members have the skills to advance the Canadian life sciences industry along with their own careers. This program is now known as the We@adMare Institute.

Methodology

- About the Evaluation
- Evaluation Areas and Questions
- Data Collection Methods
- Challenges for the Evaluation

About the Evaluation

An evaluation of ISED's funding to the CDRD is required under the *Financial Administration Act*.

The **objectives** of the evaluation are to examine the relevance, performance, and efficiency of ISED funding to the CDRD in accordance with the Treasury Board Secretariat *Policy on Results.*

The **scope** of the evaluation will focus on the activities of the CDRD prior to the creation of adMare BioInnovations as well as its activities within this new organization. It covers ISED funding to the CDRD during the period from April 1, 2017 to March 31, 2021.

The evaluation was conducted in-house by the Audit and Evaluation Branch at ISED. The evaluation used a **results-based approach** which examined the achievement of expected outcomes, as identified in the logic model in Appendix A.

All evaluation findings and recommendations are supported by at least three lines of evidence.

Evaluation Areas and Questions

The evaluation examined the following areas and questions.

Relevance

To what extent is the CDRD addressing a unique and continued need in Canada's drug R&D landscape?

Efficiency

To what extent is the CDRD program delivery and funding model an efficient and effective approach for supporting drug R&D in Canada?

Performance

To what extent is the CDRD contributing to:

- Attracting, training, and retaining talent in Canada?
- Accelerating drug research and developing drug technologies?
- Commercializing technologies and realizing health benefits for Canadians?

Data Collection Methods

Four data collection methods were used to support the evaluation.

Literature and Document Review

The literature review was performed to gain a thorough understanding of the health innovation ecosystem, and more specifically, the drug R&D landscape, in Canada and internationally in order to assess the unique and continued need for the CDRD. A document review was also performed and it comprised of key program and reporting documents in order to support the assessment of performance and efficiency.

Performance, Administrative and Financial Data Review

The CDRD's performance data, collected as part of their Performance Measurement Strategy, was reviewed in order to assess the extent to which progress has been made towards achieving the expected outcomes outlined in the CDRD logic model. An analysis of the administrative and financial data from the CDRD was also performed to assess efficiency.

Virtual Interviews

A total of 30 virtual interviews were conducted using MS Teams across the following stakeholder groups to gather diverse perspectives on the relevance, performance and efficiency of the CDRD:

- CDRD Management and Board members;
- ISED program management;
- CDRD strategic partners;
- CDRD spin-off companies;
- Canadian universities, research institutes;
- Other players in the Canadian health innovation ecosystem; and
- Other government representatives.

Online Surveys

Two online surveys were used to gather detailed information on the effectiveness of the CDRD's technology development and acceleration, commercialization, and training activities. The first survey targeted Principal Investigators who have participated in a CDRD-supported research and development project between 2017-18 and 2020-21, producing a response rate of 24% (or 14 total respondents). The second survey targeted individuals who have participated in one of the training programs offered at the CDRD Academy from 2017-18 to 2020-21, producing a response rate of 36% (or 71 total respondents). Together, the two surveys resulted in a grand total of 85 respondents.

Challenges for the Evaluation

The evaluation encountered two limitations and evaluators applied related mitigation strategies.

Attribution

The presence of other funding partners makes isolating and measuring the direct impact of the ISED's contribution challenging. To alleviate this challenge, interview questions were designed and articulated in a way that respondents could answer, to the extent possible, the incremental impact of ISED's funding to the CDRD.

Survey response rates

In contrast to the trainee survey which received an overall response rate of 36%, the Principal Investigator survey had a relatively low response rate of 24%. This low response rate may have resulted from a range of factors, including conducting the survey over the summer months. In order to mitigate this limitation, data collected from the surveys was triangulated with other lines of evidence.

Findings

- Relevance
- Performance
- Efficiency

Findings

Relevance | Performance | Efficiency

Finding 1: The life sciences sector in Canada has evolved over time and the emergence of the COVID-19 pandemic has heightened its importance. There is a continued need for the federal government to support the health innovation ecosystem in Canada, particularly in regards to the translation of drug research, in order to improve the health outcomes of Canadians. The challenge of translating drug research into commercial application is characterized by high costs, high risk and long timelines.

Advancements in the life sciences sector, in particular the development of novel drugs and medicines, have led to significant health benefits.

According to interviews and literature, advancements in the life sciences have led to the development of biological solutions to health challenges including the prevention and treatment of diseases.[7] For example, research has led to the development of insulin for treating diabetes; innovative medicines for cancer therapy; and a vaccine for Hepatitis B.[8] Literature also indicates that the effective use of pharmaceutical drugs and medicines reduce healthcare costs by decreasing the need for costly health services and preventing expensive medical interventions.[9]

Furthermore, the use of these drugs and medicines positively impacts productivity by reducing workforce absenteeism.[10] Innovations in medicines and drugs contribute to increasing life expectancy and improving patient quality of life by curing, relieving and delaying sickness and disease.[11] These health innovations can also provide alternatives to current treatments or solutions to treating conditions that are currently considered incurable. Although interviews noted that there are several thousand diseases that affect humans, including those that pose high health risks (i.e., Alzheimer's disease), literature suggests that there are approximately only 500 that currently have a treatment, which demonstrates a continued need to support novel drug development.

Findings

Relevance | Performance | Efficiency

The life sciences sector represents one of the fastest growing economic sectors, providing highly skilled and high paying jobs.

Literature indicates that providing support for pharmaceutical development represents a valuable investment. For example, according to Statistics Canada 2020 data, the life sciences is one of the fastest growing sectors, comprising 1.8% of gross domestic product (GDP) and 3% of employment in Canada. Jobs in the life sciences are highly skilled and high paying. In Québec, literature noted that in 2016, the average salary in the life sciences industry was 63% higher than the overall average in the province.[12] Literature also recognizes that Canada overall has excellent research and product development in many areas in the life sciences, such as genomics, vaccine development, regenerative medicine and drug delivery systems.[13] A 2021 Statistics Canada study found that in 2018, the pharmaceutical sector contributed nearly $15 billion in GDP to the Canadian economy; supported over 100,000 full-time jobs within Canada; and spent between $1.5 and $2.0 billion on R&D.[14] Furthermore, pharmaceutical imports and exports between Canada and the rest of the world increased by 58% and 143%, respectively, from 2011 to 2020.[15]

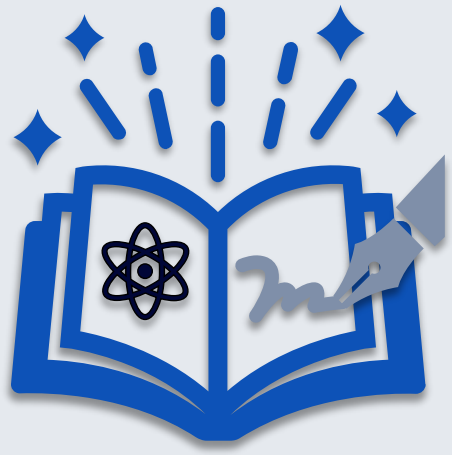
The COVID-19 pandemic impacted the health and economic well-being of Canadians, but also created a sense of urgency and opportunities for Canada's life sciences sector.

In the spring of 2020, Canada's real GDP encountered the most sudden and largest economic contraction since 1961, falling 18% compared to pre-COVID-19 levels.[16] The pandemic also led to a surge in demand of critical medical products, including essential drug products. Interviews found that the pandemic increased momentum in the life sciences sector and led to rapid growth.[17] A 2021 stakeholder survey found near consensus that the pandemic has been a 'game changer' for Canada's health innovation ecosystem, highlighting a new sense of urgency and significant opportunities.[18] Stakeholders explained that the pandemic led to a broader appreciation of the contribution of the life sciences sector to public health and safety. Canada's life sciences industry operates in a global context characterized by aging demographics and rising demand for accessible medical and digital health technologies and pharmaceuticals.[19] Literature and interviews indicate that advances in data science, artificial intelligence, and quantum computing provides an opportunity for greater innovation in drug R&D.[20] Canada has made significant contributions to life sciences advancements, with its most recent contributions being related to the COVID-19 pandemic where Vancouver-based Acuitas Therapeutics Inc. played a critical role in the development of the Pfizer-BioNTech COVID-19 vaccine.[21] Furthermore, in February 2021, Precision Nanosystems Inc., a CDRD spin-off company, received $25.1 million in funding through the Strategic Innovation Fund to establish a biomanufacturing centre in Vancouver, Canada that will contribute to supporting the Government of Canada's national biomanufacturing strategy.

Findings

Relevance | Performance | Efficiency

Canada is a leader in basic research and this strength is highly regarded internationally, but Canada struggles to translate early-stage technologies into innovation and commercialization outcomes.



With just 0.5% of the world's population, Canada produces approximately **3.8%** of the world's publications, ranking in the **top 10** countries in overall research publication output.[24]

It is widely recognized that Canada excels in basic research and "punches above its weight" in research publication output and impact, as literature and interviews suggest.[22,23] Furthermore, Canadian researchers continue to produce high-impact publications, as reflected in citation rates that continue to rise relative to the world average.[25] For example, over the 2009-2014 period, all research fields in Canada, had an Average Relative Citation (ARC) score above 1.0, indicating that citation levels exceed the world average. In natural sciences and engineering research in particular, Canada ranked 18th among 37 OECD countries with a score of 1.37 in 2018.[26]

Despite these strengths, literature and interviews indicate that Canada's ability to translate promising research into marketable goods and services that people can use is comparatively weak and that Canada has not reached its full potential in translating research discoveries into innovation and commercialization outcomes.[27] Literature and interviews also suggest that Canada's existing research strengths have not translated into sufficient applied research, technology or innovation outcomes suggest that there are barriers preventing the translation of research achievements into commercial applications.[28, 29]

Overall, according to interviews, Canada is perceived by stakeholders to be a mid-level player in drug research and development, having a strong global reputation in life sciences research, but lacking end-to-end funding and support to commercialize promising health technologies. In other words, advancing them from the 'bench' (i.e., the laboratory), to the 'bedside', which is ultimately the patient. In particular, Canada's lack of capital for early and late-stage start-up companies; insufficient talent and skills, particularly at the executive level; and Canada's health innovation ecosystem being in the early stages of maturing were noted in interviews as key reasons for limited commercialization outcomes. These findings mirror those of the 2021 stakeholder survey which found that 63% of participants did not believe that Canada is yet a global player in health sciences. Notably, the survey also reflected optimism regarding Canada's potential to become competitive globally based on Canada's significant strengths in discovery research and high number of start-up companies.[30]

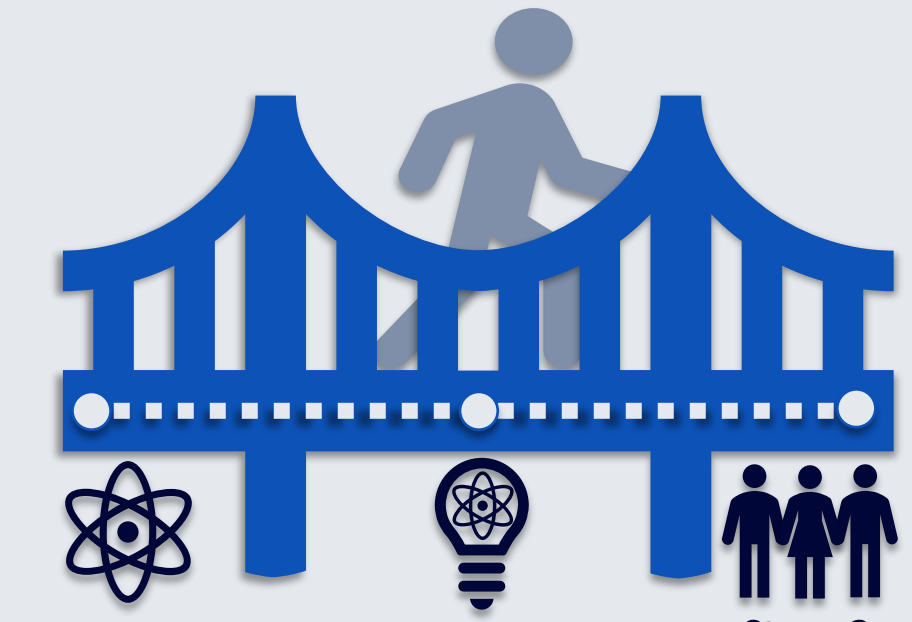
Findings

Relevance | Performance | Efficiency

There is a need to support the translation of promising, life sciences research by bridging the gap between basic health research and the development of a new drug product.

Canadian innovators in the life sciences sector, in both academia and the private sector such as small and medium enterprises (SMEs), face significant challenges in accessing funding and support for the earlier stages of commercialization because investors such as venture capital and global pharmaceutical companies traditionally seek opportunities that are more de-risked, or in other words, have greater scientific validation and demonstrated commercial potential.[31] As a result of these challenges, many promising research opportunities and early-stage technologies developed by academia and Canadian SMEs do not reach maturity, which is necessary in order to generate economic and health benefits for Canadians.[32]

Although basic research is foundational for drug development, literature suggests that the utility of health discoveries is uncertain and must be further developed through targeted R&D activities, often referred to as *translational research*.[33] These activities may include validating what molecules the drug is targeting in the body and testing the most promising drug candidates, with an aim to reduce the risk of failure and increase the likelihood of successful application in humans. As literature and interviews suggest, translational research increases the probability that investors will support the drug's development through the later stages, such as clinical trials, which are costly but are required to bring a new drug to market. Literature and interviews indicates that investors are hesitant to invest dollars into basic research or early-stage technologies, but are attracted to opportunities that have reached the clinical trial phase.[34]



Stage 1
Basic health research and pre-discovery

Stage 2
Drug discovery development and pre-clinical

Stage 3
Clinical trials

Targeted **federal investments are needed to bridge the gap** between research discovery and the translation into pharmaceutical drugs.

According to literature and interviews, despite the need for translational research, this stage is underfunded. Thus, it is unsurprising that a 2018 report by the House of Commons Standing Committee on Health found that "increased federal investments in health research across the continuum of basic to clinical research would lead to a greater number of innovative treatments for diseases."[35] According to ISED survey results, Principal Investigators indicated that the main challenge they face in translating basic research into clinical applications is a lack of funding for the commercialization of health research.

Findings

Relevance | Performance | Efficiency

Bridging the gap between basic research and the successful development of a new drug is costly and associated with high risk and long timelines.

Overall, literature indicates that the productivity of drug R&D, measured as the dollar amount spent per approved medicine, has declined over time.[36] For example, in the United States, which represents the greatest share of the global pharmaceutical market (44% in 2016), the number of new drug approvals for every US $1.0 billion declined from 17 in 1980 to 2 in 2002.[37] This declining productivity is driven partly by rising overall R&D costs as well as the difficulty in discovering new, promising ideas with significant commercial potential.

The combined challenges of high costs in the range of a **billion** dollars, high risk of **thousands** of unsuccessful drug R&D projects, and timelines longer than a **decade** to develop a drug product, suggest that there is a continued need for federal government support.

While estimates vary, overall, literature indicates that the cost to develop a new drug ranges from US $0.8 billion to more than US $2.0 billion.[38] According to interviews, these costs include research activities, pre-clinical activities, clinical trials, and expenditures on drug candidates that fail to reach market. Furthermore, literature indicates that the costs of developing a new drug are rising, with some organizations such as the U.S. Congressional Budget Office reporting an annual increase of 8.5% over the past decade.[39]

Literature and interviews indicate that drug R&D is inherently risk prone and its progress is influenced by significant uncertainty, particularly whether a drug will successfully complete all three stages of clinical trials, reach market approval, and if it will generate sufficient profit to recoup R&D costs.[40,41] On average, and applicable to the Canadian context, of the 5,000 to 10,000 promising opportunities that are reviewed in the drug discovery phase, 250 of them will proceed to the pre-clinical phase, 5 will reach clinical trials and 1 drug is finally approved.[42,43] Literature and interviews suggest that risky, canceled or failed projects are a normal part of any drug development program.[44]

The development of a new drug is estimated to take between 10 to 15 years, on average. Relative to other industries, the life sciences sector has longer timelines for technology development.[45] One study estimates the pre-clinical phase takes 31 months followed by 95 months for clinical trials or 10.5 years from inception to finish.[46]

Findings

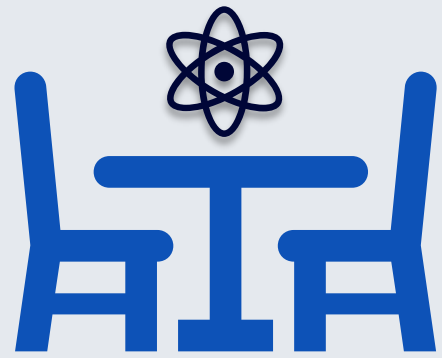
Support for R&D and commercialization activities in the life sciences sector is aligned with the Government of Canada's current priorities.

The priorities of the Minister of Innovation, Science and Industry's mandate letter include continuing to support innovation ecosystems across the country and investing in scientific research, with an appropriate balance between fundamental research to support new discoveries and the commercialization of ideas.[47] Furthermore, the Minister's 2021 supplementary mandate letter identifies continued investment in Canada's long-term bio-manufacturing capacity as a priority. In the context of COVID-19, this priority aims to ensure that Canadian scientists, researchers and post-secondary institutions have the tools and resources they need to advance discoveries of vaccines and therapeutics.[48] The CDRD advances the objectives of the Government of Canada's 2021 Recovery Plan for Jobs, Growth and Resilience which aims to strengthen Canada's life sciences sector and contribute to Canada's post-pandemic economic recovery.

Past evaluations of tri-council agency programs such as the Centres of Excellence for Commercialization and Research and the CIHR's commercialization programs, which aim to advance the commercialization of health research in Canada, clearly note there is a role for the federal government to fund and support the early stages of commercialization deemed too risky for the private sector to undertake.[49] The creation of the Canada Health and Biosciences Economic Strategy Table in 2018 further reflects the importance of supporting the life sciences sector, as it was one of six economic strategy tables established for areas where there is great potential for Canadian businesses to grow and create jobs.[50]

ISED plays a key role in supporting the development and commercialization of health research through its funding to the CDRD.

ISED's funding to the CDRD from 2017-18 to 2020-21 was aligned with the federal government's Health and Biosciences Economic Strategy Table. ISED's funding to the CDRD also contributed to achieving the objectives of the Innovation and Skills Plan and aligns with the critical role that the federal government plays in supporting the development and commercialization of promising health research. ISED's funding to the CDRD helped to advance efforts to develop Canada into a centre for innovation by strengthening Canada's life sciences sector and advancing the commercialization of Canadian health innovations.[52] Most recently, Budget 2021 announced $92 million in increased funding to adMare BioInnovations from 2021-22 to 2024-25, which supports the Biomanufacturing and Life Sciences Strategy.



Canada's Health and Biosciences Economic Table has set ambitious targets, which includes doubling the number of bioscience and health firms to **1,800**; and doubling the number of high-growth firms by 2025.[51]

Findings

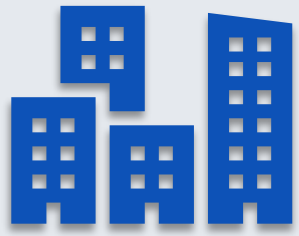
Relevance | Performance | Efficiency

Finding 2: The CDRD addressed the need to support the translation of drug research in Canada by providing the health innovation ecosystem with a full spectrum of services, including scientific expertise, research infrastructure, business development support and funding to projects with commercial potential. The creation of adMare BioInnovations enabled the CDRD to strengthen its presence nationally, combining the complementary roles of the NEOMED Institute and Accel-Rx. In recent years, the CDRD shifted its focus to supporting projects that are further along the drug R&D continuum and to building life sciences companies in Canada.

The health innovation ecosystem in Canada requires a broad range of support and services to advance early-stage technologies and companies towards commercialization.

Without focused R&D activities to validate and add value to basic research, it may never be commercialized. Although these activities are critically important, they typically cannot be obtained through traditional research funding mechanisms.[53] Academic researchers and SMEs have overlapping and unique needs in terms of support for translational research and commercialization.

Academic researchers lack the knowledge, resources and experience to commercialize technologies and there is a misperception that research expertise and drug development skills go hand in hand, according to literature and interviews. Furthermore, academics require help in validating and replicating promising research to produce a scientific data package that is attractive for later-stage investors to develop.



SMEs require investment capital and access to expertise and infrastructure that they may not have available in-house or at an affordable cost from contract service providers, according to interviews. Literature indicates that the majority of Canadian SMEs developing drug technologies are at early stages of development with their greatest obstacle to commercialization being access to sufficient capital.[54]

While academic researchers and SMEs still provide a source of early-stage technologies for major biotech/pharmaceutical companies looking to access promising opportunities, SMEs are now much more frequently advancing products through to commercialization. Today, a number of Canadian SMEs that continue to grow in Canada are successful examples of that (e.g., AbCellera, Medicago, Zymeworks, etc).

Findings

Relevance | Performance | Efficiency

Over the evaluation period, the CDRD was regarded as a 'one-stop shop' for the health innovation ecosystem to access scientific and commercial expertise, research infrastructure, partnerships and capital.

Scientific expertise

Documents and interviews found that the CDRD supported academic researchers and SMEs by providing high-quality scientific assistance and drug development expertise that contributes to addressing challenges that inhibit commercialization. For example, CDRD stakeholder surveys consistently highlighted the strength of the CDRD's internal R&D capabilities and scientific personnel who are knowledgeable, well-regarded, and provide assistance to academics who lack commercial experience.[55] The CDRD provided translational research services which include, for example, medicinal chemistry (a discipline concerned with drug design and development) and proof of concept studies that advance drug R&D. Moreover, ISED survey results found that 8 of 14 (57%) Principal Investigator respondents indicated that the CDRD's reputation for high-quality research and drug development was the main factor in pursuing an R&D project with the CDRD.

Interviews and the document review indicate that the CDRD provided access to infrastructure and high-quality equipment that may not otherwise be available to academics or SMEs. For example, stakeholders indicated that one of the key factors that make the CDRD unique relative to other Canadian accelerators is its infrastructure capabilities which includes over 40,000 sq. ft. of specialized research infrastructure.[56] One university representative indicated that researchers are able to access advanced equipment that their institution cannot afford to purchase or maintain. Interviews from SMEs suggest that the CDRD was especially valuable for early-stage companies because it provided critical services and infrastructure that may not have otherwise been available (e.g., medicinal chemistry services, wet labs). Interviews also explained that while SMEs can access similar services from contract research organizations, these entities are generally expensive and provide a service, rather than a partnership.

Research infrastructure

Business support

The CDRD offered a range of commercial and business development services that included, among other things, drug development planning; intellectual property management and advice; assistance with company creation, financing, and investment attraction; and access to regulatory expertise. These services contributed to assessing the commercial viability of projects (e.g., whether or not the technology could form the foundations for a spin-off company). The CDRD also supported early-stage life sciences companies through its ability to provide seed investment. Interview evidence indicates that CDRD provided seed capital to various Canadian SMEs which was important for helping these companies to advance to the next stages in their development.

Findings

While there are other organizations in Canada that undertake similar activities as the CDRD, these organizations were either in niche areas of drug R&D or were regionally based.

Interviews, documents and literature indicate that there are other organizations in Canada that served a similar bridging function as the CDRD with a parallel objective to accelerate the commercialization of health research.[57] While some organizations have overlapping functions, there are few organizations with a similar scope and breadth.[58] In particular, the CDRD's in-house scientific expertise and infrastructure were regarded as key elements that made it unique.[59] The entities that were most referenced in interviews and CDRD stakeholder surveys were those that are currently or were formerly funded through the Centres of Excellence for Commercialization and Research (CECR) or the Business-Led Networks of Centres of Excellence programs.

Drug commercialization activities exist at **organizations across Canada**.

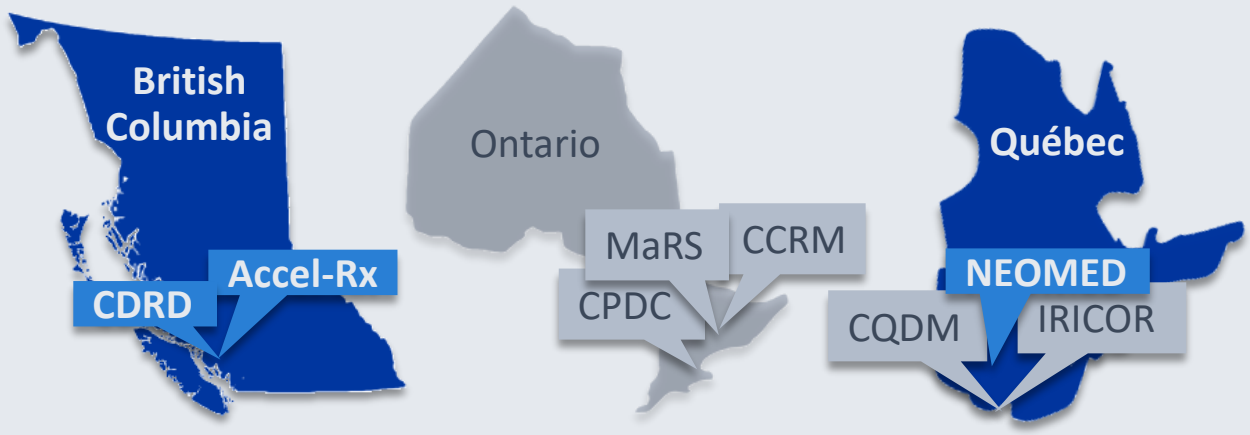
MaRS Innovation, (now known as Toronto Innovation Acceleration Partners) a CECR-funded technology transfer organization based in Toronto, Ontario is regarded as the closest of all organizations to the CDRD and documents show it has engaged in similar drug development activities such as identifying and incubating opportunities, providing early-stage financing and launching companies. However, one of the key differences is that its activities focus on eleven Toronto-based member institutions.[60] In addition, interviews found that CECR-funded organizations such as the Institute for Research in Immunology and Cancer (IRICOR), the Centre for Probe Development and Commercialization (CPDC) and the Centre for Commercialization of Regenerative Medicine (CCRM) play a key role in early-stage drug development as well, but their activities are more specifically focused in niche areas such as oncology, molecular imaging probes, and regenerative medicine respectively. According to a 2018 CCA report, organizations such as the CDRD, MaRS Innovation, the Consortium de recherche biopharmaceutique (CQDM) and others have all contributed to developing a niche for Canada in pre-commercial drug R&D.[61] The complementary roles of these organizations is also reflected in their efforts to collaborate.[62]

Given the complexity of drug development, there are other players that also have a key role in the process, all contributing to the creation of a new drug. Interviews and documents highlight the role of key federal programs in supporting specific aspects of the drug development process.[63] For example, the National Research Council's Industrial Research Assistance Program (IRAP) was noted as being indispensable for supporting Canadian SMEs in advancing their drug programs and Mitacs has provided support to companies to access valuable talent. In fact, during the evaluation period, CDRD spin-off company Zucara Therapeutics was awarded NRC IRAP funding to develop a highly promising therapeutic as well as a Mitacs Accelerate Postdoctoral Fellowship grant to fund its preclinical Type 2 diabetes model.[64]

Findings

Relevance | Performance | Efficiency

Recently, a new organization was created in Canada, known as adMare BioInnovations, and it joined together three national Centres of Excellence for Commercialization of Research in an effort to grow the health innovation ecosystem.



The **CDRD** and **Accel-Rx** in British Columbia along with **NEOMED** in Québec amalgamated to create adMare BioInnovations, an organization that supports drug R&D and commercialization projects across Canada.

In Canada, the federal government's Networks of Centres of Excellence expanded its offerings in 2007 to include the CECR program which aimed to create internationally recognized centres that help to bridge the commercialization gap in four priority areas, including the health and life sciences. The CECR program had funded 18 health and life sciences organizations as of 2017-18, including the CDRD. In addition, the CECR program also provided support to the NEOMED Institute, a Montreal-based drug R&D incubator with significant infrastructure capabilities, as well as Accel-Rx, a health sciences accelerator providing seed capital to create and fund life sciences companies with high commercial potential.[65] Respondents to the CDRD's 2017 and 2019 stakeholders surveys highlighted the NEOMED Institute as well as Accel-Rx as being among a group of other Canadian organizations with a similar bridging function as the CDRD.[66]

During the evaluation period, the CDRD underwent a significant transformation in efforts to better support the growth of the health innovation ecosystem in Canada, announcing the creation of adMare BioInnovations, a new pan-Canadian entity that combined the CDRD with the NEOMED Institute in May 2019 and Accel-Rx in January 2020.[67] The CDRD thus strengthened its reach nationally through the creation of adMare BioInnovations. According to interviews, this was driven by a desire to expand the CDRD's national reach and strengthen its position as a one-stop shop for R&D support and services. It also provided the opportunity to leverage the unique capabilities offered by the NEOMED Institute and Accel-Rx, expanding the organization's overall suite of services offered and physical presence beyond Vancouver, British Columbia. Furthermore, given the limited resources available in Canada to support health commercialization, CDRD management, according to documents and interviews, recognized that it was important to build partnerships with synergistic organizations across Canada.

Findings

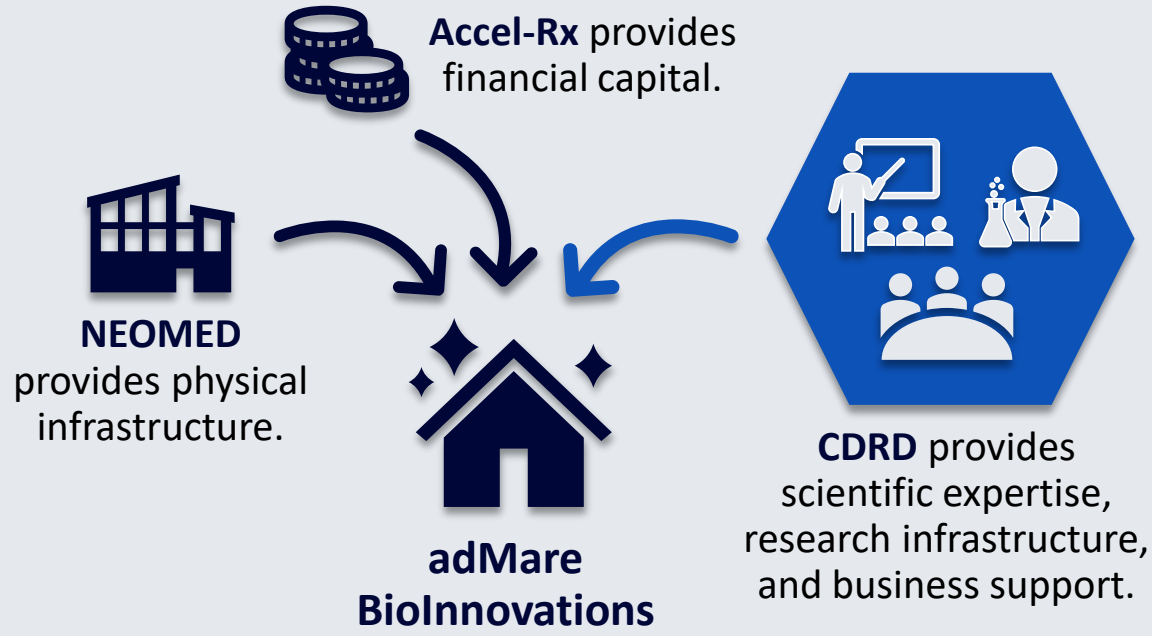
Relevance | Performance | Efficiency

Within adMare BioInnovations, the CDRD plays a complementary role to the NEOMED Institute and Accel-Rx.

Interviews and documents indicate that each of the three organizations provided a unique contribution to adMare BioInnovations that complements, rather than duplicates, the capabilities of the other entities. Although the NEOMED Institute and the CDRD conducted similar activities prior to joining together (e.g., identifying and incubating promising academic research), interviewees explained that under adMare, the **CDRD** provides excellent training programs and drug development experience, the **NEOMED Institute** offers high-quality facilities and infrastructure, and **Accel-Rx** provides greater capacity to provide seed funding to promising early-stage companies. More specifically, interviews noted that the NEOMED Institute's inclusion in adMare provides the new entity with a greater national presence, particularly in Québec, allowing it to deliver programs more efficiently and effectively. Its high-quality physical infrastructure, equipment and wet lab space is regarded by stakeholders as a unique contribution helping to address limited infrastructure capabilities in Canada, especially in Vancouver, BC. With respect to Accel-Rx, interviewees expressed that it provides adMare with a greater ability to offer capital and seed funding to companies, helping to address a gap in early-stage financing that prevents spin-offs and young companies from scaling and attracting follow-on investment.

Evidence from interviews and documents suggests that adMare BioInnovations is a key national player that helps to connect regions of Canada through its role as a facilitator and project funder. According to interviews and CDRD stakeholder surveys, it is increasing its presence in the ecosystem, with the opportunity to achieve pan-Canadian impact as a one-stop shop for drug R&D support.

Interviews suggest that adMare can contribute to addressing some of the key challenges facing Canada's life sciences sector (e.g., building scalable companies). However, as noted in the 2021 stakeholder survey, given adMare's recent formation it is too early to assess the extent to which the merger has been successful.[68] A significant number of respondents indicated that they were not ready to provide an assessment of its success to date. Despite this, these survey respondents as well interview participants viewed adMare's strategic direction positively, particularly regarding its efforts to establish a national footprint.



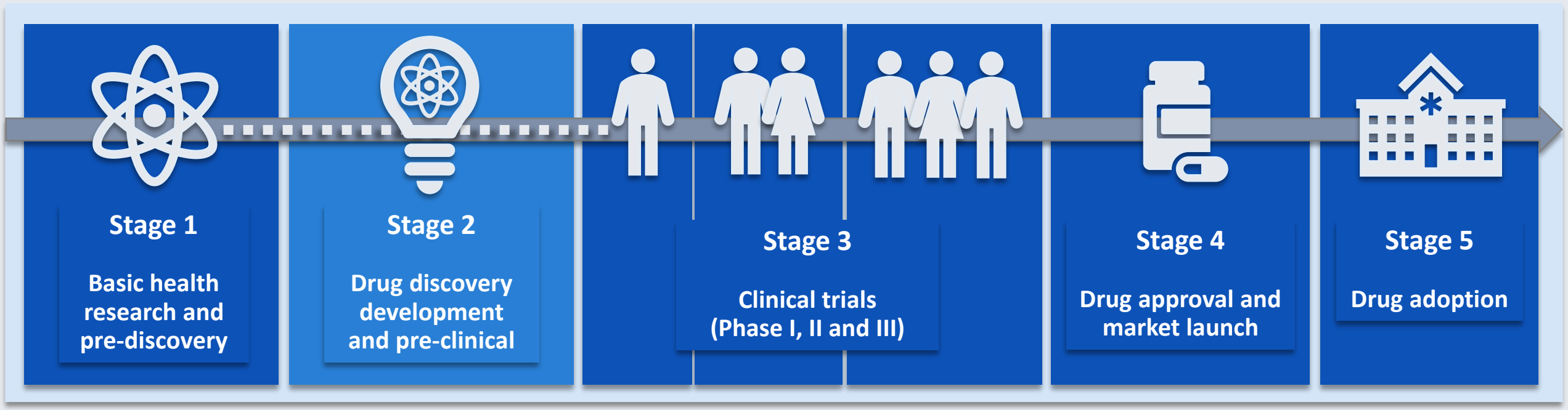
The suite of services that the CDRD offers is **unique** relative to NEOMED and Accel-Rx.

Findings

Relevance | Performance | Efficiency

Overall, the CDRD's role was similar to other international organizations, which is to bridge promising basic research and clinical development, helping to advance scientific discoveries to commercialization.

In contrast to the United States where private entities have similar functions, interviews suggest that bodies like the CDRD are necessary in Canada given its much smaller, younger and more fragmented sector. [69] Literature suggests that the CDRD operated in a global context in which other countries also recognize the translational challenge. The CDRD's emergence in 2007 occurred at a time when other countries were beginning to fund similar organizations to bridge the commercialization gap. From 2000 to 2011, many translational research organizations were created around the world including LifeArc in the United Kingdom, the European Infrastructure for Translational Medicine, Therapeutic Innovation Australia, and the US National Center for Advancing Translational Sciences.[70] While these organizations have unique models, they are comparable to the CDRD in that they provide scientific and technical expertise, infrastructure and capital to support the de-risking and advancement of promising discoveries. These international centres along with the CDRD play a critical role in **Stage 2: Drug discovery development and pre-clinical**.



Interviews and CDRD stakeholder surveys indicate that the CDRD's bridging role in **Stage 2 involved several steps** to help identify, select and incubate basic research and nascent drug technologies from Canadian academic institutions and SMEs, **leading to de-risked opportunities that stimulate investor interest**.[71]

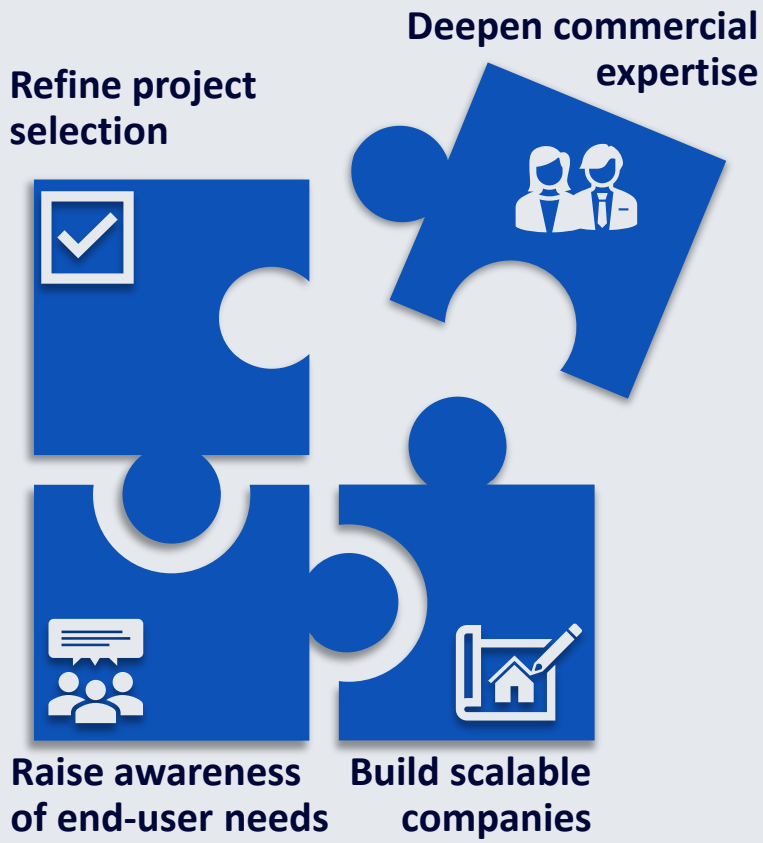
Findings

Relevance | Performance | Efficiency

In recent years, the CDRD adopted a new strategic approach to support drug R&D and commercialization in Canada, one that focuses on launching companies and helping existing companies scale up.

In 2017-18, following the appointment of a new President and CEO, the CDRD examined its historical approach of supporting drug R&D in Canada and formulated a new strategic plan. Documents and interviews noted that there was a need to examine and refine the CDRD's activities and processes to better meet the organization's objectives including demonstrating progress towards achieving commercialization outcomes and reducing reliance on public funding.[72] A 2017 stakeholder survey found that the most important issue facing CDRD leadership was the uncertainty and perceived lack of commercialization.[73] This examination resulted in a new strategic plan that identified a need for the CDRD to expand its focus beyond its traditional academic base and the translating of academic discoveries.[74] The strategic plan noted that:

1. The CDRD's project selection processes should be more focused, highly selective and proactive rather than reactive.[75] For example, it noted that the CDRD should use its expertise to identify commercial opportunities and proactively mine Canadian academia and SMEs for technologies that could be advanced by CDRD, thus better leveraging opportunities to grow the industry, earn financial returns, and advance products to the market to improve health outcomes. [76]
2. There is an identified need to focus on later-stage "end users" such as venture capital and biotechnology companies who play a key role in advancing drug development projects after the CDRD has added value.[77]
3. In addition to increasing awareness of end-user needs, the plan highlighted a need to focus commercialization efforts on spinning out and building scalable companies as the best means to achieve commercial outcomes and self-sustainability for the CDRD.

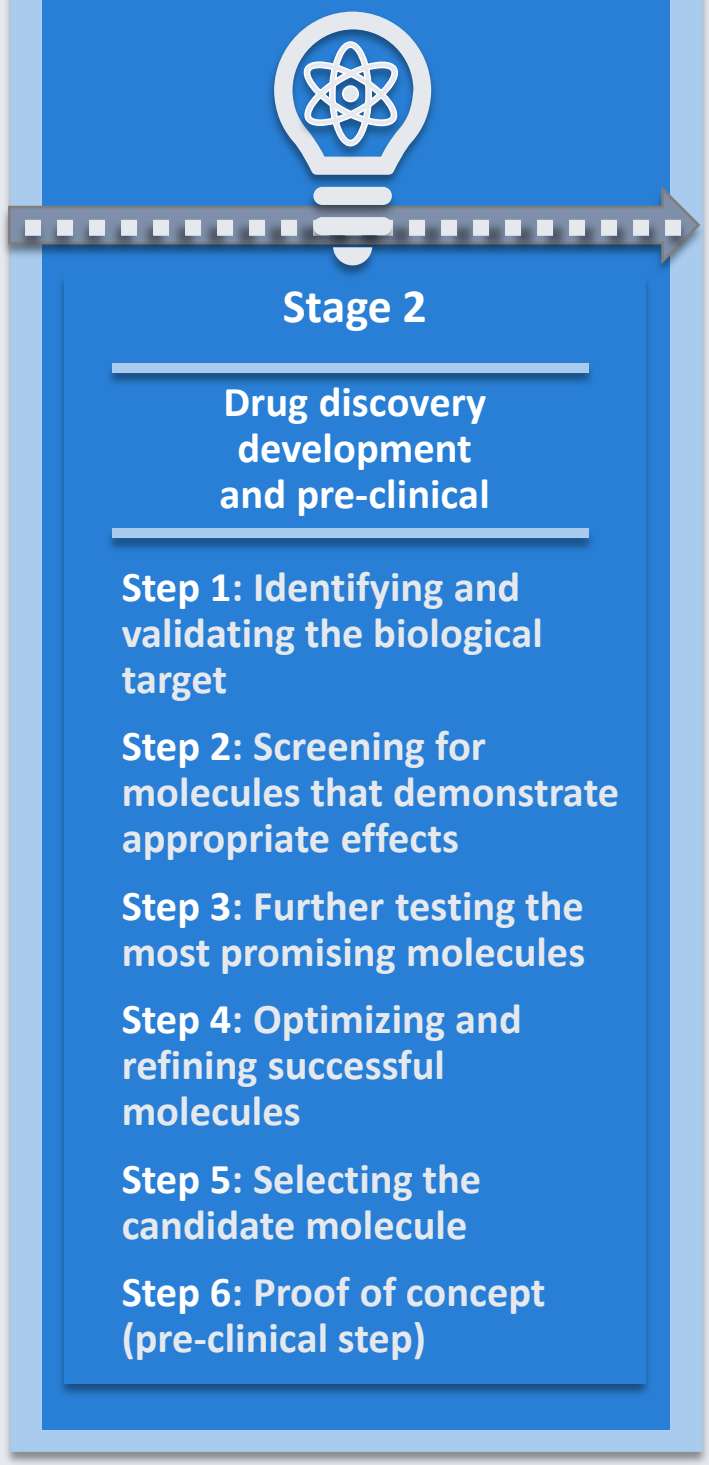


The CDRD introduced **Venture Partners** to help implement its new strategic plan.

In October 2018, the CDRD announced a major operational re-organization to align with its refined objectives. According to documents and interviews, the new structure sought to facilitate the CDRD's efforts to be more proactive, selective and commercially focused by recruiting leadership with significant experience leading the development of a drug from inception to market approval.[78] In practice, interviewees indicated that the organization is more commercialization and translation-oriented than the CDRD's previous approach which was more focused on scientific and academic outputs. Furthermore, the commercial and intellectual property prospects of potential projects became more deeply examined at the early assessment stages than before. The new model also aligns with the Government of Canada's priority to support the commercialization of promising health technologies and innovations.

Findings

Relevance | Performance | Efficiency



To increase the depth and scale of its R&D efforts and commercialization outcomes, the CDRD shifted towards a focus on supporting a smaller portfolio of projects in the drug discovery development stage.

Under the new **strategy and operational plan**, the CDRD's portfolio of R&D projects are managed by Venture Partners. Specifically:

1. Venture Partners are individuals who have a commercial and industry skillset that allows them to proactively identify and advance the most promising commercial opportunities in Canada, increasing the likelihood of success.
2. Each Venture Partner portfolio is dominated by a major project that aims to produce a spin-off company, complemented by other developing assets.

Documents and interviews suggest that although the CDRD continued to support **Stage 2: Drug discovery development and pre-clinical** projects, it reduced the total number and breadth of projects in its portfolio, allocating greater resources to fewer projects, more specifically, those with a higher chance of achieving commercialization.[79]

According to interviews and CDRD stakeholder surveys, there is a perception among stakeholders that the CDRD moved away from its historical focus in supporting academia at the earliest steps of drug discovery development such as **Step 1: Identifying and validating biological targets**. CDRD stakeholder surveys conducted between 2017 and 2021 reflect a perception that the CDRD became increasingly focused on commercial outcomes and shifted its attention towards the middle steps of the drug discovery development stage, reducing its involvement in the early academia stage.[80] For example, the 2021 stakeholder survey highlighted a common view that adMare BioInnovations has shifted from the CDRD's original mandate which was primarily focused on academia and as a result is perceived as de-emphasizing its ties to researchers.

According to stakeholders, over the last few years the CDRD was focused on selecting opportunities that were "closer to the clinic". In other words, those that were in the later steps in the drug discovery development and pre-clinical stage. Interviews corroborate these observations as many participants, particularly academia, explained that the CDRD's shift raised questions regarding the extent to which it continued to address the needs of the academic community.

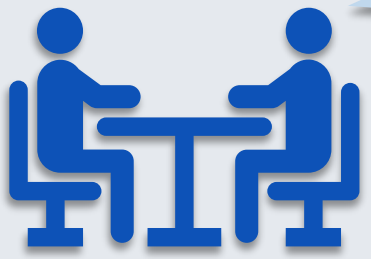
Findings

Relevance | Performance | Efficiency

Stakeholders in the health innovation ecosystem viewed the CDRD's Venture Partner model and strategic shift as a positive change for the organization, but there was a lack of clarity in the academic community regarding the objectives, focus and priorities of the CDRD, and now, as adMare BioInnovations.

Multiple stakeholder groups remarked that the CDRD's focus on academia decreased as a result of the strategic shift and there is uncertainty regarding how the new organization, adMare BioInnovations, now fills this gap. In response to the CDRD's strategic shift, one university representative explained that their university and other major research institutions in Canada were required to take on a greater role internally to determine how to advance technologies forward. Stakeholder survey and interview responses generally expressed positive perceptions towards the new Venture Partner model and strategic shift. For example, CDRD stakeholder surveys indicated that the CDRD's strategic shift to focus on fewer, commercially promising projects and building companies was appropriate and necessary if the organization hoped to achieve long-term commercial success and self-sustainability.[81] In fact, many stakeholders regarded this shift as necessary for the organization to produce the impact it desired due to limited resources and the need to better support early-stage companies. Until this shift, interviews and documents found that the CDRD was perceived as having too broad a focus with too many projects, many of which were weak.

Interviews and CDRD stakeholder surveys suggest that it is important for adMare BioInnovations to ensure that all stakeholders in the health innovation ecosystem understand its objectives, direction and priorities. In particular, its greater focus on commercialization should be clearly communicated to academia. All surveys conducted in 2017, 2019 and 2021, as well as interviews, highlighted a lack of awareness among the life sciences community of the CDRD, and now adMare's, current objectives, focus and priorities. Furthermore, to help facilitate partnerships, stakeholders suggested that the organization should clearly communicate how it operates, what suite of services it offers, its project selection criteria and benchmarks, and overall, how it supports different stakeholders in the health innovation ecosystem, including academia. Stakeholders also expressed a need for adMare to clearly define its position within the drug discovery development and pre-clinical stage.



Recommendation 1: ISED's Science and Research Sector should work with adMare BioInnovations to increase understanding within the academic community of its refined focus, role and objectives in regards to advancing drug R&D projects.

Findings

Relevance | **Performance** | Efficiency

Finding 3: The CDRD training programs contributed to addressing Canada's talent and skills gap and were further expanded under adMare BioInnovations to build a diverse talent pipeline in Canada's health innovation ecosystem. These training programs helped attract talent to Canada, particularly those who have significant expertise in the commercialization of drug R&D.

Canada's life sciences sector faces challenges in accessing talent with the necessary skills, knowledge and experience to support the advancement and commercialization of basic research and early-stage technologies into new drug products.

Literature indicates that a significant proportion of jobs in the pharmaceutical industry relate to research and development, thus requiring highly developed skills.[82] However, interviews and documents show that there is a significant skills and talent gap in Canada's life sciences sector that is particularly acute at the management levels of Canadian life science companies. In 2018, the Health and Biosciences Economic Strategy Table concluded that across all levels of the ecosystem, there is a serious shortage of skills and talent which hinders Canada's competitiveness.[83] For example, job openings in the life sciences are projected to exceed the labour supply until at least 2024 and Canadian life sciences companies consistently indicate that their firms suffer from a skills shortage.[84] Notably, the Table emphasized that deficiencies in accessing executive-level talent is a significant barrier preventing Canadian businesses from scaling their firms.[85] According to interviewees, some promising Canadian life sciences companies have left Canada due to an inability to find experienced leadership. Interviewees also noted that Canada faces a brain drain challenge more broadly, as skilled personnel leave for attractive opportunities in the United States.

Documents and interviews found that the CDRD played a significant role in developing the life sciences ecosystem through training programs that help to address a need for highly qualified and skilled personnel with the scientific and commercial skills to advance drug technologies. The 2019 CDRD stakeholder survey found that the CDRD, through adMare BioInnovations, helped to build the Canadian life sciences sector at a national level through its training activities, networks and collaboration.[86] The CDRD was also regarded as a strong collaborator, adding significant value to the partnerships it pursues and having access to different capabilities and expertise needed to advance R&D projects.[87]

76%

or 54 of 71 CDRD trainees surveyed by ISED perceived the CDRD training programs as important for **increasing the pool of talent in Canada.**

Findings

Relevance | **Performance** | Efficiency

The CDRD helped address Canada's talent gap through its training programs that target diverse trainees and these training programs have expanded beyond the traditional academic base to include early-career scientists and life science executives.

According to documents and interviews, the CDRD Academy and its distinct program streams aimed to develop the next generation of highly qualified, industry-ready personnel. Although undergraduate, graduate and postdoctoral training has always been a key element of the CDRD's mandate, over the evaluation period, the organization continued to expand its training programs to reach broader audiences.[88] For example, the Executive Institute, a 10-month executive development program designed to produce strong management talent capable of growing and scaling life sciences companies into anchor firms.[89] Documents and interviews indicate that the program helps to build leaders that are capable of thinking in more complex and strategic ways by covering the most relevant topics and experiences such as exploring current and future company challenges, developing leadership competencies and participating in executive coaching.

In 2018-19, the CDRD **partnered** with Pfizer and the Center for Creative Leadership (a global leader in executive-level training) to **launch** its Executive Institute.

In 2020-21, building on the success of its post-graduate stream, the CDRD, through adMare BioInnovations, launched the BioInnovation Scientist (BIS) program, which according to documents and interviews, is a multi-year, progressive training initiative aiming to help early-career scientists in academia and industry develop valuable skills in bioinnovation, enhance their networks and become more commercially-minded. According to CDRD stakeholder surveys and interviews, the expansion of the CDRD's training programs reflected the organization's broader contribution to the life sciences ecosystem beyond supporting the commercialization of early-stage technologies and aligns with the need to develop a pipeline of industry-ready Canadian talent, including a key gap in management talent.[90] As noted in the 2021 stakeholder survey, one of the main challenges facing Canada's life sciences sector is the lack of experienced high-level managers to grow promising companies as well as the need for developing initiatives to address this gap.[91] Evidently, programs such as the CDRD's Executive Institute have helped to address this talent shortage.

Findings

Relevance | **Performance** | Efficiency

The increase in the total number of trainees in the CDRD Academy as well as the distribution by program reflect the CDRD's talent and skills development priorities.

From 2017-18 to 2020-21, the data review found that the CDRD provided over 200 training opportunities to individuals through the CDRD Academy's four external streams, averaging 50 new trainees per year.[92] This greatly exceeds the 2018 CDRD Performance Measurement Strategy's target of 20 new trainees per year. Furthermore, 45% of all training opportunities during this time period were delivered through the BioInnovation Scientist stream; 26% through the Undergraduate stream; 24% through the Executive Institute; and 5% through the Post-graduate stream (see **Figure 1**). The data review also found that nearly 7 out of 10 (69%), on average, of all newly attracted trainees to the CDRD were in the BioInnovation Scientist and Executive Institute streams reflecting a significant focus on these programs.

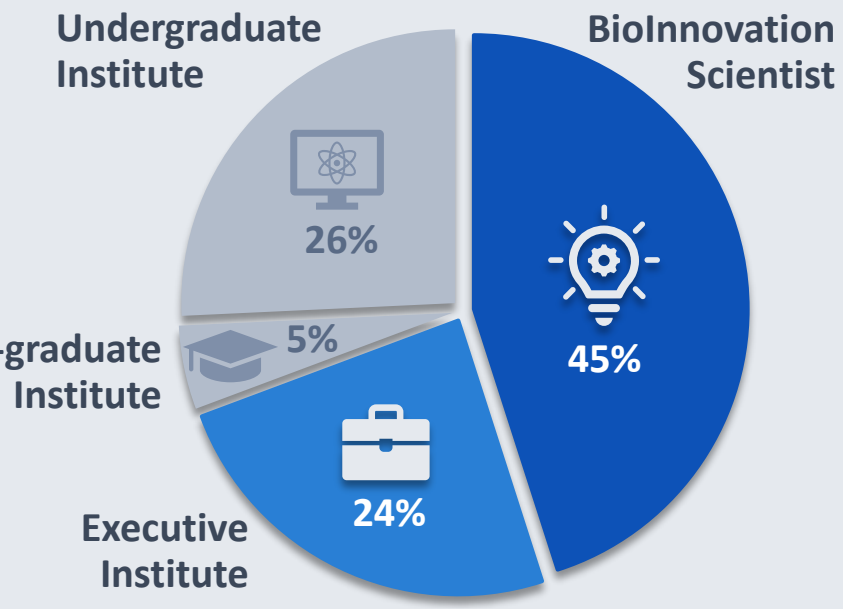


Figure 1: Distribution of newly attracted trainees to the CDRD for 2017-18 to 2020-21, with emphasis on the BioInnovation Scientist program (45%) and Executive Institute (24%)

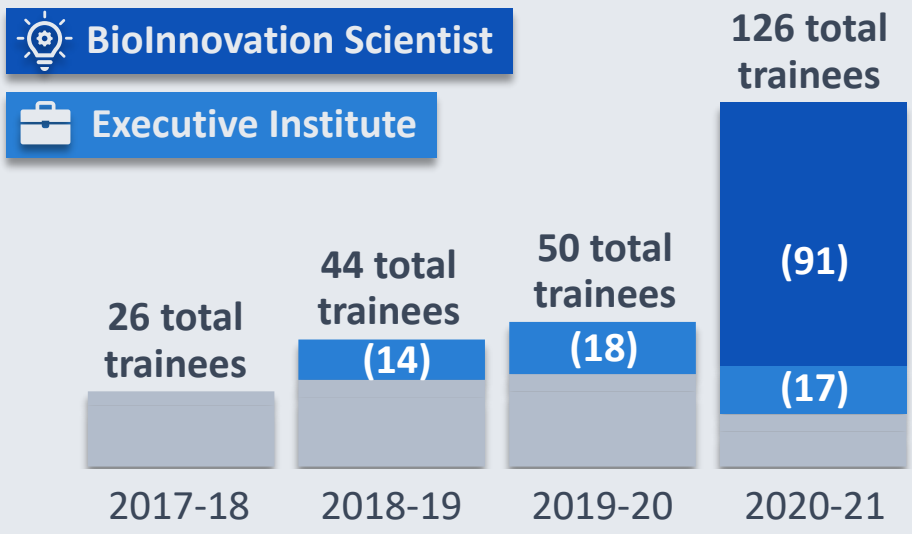


Figure 2: Total trainees increasing from 26 in 2017-18 to 126 in 2020-21.

The data review found that the total number of trainees, which includes newly attracted trainees to the CDRD as well as trainees that are already participating in at least one CDRD Academy program has increased significantly from 26 in 2017-18 to 126 in 2020-21, driven primarily by the launch of the new Executive Institute in 2018-19 and the BioInnovation Scientist stream in 2020-21. The Executive Institute had 14 trainees in 2018-19, 18 trainees in 2019-20 and 17 trainees in 2020-21, while the new BioInnovation Scientist stream had 91 trainees in 2020-21 (see **Figure 2**).

Findings

Relevance | **Performance** | Efficiency

The CDRD attracted more female participants in its training programs.

Overall, data indicates that from 2017-18 to 2020-21, the gender distribution of participants in the Executive Institute has been consistently at or near gender parity, with an average of 51% female participation. Notably, the number of female participants in each year has consistently exceeded male participants for both the postdoctoral fellowships under the Post-graduate Institute and the BioInnovation Scientist program, with average female representation at 70% and 59% respectively (see **Figure 3**).[93]

The number of total female participants relative to males across all four training streams has generally increased. For example, in 2017-18, 42% of all trainees were female.[94] By 2020-21, 54% of all trainees were female, reflecting a significant increase in the proportion of female trainees.[95]

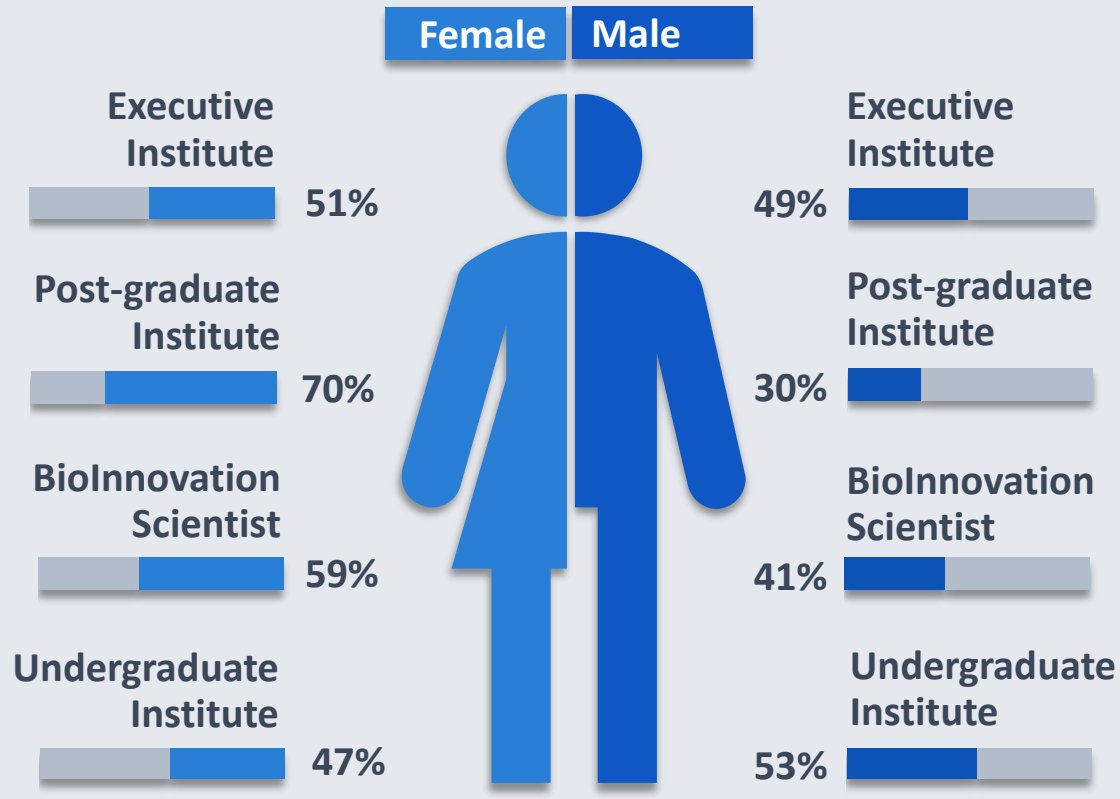


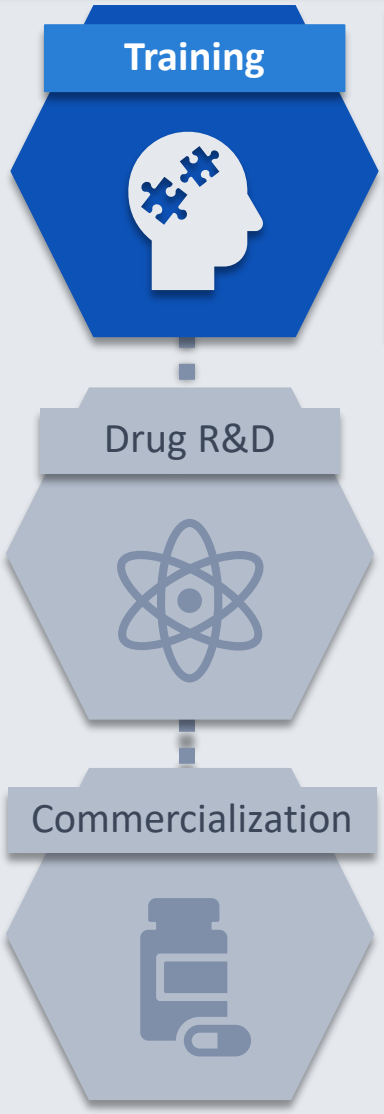
Figure 3: Female (left) and male (right) average gender distribution of participants for 2017-18 to 2020-21, expressed as a percentage (%) of total participants in each training program

The CDRD also made notable efforts to consider equity, diversity and inclusion (EDI) issues beyond gender in the delivery of its programs. From 2017-18 to 2019-20, the CDRD hosted 14 high school students as part of the Verna J. Kirkness Science and Engineering Education Program which focuses on addressing the underrepresentation of First Nations, Metis and Inuit students in Canadian science and engineering programs. The CDRD has not collected EDI data historically, however, documents and interviews suggest that adMare BioInnovations is in the process of implementing a new EDI policy and initiatives that include an organization-wide self-identification survey. Notably, 33 of the 71 respondents (46%) to ISED's trainee survey identified as being a member of a visible minority group.

Findings

Relevance | **Performance** | Efficiency

Finding 4: The CDRD training programs supported skills and knowledge development in areas related to commercializing drug R&D and business development, as well as retaining talent in Canada. adMare BioInnovations continues to improve and expand the CDRD's training programs, prioritizing the training of scientists in areas including drug development, commercialization and company creation. These training programs were effectively delivered virtually during the COVID-19 pandemic.



The CDRD training programs were unique in that they help researchers develop the business and commercial skills that are required to advance drug products to market.

Overall, interviews indicate that CDRD training programs were effective in providing trainees with a diverse set of commercially-relevant skills, knowledge and experiences required to advance research towards commercialization or to prepare for a career in the life sciences sector. In addition to acquiring advanced scientific skills, trainees become more business savvy and commercially-minded through their experiences in the CDRD's labs, spin-off companies and partner firms. Interviews also highlighted the uniqueness of these training experiences in that they cannot be obtained in a traditional academic setting and are particularly important to acquire because academic strengths often do not include effective skills in commercializing research. CDRD training programs provided individuals with academic experiences with the business skills necessary to advance drug products and scale up companies. According to interviewees, CDRD training is a "stepping stone" to career opportunities in the broader Canadian ecosystem.

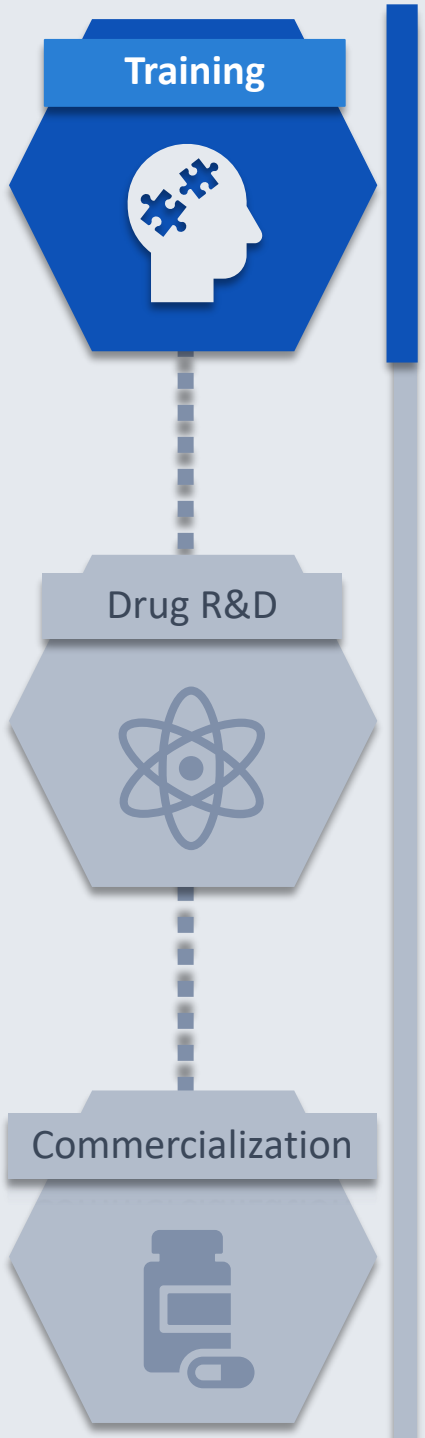
79%

or 56 of the 71 CDRD trainees surveyed by ISED were **satisfied** with their training, **reporting benefits** such as leadership and communication skills, as well as an **increased knowledge** of drug R&D processes in Canada.

A review of the CDRD's Training Academy documents indicates that training streams were highly customized and tailored to the unique needs of each talent segment, ranging from undergraduates to business executives. Interviews indicate that researchers are most attracted to the commercial, business and industry focus of the CDRD's training programs. A common theme across all training programs is a focus on commercial and industry-relevant content. This was clearly reflected in the types of skills highlighted by interviewees which included increased knowledge of drug development processes and intellectual property considerations; investment decision-making; how to launch and scale companies; and life sciences project management.[96]

Findings

Relevance | **Performance** | Efficiency



Participants in the CDRD Training Academy leveraged their skills and knowledge to pursue employment in the life sciences sector, both in Canada and abroad.

CDRD stakeholder surveys in 2017 and 2019 noted that the CDRD was an attractive training ground for early-career researchers and its training programs are well regarded. For example, in 2019, 72% of stakeholders rated the CDRD's performance in training the next generation of science and business personnel as good, very good or excellent.[97] While some stakeholders felt the impacts of the CDRD's new Executive Institute program and BioInnovation Scientist program are too early too assess, interview evidence suggests a positive impact. Interviewees representing Canadian life science companies noted that their colleagues have participated in the Executive Institute and had very positive assessments of its value. Furthermore, they intend to have more team members participate in the program. Interviews also suggest that the CDRD's recruitment of leaders in drug development with commercially-relevant experience is a key source of executive-level mentorship for spin-off companies and helps to expose CDRD staff to new business and commercialization skills. According to ISED survey results, 48 of the 71 trainee respondents (68%) indicated that they use the knowledge and skills they gained from CDRD training programs in their current positions.

Alumni of the CDRD's postdoctoral fellow program have obtained senior positions within leading Canadian life science companies. Performance data shows that as of 2020-21, 57 postdoctoral fellows have graduated from the CDRD's training program since inception, 95% of whom are employed in the life sciences industry. Of the postdoctoral fellows who are employed in the life sciences industry, 78% have positions in Canada while 22% work internationally. According to documents and data, CDRD-trained postdoctoral fellows are employed in top life science companies and research institutions such as Johnson & Johnson, Pfizer, Janssen Pharmaceuticals, Roche, GlaxoSmithKline, the BC Cancer Agency and the University of British Columbia. Furthermore, they are also employed in Canadian life science companies such as Zymeworks, Precision Nanosystems, Notch Therapeutics, STEMCELL Technologies and AbCellera, occupying a myriad of positions ranging from research associates, senior managers and physicians, to director-level and principal scientist positions in life science companies.[98]

62%

or 8 of 13 undergraduate trainees surveyed by ISED pursued further training at a **Canadian university** after completing their program.

89%

or 32 of 36 Executive Institute and BIS trainees surveyed by ISED continued to work in their current **organization or company in Canada** after completing their CDRD training.

Findings

Relevance | **Performance** | Efficiency

Throughout the evaluation period, and during the COVID-19 pandemic, the CDRD consistently demonstrated efforts to enhance and strengthen its training programs.

In 2020, the CDRD conducted a comprehensive review of its training strategy, focusing on analyzing talent gaps and identifying the critical training content required to produce industry-ready life sciences personnel.[99] This review focused on assessing the immediate and longer term training needs of the health innovation ecosystem and currently informs adMare BioInnovation's training strategy. In addition to launching the Executive Institute and the BioInnovation Scientist program, documents and interviews revealed that adMare BioInnovations is also exploring options for expansion of its training programs. One possibility under consideration is the creation of a new Venture Management stream which would train entrepreneurs with the business skills needed to launch and grow their firms. [100] Documents, interviews and surveys also indicate that the CDRD adapted its training programs to ensure continued online delivery during the COVID-19 pandemic. In particular, the BioInnovation Scientist Program, launched in November 2020, was designed to be delivered virtually in order to increase reach and comply with social distancing requirements.[101]

73%

or 38 of 52 trainees that participated in a CDRD training program during the COVID-19 pandemic perceived the CDRD as **effective** in delivering its training programs **virtually**, according to ISED survey results.

Going forward, there is an opportunity to further increase reach and awareness of adMare BioInnovations' training programs at a national level.

According to ISED survey results from 71 trainee respondents, the top three most cited reasons for seeking to participate in a CDRD training program was the opportunity to receive mentorship and coaching; participate in a collaboration and network with the private sector; and the potential for career advancement. Interviews indicate that the creation of adMare BioInnovations is expected to allow for a more efficient and effective delivery of training programs to participants at the national level. Notably, adMare BioInnovations is building on the training programs established by the CDRD and documents suggest that there is an opportunity to continue to increase reach and overall awareness of the training programs across Canada, as indicated in the 2021 stakeholder survey which found a lack of stakeholder knowledge regarding the training programs.[102] This is supported by interviews which found that CDRD-affiliated university and research institutions, as well as CDRD spin-off and portfolio companies, had minimal knowledge of the CDRD's training programs and activities.

Findings

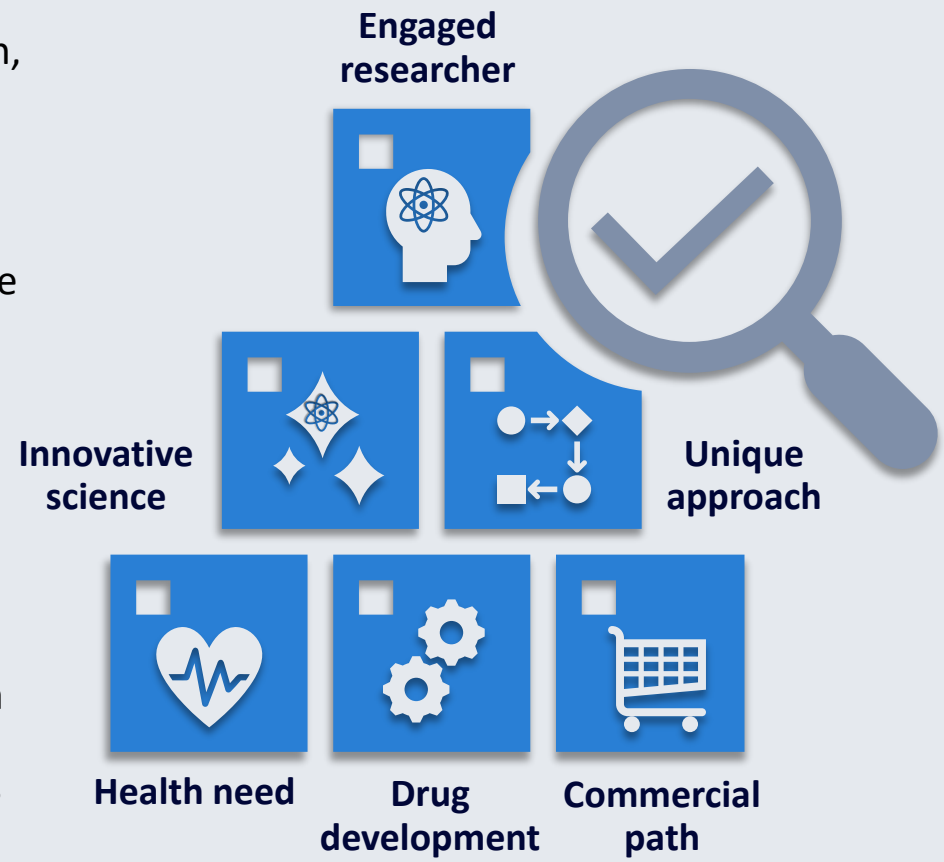
Relevance | **Performance** | Efficiency

Finding 5: In the last few years, the CDRD tightened its criteria for selecting drug R&D projects in line with its new strategic plan, resulting in a smaller portfolio of projects. The CDRD's R&D activities contributed to advancing promising opportunities and its refined approach to project selection helped to identify those with a greater potential to achieve commercialization.

The CDRD applied scientific, business, and commercial lenses to select opportunities that are most likely to reach the next stages of drug development and commercialization.

According to documents and interviews, the most critical step in the CDRD's process to advancing drug R&D was the identification, evaluation and selection of promising health research and early-stage technologies in academia and SMEs. The CDRD identified opportunities with high therapeutic and commercial potential, examining areas such as scientific excellence, IP potential, therapeutic area and prospects for future company creation. The CDRD's therapeutic focus was broad, covering oncology, neuroscience and 'opportunology' which refers to the CDRD's openness to projects in other therapeutic areas that it has not identified as an area of strategic focus.

The CDRD emphasized the selection of projects based on innovative science and an engaged researcher (i.e., Principal Investigator) who is committed to the project; highly differentiated approaches addressing unmet health needs; and a clear drug technology development and commercial path in which critical scientific experiments and commercialization steps can be defined.[103] As noted in interviews, the CDRD has increased the level of upfront work to assess the IP and commercialization prospects of potential R&D projects and may be seeking more de-risked technologies with shorter timelines to commercialization.



The CDRD used a **systematic** search to **identify** drug R&D opportunities.

Findings

Relevance | **Performance** | Efficiency

The CDRD executed scientific experiments to validate the potential of promising drug R&D projects and advance them towards commercialization.

According to documents and interviews, the CDRD designed and conducted scientific experiments in collaboration with its partners, thereby de-risking and advancing drug R&D projects. At the CDRD, all R&D project plans define key scientific milestones that must be achieved in order to continue developing the technology. Each project had unique milestones and the CDRD aimed to meet them as efficiently as possible to determine if there is a major scientific barrier that would preclude further development.[104] Data and documents indicate that these milestones provided information that influenced project progression including, but not limited to, the ability to validate and advance the drug technology; the quality of promising molecules; and the toxicity of a promising drug technology in animal models. This approach aligned with both literature and interview findings which indicate that the early identification of barriers is critical for R&D efficiency.[105] Notably, 9 of 14 Principal Investigators (64%) surveyed by ISED indicated that they found the CDRD's scientific and drug development support to be the most useful for advancing their project while 10 of 14 Principal Investigators (71%) were satisfied with the overall quality of the CDRD's services and support.

142

PROJECT MILESTONES ACHIEVED in 2017-18 to 2020-21

76

UNIQUE PROJECTS between 2017-18 and 2020-21

36%

of active projects **ADVANCED TOWARDS COMMERCIALIZATION**

While the most important milestones are "Go/No Go" decision points, documents and interviews suggest that completing other scientific testing milestones also adds value by generating experimental data and addressing scientific challenges that researchers may not have otherwise been able to address on their own. Interviews suggest that even if R&D projects do not advance to the next stage, they often produce tools and data that can be used or lead to new avenues of research. Across the portfolio of 76 active R&D projects from 2017-18 to 2020-21, the CDRD reached 142 project milestones, reflecting its ability to advance promising R&D projects. Documents and interviews also indicate that the CDRD engaged in a review of its project portfolio on an on-going basis, involving multidisciplinary reviews by both scientific and business personnel to ensure alignment with the CDRD's objectives. Of these 76 active projects, 27 (36%) advanced towards commercialization in at least one fiscal year. The CDRD, and now adMare BioInnovations, defines a project as advancing towards commercialization if it reaches a positive milestone.

Findings

Relevance | **Performance** | Efficiency

The CDRD reduced the number of active R&D projects in its portfolio, reflecting the organization's new strategy, and focused on applying a greater amount of resources to fewer, more commercially promising projects.

Documents indicate that the CDRD's selection process became more focused on commercialization potential since the launch of the organization's new strategy which called for a more targeted, focused and selective process. As noted by interviewees, increasing the level of commercial and drug development expertise throughout the CDRD has allowed the organization to bring in more commercially promising R&D opportunities. Of the CDRD's 76 unique R&D projects between 2017-18 and 2020-21, 52 projects (66%) were with non-industry partners such as universities, research institutes, and government organizations while 24 active projects (34%) were with industry partners, such as SMEs, spin-off companies and existing Canadian life science firms (see **Figure 4**).

Figure 4: Distribution of 76 unique projects based on industry (34%) and non-industry (66%) partnerships in 2017-18 to 2020-21

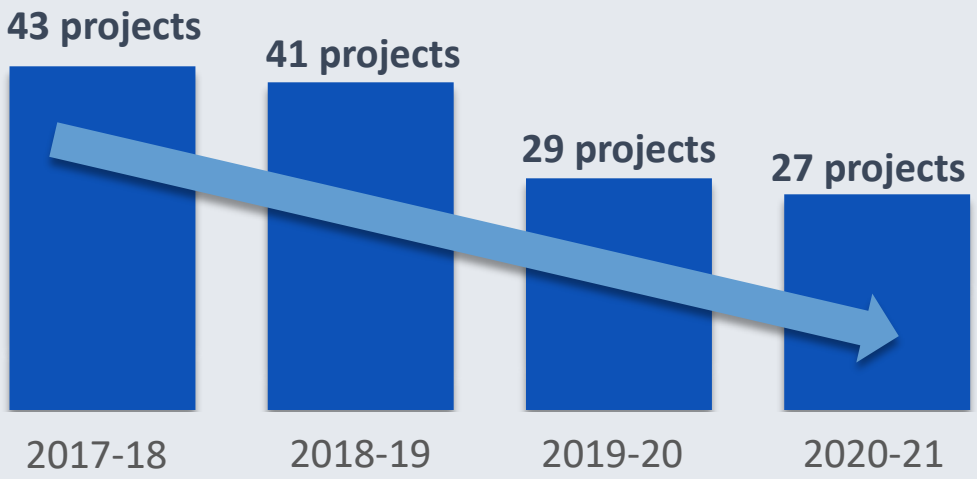


Figure 5: Total active CDRD projects decreasing from 43 in 2017-18 to 27 in 2020-21

The total number of active R&D projects in the CDRD's portfolio annually, which includes new projects launched as well as previous projects that span over multiple years, decreased from a high of 43 in 2017-18 to 27 in 2020-21 (see **Figure 5**). This trend in the project pipeline is consistent with the implementation of the CDRD's new strategy in 2018-19 which aimed to focus a greater level of effort and resources on fewer, more commercially promising R&D projects which is expected to lead to greater potential for value creation.

Findings

Relevance | **Performance** | Efficiency

Training

Drug R&D

Commercialization

A greater proportion of new CDRD R&D projects launched in the last two years were with industry partners (spin-off companies and Canadian SMEs) compared to the first two years of the evaluation period.

Of the 76 unique projects in the CDRD's portfolio, 25 projects were launched prior to the evaluation period with start dates between April 2008 and March 2017. As such, 51 new projects were launched during the evaluation period from April 2017 to March 2021. The data review found that fewer projects were launched in the last two years of the evaluation period compared to the first two years. Between 2019-20 and 2020-21, a total of 19 new projects were launched, relative to a total of 32 new projects launched from 2017-18 to 2018-19.

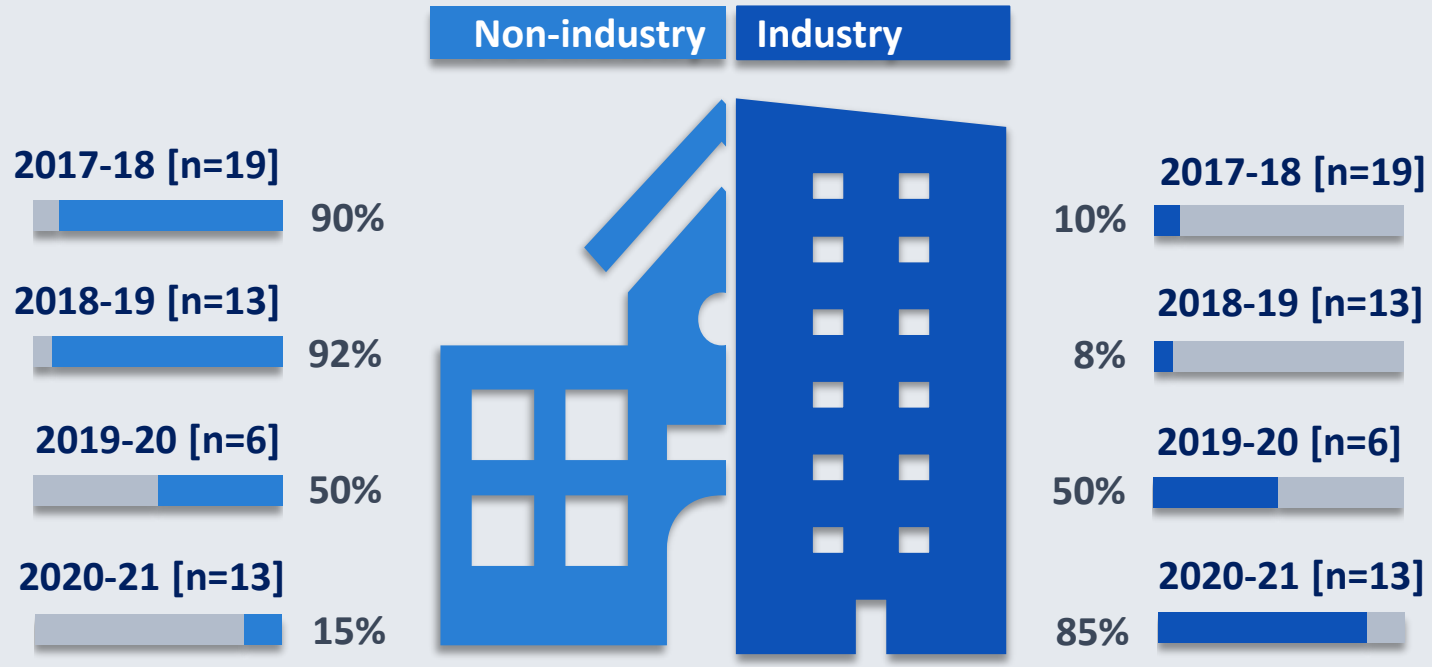
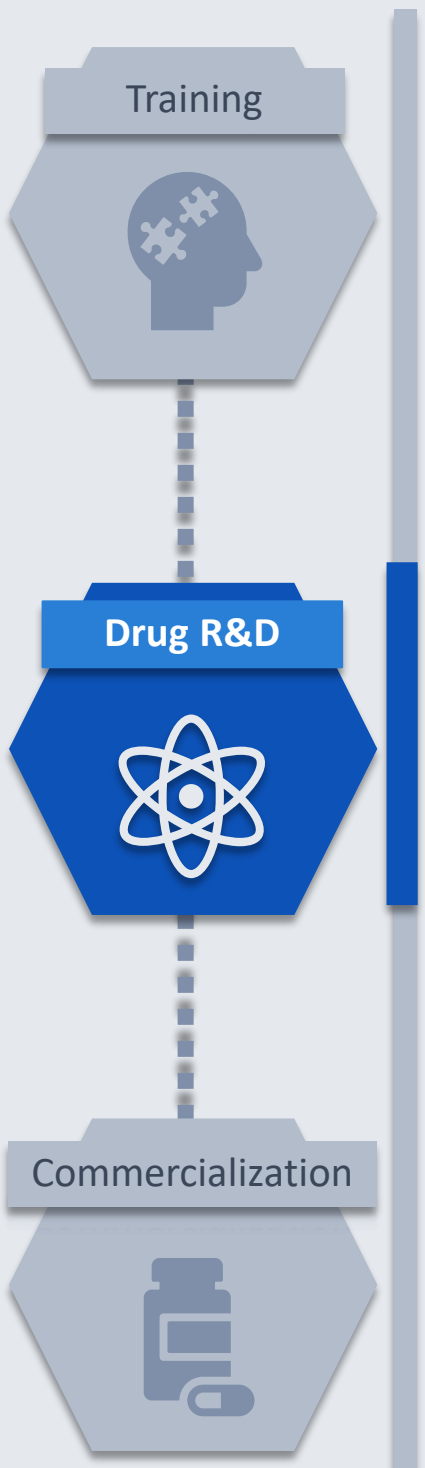


Figure 6: Non-industry (left) and industry (right) distribution of 51 total new projects launched in 2017-18 to 2020-21. The proportion of new projects from non-industry decreased from 90% in 2017-18 to 15% in 2020-21 while the proportion of new projects from industry increased from 10% in 2017-18 to 85% in 2020-21.

The data review also found that a greater proportion of new projects launched in the last two years were projects with industry as opposed to non-industry**.** For example, two new projects (10%) launched in 2017-18 were with industry partners compared to 11 new projects (85%) in 2020-21 (see **Figure 6**). In comparison, 17 new projects (90%) launched in 2017-18 were with non-industry partners (e.g., academia) compared to only two new projects (15%) in 2020-21. Documents indicate that the large increase in projects with industry was driven by the implementation of the CDRD's new strategy which focuses on building sustainable and scalable Canadian companies. As such, the CDRD continued supporting spin-off companies for their first few years following inception. Notably, 6 out of 11 new industry R&D projects in 2020-21 were associated with Abdera Therapeutics, one of the CDRD's most promising spin-off companies.

Findings

Relevance | **Performance** | Efficiency



Over the evaluation period, the number of companies that have accessed the CDRD's business support and services has increased with the creation of adMare BioInnovations.

In addition to engaging directly with existing life science firms and spin-off companies on collaborative R&D projects, data and interviews indicate that the CDRD continued to provide business development and intellectual property support throughout the evaluation period to companies, including Sepset Biosciences which is currently advancing a promising diagnosis test to identify sepsis in patients.

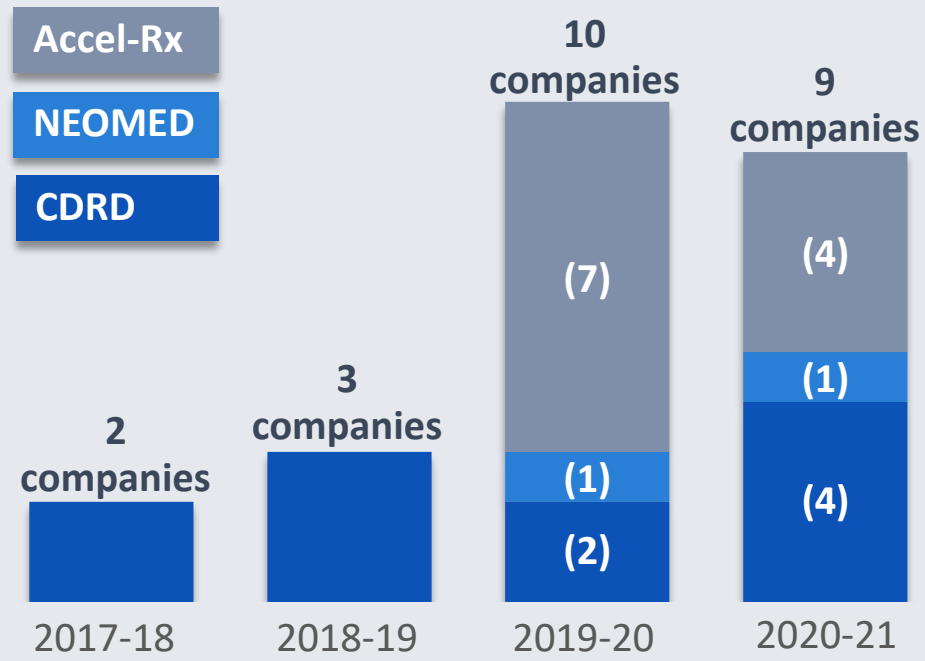


Figure 7: Total number of companies accessing CDRD business support from 2017-18 to 2020-21, with emphasis on the portfolio distribution by organization in 2019-20 and 2020-21, after the amalgamation of the CDRD, NEOMED and Accel-Rx to create adMare BioInnovations

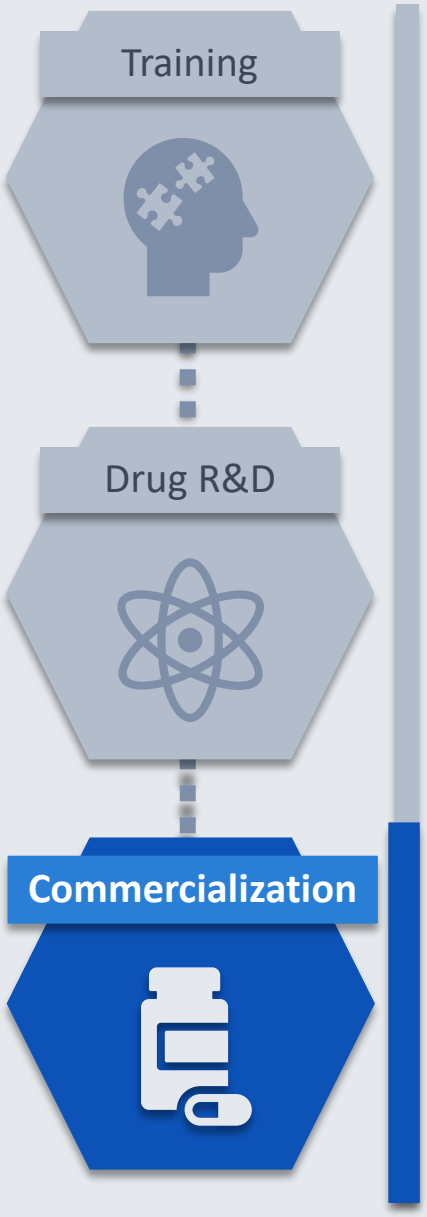
Following the amalgamation of the CDRD with the NEOMED Institute in May 2019 and Accel-Rx in January 2020 to create adMare BioInnovations, the number of companies accessing business support and services in the joined portfolios has expanded. For example, the CDRD had two companies access its support in 2017-18 compared to 10 in 2019-20, after the creation of adMare (see **Figure 7**). The data review and interviews indicate that companies initially under the Accel-Rx and NEOMED portfolios are now accessing the support and services of adMare.

Interviews explained that in one case, the CDRD assisted a Montreal-based company that was struggling to access investment, lacked expertise and capital to move their projects forward. The CDRD assisted this company to develop an attractive development plan for investors, identify key challenges preventing the drug technology's further development and generating a scientific data package required to attract further investment. In another case, the CDRD was instrumental in conducting early-stage chemistry to identify a company's lead product candidate which helped them to attract further investment.

Findings

Relevance | **Performance** | Efficiency

Finding 6: The CDRD supported the launch of start-up companies, as well as supported existing companies in Canada's life sciences sector that are developing drug products with potential future health benefits to Canadians. These companies are at different stages in the drug R&D process, with the most advanced being in pre-clinical and clinical development.



The CDRD was effective in generating intellectual property and providing researchers with scientific and commercial expertise to help create start-up companies.

Given the long timelines associated with drug development, literature indicates that various activities, including for example, the application and registration of patents, launching new spin-off companies, and continuing to advance promising products through the various stages of drug development are indicative of progress on the path to drug commercialization. Generating new patents with the CDRD as a co-inventor demonstrates the scientific expertise of the organization in developing novel technologies, and also contributes to its ability to generate financial value to the organization. Over the evaluation period, data suggests that adMare BioInnovations submitted a total of 57 patent applications, with 36 applications (63%) attributable to CDRD projects and 21 applications (37%) attributable to the NEOMED Institute's portfolio (see **Figure 8**).

Documents and interviews indicate that generating, developing and managing intellectual property was critical to the CDRD's success and ability to build companies. An academic stakeholder based in Quebec noted that the CDRD's scientific and patenting expertise was instrumental in advancing research from their institution that eventually led to the launch of a new spin-off company. Interviews also suggest that the CDRD's support and services were particularly useful for early-stage companies seeking to advance their technologies, but more mature companies are less likely to require its assistance. Overall, interviews and documents indicate that the CDRD's ability to develop and accelerate promising opportunities improved with the adoption of the Venture Partner model. Also, ISED surveys found that 45 of 70 trainee and Principal Investigator responses (64%) indicated that the CDRD has improved the advancement of Canadian drug R&D towards commercialization.

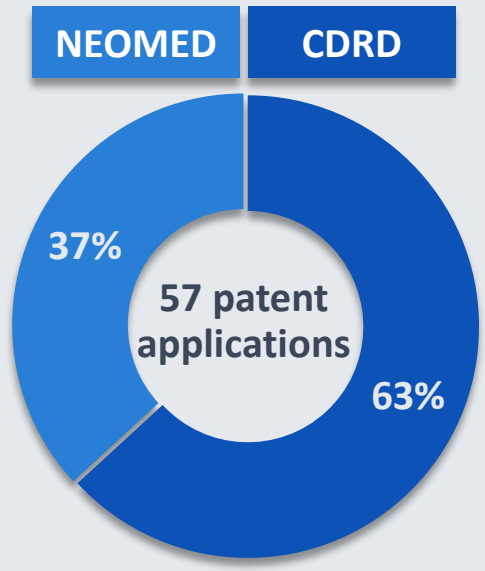
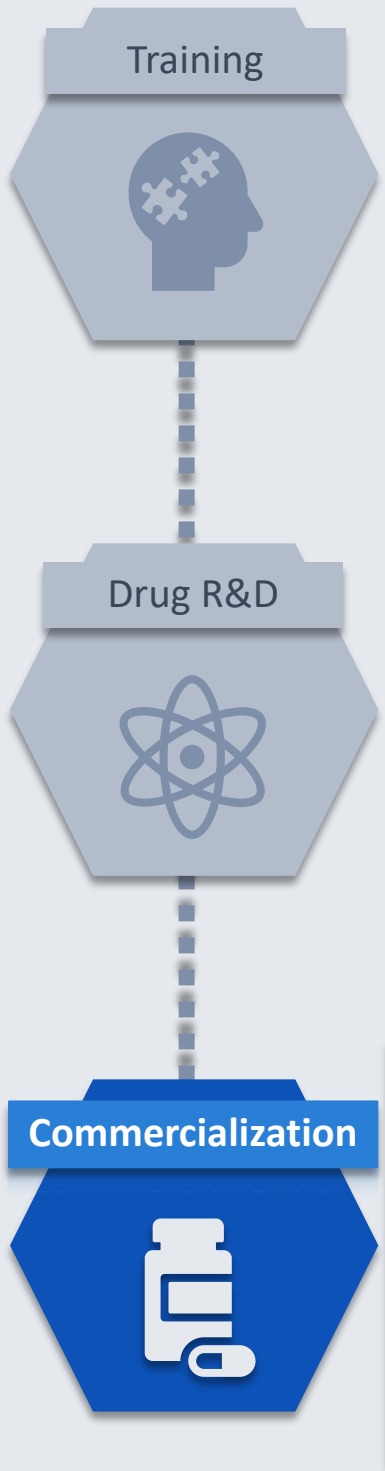


Figure 8: Proportion of new patent applications submitted by the CDRD (63%) and NEOMED (37%) as a percentage of 57 total adMare BioInnovations' patent applications.

Findings

Relevance | **Performance** | Efficiency



The CDRD was effective in launching and supporting start-up companies to help accelerate the commercialization of drug R&D.

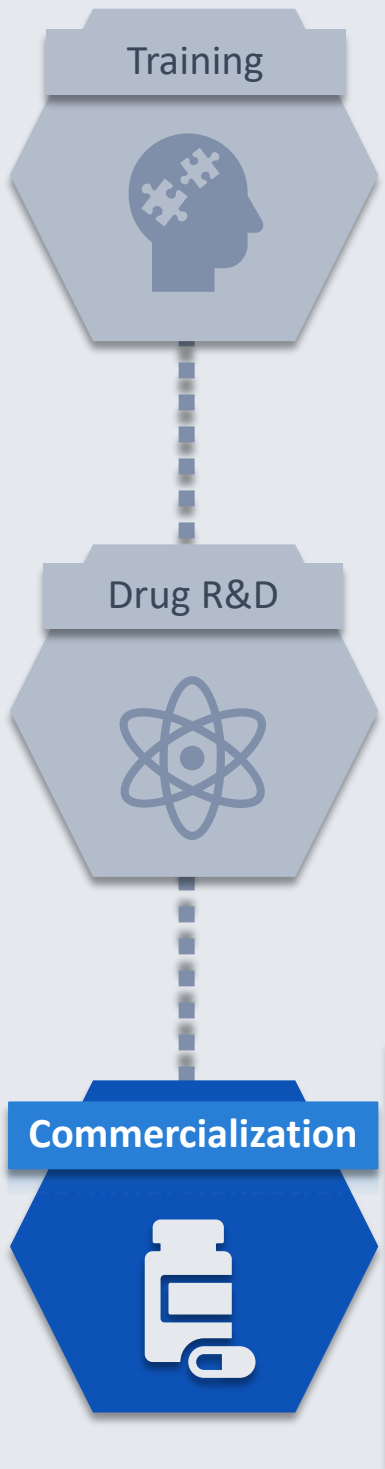
Interviews indicate that the CDRD provided academia and small biotechnology companies with access to the scientific, business and commercial expertise as well as infrastructure needed to advance technologies. Interviews also suggest that the CDRD's support and services were particularly useful for early-stage companies seeking to advance their technologies. For example, a small Canadian drug discovery company noted that the CDRD was instrumental in helping validate its molecules in its unique labs, a capacity that the company did not have by virtue of its small size and in-house capabilities. This company noted that without the CDRD, it would have had to partner with a contract research organization, thereby increasing costs. While interviews suggest that mature companies are less likely to require CDRD's scientific and commercial expertise, these firms benefited from access to CDRD's infrastructure, laboratory space and equipment which is limited in Canada and a significant need for life sciences companies.

Documents and interviews indicate that in line with its new strategy, the CDRD's primary objective, particularly under adMare BioInnovations, focuses on launching and building scalable companies that can grow in Canada and advance promising drug technologies to market. In contrast to licensing technologies, the creation of spin-off companies is viewed as a more diversified and near-term opportunity to generate financial returns, and therefore the best means to generate value for CDRD. Rather than highlighting examples of specific drug R&D projects, nearly all interviews referred to drug products currently being advanced by CDRD spin-off companies and existing life science companies that it supports as evidence of its effectiveness in selecting and accelerating promising technologies. Between January 2020 and January 2021, the CDRD's support led to the creation of four spin-off companies with promising technologies capable of addressing unmet health needs in four unique therapeutic areas: 1) **Neurasic Therapeutics**, 2) **Find Therapeutics**, 3) **Abdera Therapeutics**, and 4) **Forus Therapeutics**. According to interviews, CDRD Venture Partners and private venture capital partners were involved in the launch of these four start-up companies, reflecting their commercial potential and the CDRD's focused engagement with this stakeholder group. The CDRD continues to support the advancement of these four start-up companies through collaborative R&D projects, access to scientific services and facilities, and by providing expertise as well as recruiting executive-level talent to lead newly formed start-up companies.

Members of the **CDRD management** team serve as interim Chief Executive Officers (CEOs) and Board Members of CDRD **spin-off and portfolio companies**, addressing the need for executive-level talent to grow early-stage firms.

Findings

Relevance | **Performance** | Efficiency



There are new CDRD spin-off companies with promising drug technologies capable of addressing unmet health needs. Although in the early stages of development, these companies have significant potential to scale.

Neurasic Therapeutics focuses on developing drug therapies that help patients with chronic pain conditions. The CDRD identified, validated and advanced Canadian academic research from McGill University which led to a method to identify promising molecules that could reduce the need for opiate-based drugs in addressing chronic pain conditions. These validation activities drew in early-stage venture capital partner AmorChem.

Find Therapeutics is a drug discovery and development company dedicated to developing therapies against rare diseases, with an initial focus on inflammatory and fibrotic diseases of airways, the liver and gastrointestinal systems. The company aggregates technologies developed from PeptiMimesis Pharma and Domain Therapeutics, creating a unique drug discovery engine and has attracted Canadian venture capital partner, CTI Life sciences.

Abdera Therapeutics is a precision oncology company focused on developing novel antibody-based therapeutic products that target and destroy cancer cells. Prior to launch, CDRD R&D projects and expertise in radiotherapeutics advanced the company's underlying IP and technology. The CDRD attracted founding partner AbCellera Biologics, a Vancouver-based biotechnology firm, to leverage its antibody discovery platform that will enable the company to develop new cancer therapies that target tumor cells and spare healthy ones.

Forus Therapeutics advances novel medicines for different forms of cancer. It differs from a traditional drug start-up company model which begins with early research leading to a new product. In contrast, the company aims to commercialize an existing cancer medicine for adults with Multiple Myeloma and Lymphoma in Canada. Forus secured an exclusive Canadian distribution agreement with Karyopharm Therapeutics Inc., a US pharmaceutical company, for the commercialization of XPOVIO® and is seeking approval from Health Canada to deliver a novel cancer treatment to Canadians.

Findings

Relevance | **Performance** | Efficiency

The pipeline of opportunities currently being advanced under the broader adMare BioInnovations portfolio is promising, with the potential to yield significant health benefits.

Under adMare BioInnovations' nine clinical development programs, the CDRD is associated with: 1) **Zucara Therapeutics**, 2) **Sepset Biosciences** and 3) **Kairos Therapeutics (Zymeworks)**, while the remaining six are associated with companies originating from Accel-Rx and the NEOMED Institute with stages ranging from Phase I to Phase II clinical trials. For example, in 2020-21, Inversago, an Accel-Rx portfolio company focused on developing treatment options for patients with metabolic conditions, conducted a Phase I clinical trial for INV-101, a potential therapeutic to address Prader-Willi syndrome. In addition, Bellus Health, a NEOMED Institute portfolio company continued to advance its BLU-5937 chronic cough product through Phase II clinical trials throughout 2020-21.

Interviews suggest that many of the CDRD's commercialization outcomes (e.g., spin-off launched; former spin-off company technologies continuing to advance) may not have occurred or would not have advanced as quicky to their current stage without the CDRD. Interviews suggest that although Canada's life science sector does not currently have an *anchor company*, which is an innovative, high-impact firm that plays a key role in incubating other businesses and has at least $1 billion in annual revenue, Canadian companies associated with the CDRD, such as Zucara, Zymeworks and Abdera, have the potential to become one.[106] Due to their size and spending on R&D, anchor firms can help to create or transform other firms in the life sciences sector by sharing expertise and engaging in knowledge transfer.

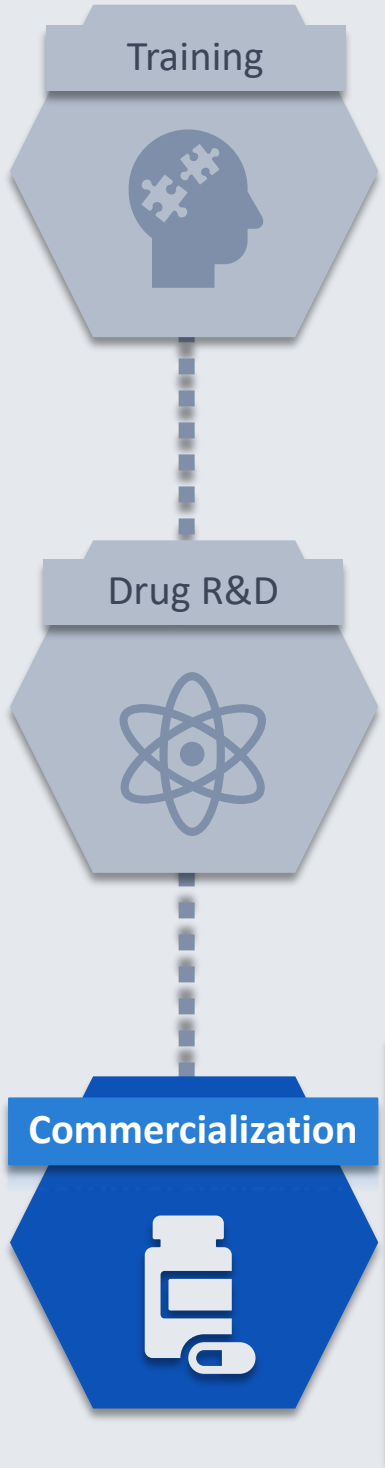
In addition to directly launching spin-off companies, documents and interviews suggest that the results of the CDRD's collaborative R&D projects have been used by its partners to launch new companies. For example, upon completing a collaboration with the CDRD in 2018-19, a researcher at the University of British Columbia launched CoMotion, a company focused on developing therapeutics to manage severe bleeding from surgery and trauma. Overall, interviews and documents indicate that no CDRD spin-off or supported company has advanced a new drug to market for use in the clinic. However, CDRD-supported companies have continued to advance products through the next stages of development.

3

of nine clinical development programs in adMare BioInnovations' portfolio that are advancing potential **new drug products** through the various stages of **clinical trials** are associated with CDRD spin-off companies.

Findings

Relevance | **Performance** | Efficiency



Within the CDRD portfolio specifically, its former spin-off companies are preparing for or advancing through to clinical trials.

Zucara was launched in 2016 through a collaboration with academic researchers and MaRS Innovation. This company is focused on developing a novel therapeutic to prevent low blood glucose levels in Type 1 diabetic patients that use insulin. The CDRD played a key role in conducting early stage R&D for Zucara's ZT-01 drug candidate, and provided Zucara with drug development expertise, access to laboratories and infrastructure. Zucara secured US$21M in financing from a U.S. based venture capital fund to support its clinical trials and Phase I was launched in September 2020. Most recently, Zucara announced that it will be developing a model to expand ZT-01 to Type 2 diabetes.

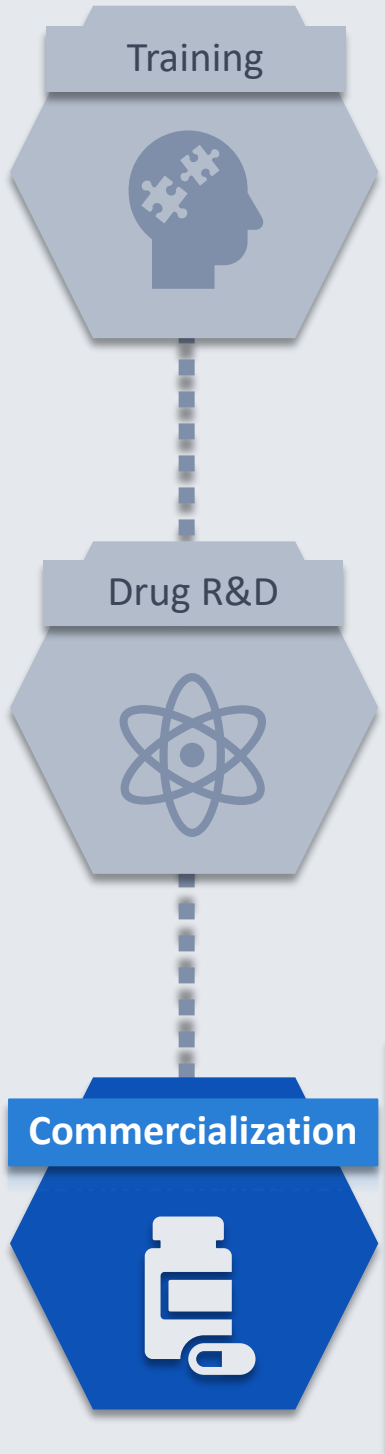
Kairos Therapeutics is a CDRD spin-off company that developed a novel antibody-drug conjugate platform technology. Kairos Therapeutics' platform attracted interest from BC-based Zymeworks who was searching to enhance their pipeline of potential cancer products. As such, Zymeworks acquired Kairos Therapeutics in 2016.

Zymeworks is advancing a novel anti-body drug conjugate to treat various forms of cancer. The company acquired Kairos Therapeutics, resulting in the creation of Canada's largest biologics company at the time, and the potential for significant financial returns for CDRD. In 2018-19, it entered Phase I clinical trial for its ZW49 product which is based on Kairos Therapeutics' antibody-drug conjugate platform technology. Zymeworks has also attracted $890M in additional investment over the evaluation period, partially based on Kairos' platform technology.

Sepset Biosciences is a biotechnology company developing a novel test for the rapid and early diagnosis of sepsis, a major global health challenge. The results of initial studies showed promise and the company is now in the process of preparing for larger multi−centre, multi−country trials. The CDRD provided management services, seed capital and patenting expertise to this company and continues to be a source of business development and intellectual property support as the company continues to advance.

Findings

Relevance | **Performance** | Efficiency



The CDRD has also supported existing life sciences companies in an effort to retain business operations in Canada and grow the country's health innovation ecosystem.

Overall, documents, data and interviews were unable to identify a CDRD-supported project or company that has advanced to the stage of achieving market approval for a drug currently being used by patients. Moreover, ISED survey results found that 34 of 85 participants (71 trainees and 14 Principal Investigators), or 40%, indicated that it was either too early to assess or that they did not know the extent to which the CDRD has produced drug technologies that have yielded health benefits and improved health outcomes. However, interviews explained that the drug development process is long-term and many promising products associated with the CDRD have continued to advance over the last five years at various stages. Many interviews explained that the CDRD's pipeline of drug candidates are still in the early stages of development which can be partially explained by the fact that drug development overall takes a long time to advance products to the stage of becoming an approved drug. In terms of future prospects, CDRD management noted that the organization expects more products to reach market within the next five years. Interviews and documents indicate that overall, adMare BioInnovations portfolio companies have created over 900 new jobs, cumulatively.

Literature and interviews indicate that Canada faces challenges in retaining promising Canadian life sciences companies despite a successful record in creating new start-up health and biosciences firms. For example, the Canada Health and Biosciences Economic Strategy Table emphasized the importance of scaling up Canadian firms to prevent their acquisition by foreign entities. Notably, in Quebec, eleven life sciences companies valued in excess of $250 million have been acquired by mostly U.S.-based foreign entities. Data indicates that over the evaluation period, the total number of Canadian life sciences companies that have either participated in a R&D collaboration with the CDRD, accessed its businesses development or IP expertise, or received investment from the CDRD and currently maintain operations in Canada has increased from 12 in 2017-18 to 25 in 2020-21. Overall, the CDRD has been effective at accelerating the commercialization of drug R&D by providing infrastructure, scientific and commercial expertise, creating attractive scientific data packages, acting as a source of IP support and expertise, launching spin-off companies, and recruiting talent for them to help retain operations in Canada.

25

companies that **maintain operations in Canada** as of 2020-21 have received R&D, intellectual property, business development, or financial support from the CDRD; a result that **more than doubles** what was observed in 2017-18.

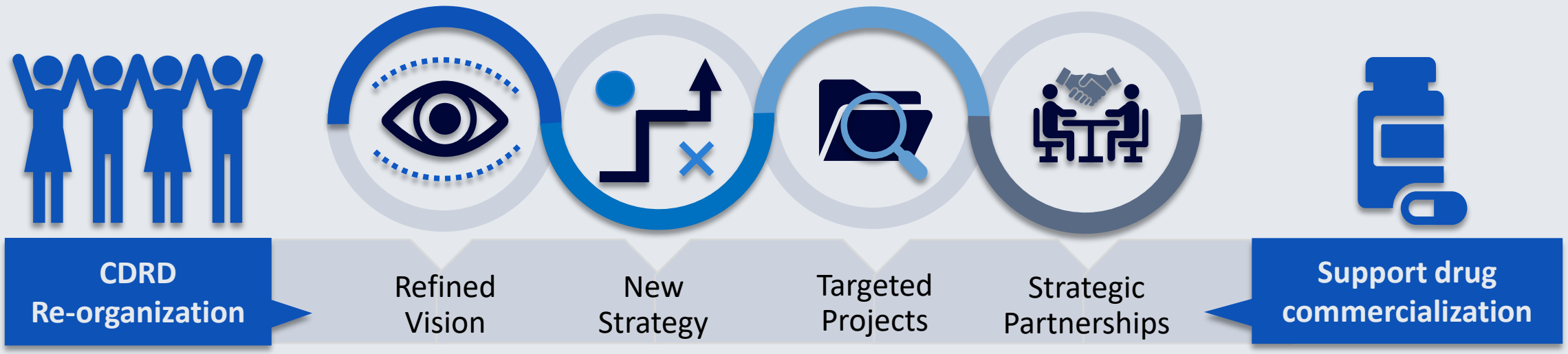
Findings

Relevance | Performance | **Efficiency**

Finding 7: The CDRD undertook an operational re-organization to improve the effectiveness and efficiency of its program delivery, which includes the translation of drug R&D and company building activities. The CDRD model can be an efficient approach to achieving self-sustainability, but it is highly dependent on its spin-off and portfolio companies achieving commercial success, which to date is limited given the nature of drug development and Canada's health innovation ecosystem.

Over the evaluation period, the CDRD made significant changes to its delivery model to better align with its overarching objective of supporting the commercialization of drug R&D and improve efficiency.

The CDRD's operational reorganization included improving its drug R&D project strategy through more proactive and focused outreach efforts, a smaller portfolio of projects, and the addition of scientific leaders with experience spanning drug development through to commercialization. The main impetus for this shift was to better support the growth of the Canadian life sciences ecosystem and to ensure continued progress towards self-sustainability for the organization which was unlikely under the previous CDRD model. While some interviewees expressed concerns with the shift towards more targeted projects, many explained that as CDRD spin-off companies mature, it may be natural for the CDRD to shift its resources and support these activities accordingly given the commercial potential of the drug products being developed.



The CDRD's **re-organization efforts** to support drug commercialization included **four key components**.

Findings

Relevance | Performance | **Efficiency**

The CDRD has been increasingly focused on developing efficient partnerships that can provide resources such as financial and intellectual capital to help the organization in achieving commercial outcomes.

Documents and interviews indicate that in the CDRD's early days, it focused a significant amount of effort on building partnerships with many industry, academic and government stakeholders. Although these partnerships helped the CDRD to establish visibility and credibility, many did not generate desired outcomes for the organization. For example, while major global pharmaceutical companies were initially regarded as promising partners for advancing early-stage technologies incubated by the CDRD to the next stages of development, it became clear that the ability of these companies to do so was unproven. The CDRD and global pharmaceutical partners allocated resources to create an "innovation fund" to support collaborative drug R&D projects, providing the pharmaceutical industry with access to promising research. However, many of these funds remained unused due to a lack of opportunities deemed beneficial to both parties. For example, one interviewee representing a global pharmaceutical company noted that the CDRD technologies were at too early a stage for their company to be interested. Rather, this company engages Canadian academics and SMEs directly. To improve efficiency of its delivery model, and in line with the CDRD's strategic plan, interviews indicate that the CDRD has increasingly focused on fostering multi-year partnerships and strengthening connections with venture capital firms who are more likely than global pharmaceutical companies to provide risk capital.

According to interviews, **strategic partnerships** are important steps towards commercialization given the **focus on company creation** which is regarded as the most likely means **towards self-sustainability**.

Documents and interviews indicate that the successful commercialization of a single drug, through strategic partnerships, may generate significant financial return with the potential to transform an organization. The trajectory of LifeArc, a UK-based medical research charity with a similar objective to support the translation of basic research, suggests that the CDRD's partnership model has the potential to generate significant financial returns. LifeArc played a critical R&D role in advancing drug development activities that eventually led to Keytruda, a highly lucrative prescription medicine used to treat melanoma. In 2016, LifeArc secured its medium-term financial future by selling a portion of its royalty income in Keytruda for £115.6M and in May 2019, it completed the monetization of royalties, generating £1.29B in revenue for LifeArc.[107] Although this single commercial transaction provided significant financial gain, an interviewee with background into this product's development, noted that R&D activities had begun in 2006 and that the benefit was not realized until 2018. According to this interviewee, this example reflects the importance of patience and a long-term perspective in drug research and development.

Findings

Relevance | Performance | **Efficiency**

The public-private partnership is effective in supporting the commercialization of drug R&D in Canada. However, there are concerns regarding whether the CDRD can achieve self-sustainability in the short-term.

Overall, interviews suggest that the public-private funding model is effective for supporting drug research, development and commercialization in Canada. Interviews found no alternative funding model that could be as effective and highlighted that the public-private funding model is effective for the following reasons:

Investor Incentives: Public investment is effective in creating incentives for later-stage investors because high-risk drug R&D is partly de-risked through government funding.

Federal Role: The perceived role of the federal government is to provide funding to organizations like the CDRD that use their expertise to select and advance promising technologies.

Funding Gap: The private sector would be unlikely to fill the funding gap for early-stage R&D which is significantly risky. The CDRD fills a gap in early-stage funding which must be met before products can be advanced to a stage to attract investors.

Interviews also suggested that the public-private model is particularly necessary in Canada because the sector lacks a sufficiently high level of private funding and is relatively small compared to advanced markets such as those in the United States. In contrast to programs such as the Strategic Innovation Fund which could provide support to drug development companies, the CDRD is seen as providing a broader suite of services and support to accelerate commercialization. Notably, many interviews highlighted the important role of the NRC's Industrial Research Assistance Program (IRAP) in helping early-stage life science companies advance. For example, Zucara Therapeutics, a CDRD-spinoff company advancing its ZT-01 drug candidate through clinical trials has accessed NRC IRAP funding and advisory services and a Mitacs Accelerate Fellowship grant to support pre-clinical development.[108] Interviews found that stakeholders are supportive of the public-private funding model, and questioned the expectation that organizations such as the CDRD become self-sustainable in the short-term. For example, interviews noted that federal government funding to the CDRD provides companies with confidence that they can engage with the CDRD and assurance that the organization can continue to deliver its activities and objectives.

Findings

Relevance | Performance | **Efficiency**

The ability to secure equity in promising spin-off and portfolio companies is a key element of the CDRD's approach to achieving self-sustainability.

Documents and interviews suggest that the CDRD secured equity in companies through its commercialization arm, known as CDRD Venture Inc. (CVI). Given the CDRD's not-for-profit status, CVI enabled the CDRD to capture any value or financial gain from its investments and drug R&D activities. CVI holds assets and investments that aim to generate profitable returns that can fuel the CDRD's long-term self-sustainability. CVI helped the CDRD retain its position in the value it has created by supporting companies with additional capital and connecting them to investors.

One of the CDRD's most successful outcomes was the merger of its spin-off company, Kairos Therapeutics, with Zymeworks. The equity CVI/CDRD earned in that transaction grew in value as Zymeworks continued to build its portfolio and partnerships. The profits earned from selling equity in Zymeworks were re-invested into the CDRD to support further activities. Interviews indicate that under adMare BioInnovations the organization negotiated with BELLUS Health, a promising clinical stage company from the NEOMED Institute's portfolio, to convert a future back-end royalty license into current liquid equity. adMare later sold shares in Bellus Health for a significant profit. Interviews also indicate that the CDRD holds equity in other promising companies such as Zucara Therapeutics and in the event that the company successfully commercializes its ZT-01 therapeutic, the CDRD would be able to sell its shares for revenue. Interviews indicated that the CDRD is also entitled to various milestone payments as the drug process through clinical development and a royalty on future sales. As such, it is clear that this model of sustainability relies on CDRD spin-off companies continuing to advance technologies through the next stages of the drug development and commercialization process.

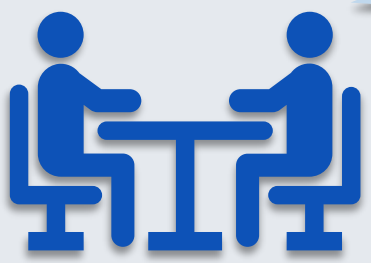
Findings

Relevance | Performance | **Efficiency**

There is a lack of common understanding regarding the definition of self-sustainability and the approach for the CDRD to achieve this goal.

Interviews with SMEs that have made use of the CDRD's infrastructure and scientific expertise noted that the self-sustainability goal for the CDRD may not be realistic given that the organization focuses on the riskiest, earliest and most challenging stages of commercialization where investors lack interest. Interviews with stakeholders also noted that the CDRD's goal of achieving self-sustainability resulted in the CDRD placing emphasis on acquiring substantial shares in a company or intellectual property in exchange for services during negotiations with SMEs who are interested in partnering with the CDRD. As a result, interviews indicated that the focus on achieving self-sustainability can risk potential partners being less engaged or hesitant to enter into collaborations with the CDRD. For example, one technology transfer office noted that their university no longer presents the most promising research to the CDRD because it aims to capture a significant share of potential profits. In addition, a company that previously received services and support from the CDRD decided to access them elsewhere due to the CDRD's strong approach to negotiating intellectual property agreements, which is viewed as being necessary in order to move towards self-sustainability.

Interviews and documents show a lack of consensus regarding the definition and expectations concerning the CDRD's self-sustainability. For example, the CDRD's 2017-18 Corporate Plan indicates that the organization aimed to reach self-sustainability, defined as a level of commercial revenue that could sustain the CDRD without subsequent public-sector support, by 2023.[109] However, in 2019, strategic planning documents indicate that the definition of self-sustainability had shifted to an objective to demonstrate that the CDRD is on track to achieve a 70:30 private to public funding ratio by 2026.[110] These documents also indicate that the CDRD's government funding partners have not yet clearly defined expectations regarding self-sustainability or developed metrics to assess the CDRD's progress towards this objective. Interviews with several stakeholder groups, including some from CDRD management, explained that the CDRD's ability to track and report on progress towards self-sustainability is dependent on its definition with some questioning if this meant independence from ISED funding or all public sector funding. Furthermore, some interviews noted that some aspects of program delivery, such as training activities, serve a broader benefit to the health innovation ecosystem and are unlikely to generate a financial return.



Recommendation 2: ISED's Science and Research Sector should engage with adMare BioInnovations to better understand the organization's metrics and plan towards self-sustainability.

Findings

Relevance | Performance | **Efficiency**

Finding 8: ISED funding to the CDRD was effective in attracting funding from other sources, thereby sharing the risk associated with commercializing drug R&D. The CDRD generated project and commercial revenue via the CVI. Its spin-off and portfolio companies experienced growth in private sector investments, highlighting in part their potential for commercial outcomes.

The majority of ISED funding to the CDRD was allocated to advancing drug R&D projects, creating companies to support commercialization, and providing training.

Since 2007, the CDRD received a patchwork of public and private sector support including funding from the Canada Foundation for Innovation (CFI), the BC provincial government, Western Economic Diversification Canada, the Michael Smith Foundation for Health Research and from industry partners such as GlaxoSmithKline, Pfizer, Merck, and Johnson & Johnson. Most notably, prior to entering into its first funding agreement with ISED, the CDRD received $23M from 2008-09 to 2018-19 from the Centres of Excellence for Commercialization and Research (CECR) program. In total, prior to ISED funding, the CDRD received $37M in federal funding. Budget 2016 provided the CDRD with $32M over two years followed by Budget 2018 funding of $48M over two years beginning in 2019-20. Most recently, Budget 2021 extended funding for the CDRD through adMare BioInnovations at $92 million over four years, beginning in 2021-22 and ending in 2024-25. Data indicates that over the evaluation period, from 2017-18 to 2020-21, the CDRD received $67.3M in funding from ISED to support its activities in drug technology advancement, company creation and growth, training, and operations and maintenance. Of these funds, the CDRD allocated $57.5M (85.4%) towards advancing drug R&D projects, creating companies, and providing training, which is in line with the ISED funding agreement (see **Figure 9**).

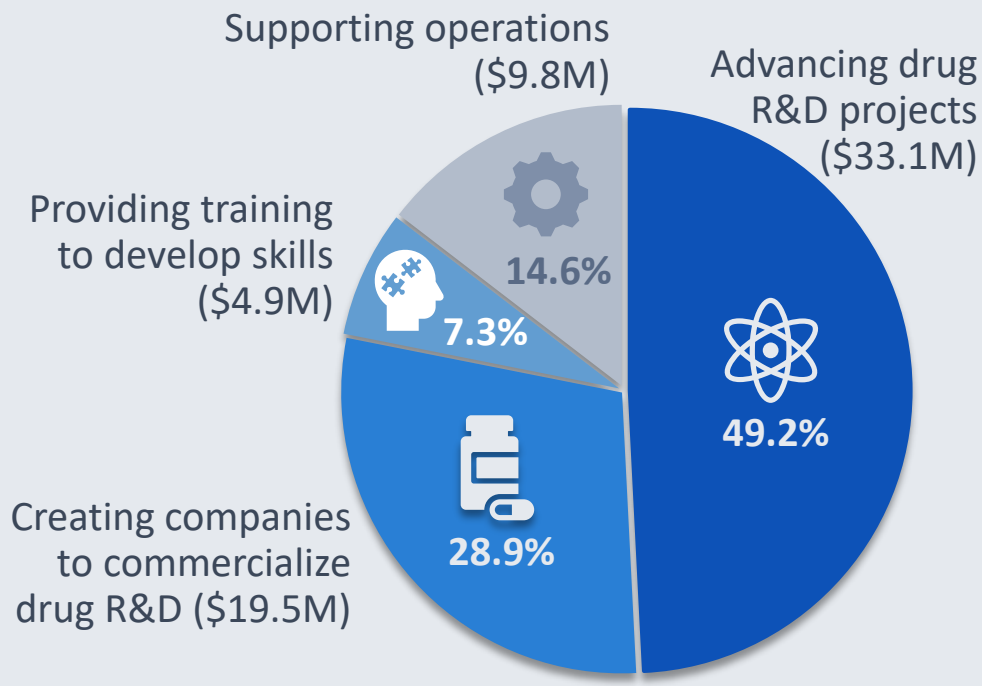


Figure 9: Distribution of ISED funding ($67.3M) based on CDRD activities from 2017-18 to 2020-21, with emphasis on direct costs in blue colours.

Interviews indicate that ISED funding increased the CDRD's ability to secure financial support from other players, including private sector partners such as pharmaceutical companies who consider federal support a key factor in de-risking investments in early-stage opportunities. ISED funding is perceived by stakeholders as an anchor by helping to demonstrate longevity and commitment to potential partners which is critical for attracting funding. The 2017 evaluation of the CECR program noted a similar observation that federal funding to Centres extends beyond financial support by serving as a catalyst for other partners to participate.[111]

The CDRD attracted financial support from other sources as well as generates project and commercial revenue via the CVI.

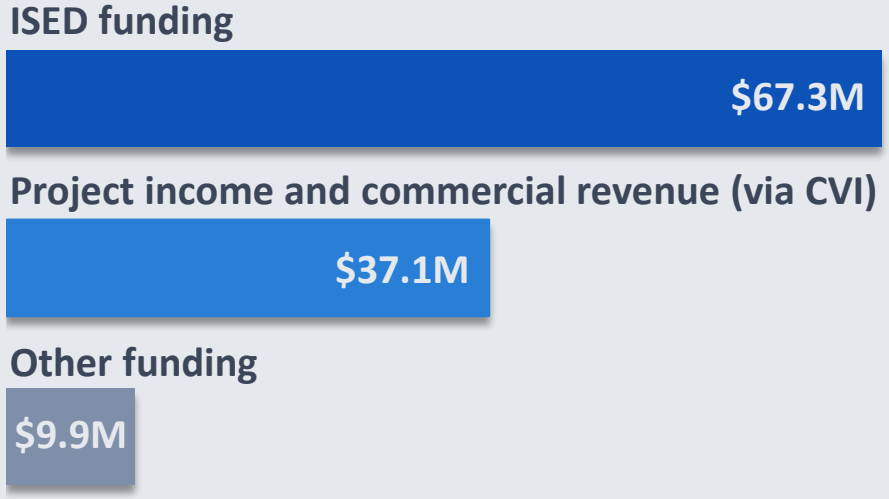


Figure 10: Distribution of the CDRD's financial sources from 2017-18 to 2020-21 totaling $114.3M, with ISED funding representing 58.9% of this total.

In addition to ISED funding of $67.3M, over the 2017-18 to 2020-21 time period, the CDRD generated $46.9M in revenue consisting of: income from R&D projects; profits from selling shares in the CDRD portfolio and spin-off companies; and licensing revenue ($37.1M); and other industry and non-industry funding sources for project and non-project costs ($9.9M) (see **Figure 10**). Other funding consisted of industry funding from global pharmaceutical companies such as Pfizer, Merck and GlaxoSmithKline, while non-industry funding sources were obtained from the Canadian Institutes of Health Research, the National Research Council's Canada Accelerator and Incubator Program, Genome BC, the Canadian Cancer Society and others. Although financial data indicates that the CDRD generated revenue from commercial activities associated with its portfolio companies, interviews indicate that these funds generated via the CVI have been reinvested back into the CDRD to support its continued growth and activities, rather than being used to build an investment fund capable of generating enough interest to cover operating expenses.

Data suggests that based solely on project income[112] and commercial revenue ($37.1M), the CDRD would not have been able to meet its $68.4M in expenses incurred over the evaluation period consisting of lab, project, administrative and other costs.[113] As such, ISED funding is critical for the CDRD to deliver its activities. Most notably, approximately 61% of project and commercial revenue ($22.7M) was generated from the sale of the CDRD's equity in Zymeworks (Kairos), a clinical stage portfolio company that has raised $890M in private capital over the evaluation period and is considered to be the CDRD's most successful commercial outcome. The CDRD noted that the most likely path towards achieving financial sustainability is through gains generated from equity in spin-off companies.[114] Company creation provided the CDRD with various options including continuing to raise risk capital, pursuing a merger and acquisition with other companies, or licensing.[115] Historical data shows that since Zymework's acquisition of Kairos Therapeutics, Zymework's price per share has increased overall, representing significant potential financial gain for CDRD.

61%

of all project and commercial revenue, or $22.7 of $37.1M, from 2017-18 to 2020-21 represents the **sale** of the CDRD's **equity** in Zymeworks (Kairos), via the CVI.

Findings

Relevance | Performance | **Efficiency**

The CDRD assisted its spin-off and portfolio companies in securing financial support which steadily increased over the evaluation period, demonstrating the commercial potential of these companies.

Furthermore, data indicates that 16 CDRD spin-off and portfolio companies (see ***Company List***) secured total private capital investments equal to approximately 19 times that of ISED's funding of $67.3M, or $1.3B, over the evaluation period (see **Figure 11**).[116] The steady increase in total capital investments reflects in part, the potential of these companies to achieve commercial success. Notably, 80% of total private capital was raised by Zymeworks (Kairos) ($890M) and Bellus Health ($156M) with the remaining 17% ($217M) in private capital divided among 14 companies. As indicated in interviews and documents, Zymeworks (Kairos) represents one of the CDRD's most successful commercial outcomes and this is clearly reflected in the ability of the company to raise nearly one billion dollars in capital. The CDRD's overall role in assisting these companies to secure private capital is dependent upon its unique relationship with each firm.

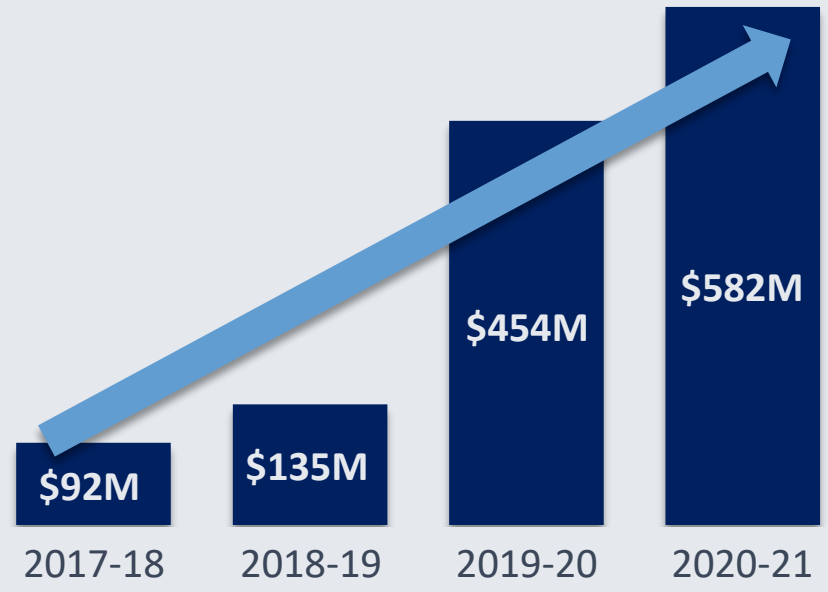


Figure 11: Private capital secured across 16 CDRD spin-off and portfolio companies increasing from $92M in 2017-18 to $582M in 2020-21, with a grand total of $1.3B.

Company List

Zymeworks (Kairos)
BELLUS Health
Inversago
Zucara
Artelo
Kisoji
Bright Angel Therapeutics
Eupraxia
Forus
Flosonics
Find Therapeutics
Neurasic Therapeutics
ARNA Therapeutics
Mesentech
Precision Nanosystems
Sitka

Interviews and CDRD stakeholder surveys indicate that given the long timelines and significant risk associated with drug R&D, it may be unrealistic to expect the CDRD to achieve self-sustainability in the near term. As noted in the 2017 evaluation of the CECR program, the time frame to achieve self-sustainability is longer for Centres operating in the life sciences sector due to higher costs, increased regulatory requirements and long development times.[117] Several interviews noted that sustainability may only be achieved through advancing a blockbuster drug to market, a possible, but exceptionally rare event. Furthermore, 55% of respondents to the 2021 CDRD stakeholder survey noted that federal funding to adMare BioInnovations indicated that the government has a continued role in developing the life sciences sector. Despite these assessments, several interviewees expressed that as the CDRD's model matures and products advance by its portfolio companies, some of these investments may generate significant revenue. However, many of the CDRD's spin-off and portfolio companies are in the early stages and significant commercial revenue may not materialize in the near term or at all. Generally, interviewees were optimistic that commercialization activities could contribute to self-sustainability, but given the nature of health innovations, outcomes such as those generated by the Zymeworks (Kairos), commercial transactions are not guaranteed.

Conclusions

- Summary of the Evaluation

Summary of the Evaluation

Two findings presented the relevance for supporting the translation of drug R&D and the continued need for organizations, such as the CDRD, in the health innovation ecosystem in Canada.

Finding 1: The life sciences sector in Canada has evolved over time and the emergence of the COVID-19 pandemic has heightened its importance. There is a **continued need for the federal government to support the health innovation ecosystem** in Canada, **particularly in regards to the translation of drug research**, in order to improve the health outcomes of Canadians. The challenge of translating drug research into commercial application is characterized by high costs, high risk and long timelines.

Finding 2: The **CDRD addressed the need to support the translation of drug research in Canada** by providing the health innovation ecosystem with a full spectrum of services, including scientific expertise, research infrastructure, business development support and funding to projects with commercial potential. The creation of **adMare BioInnovations enabled the CDRD to strengthen its presence nationally**, combining the complementary roles of the NEOMED Institute and Accel-Rx. In recent years, the **CDRD shifted its focus to supporting projects that are further along the drug R&D continuum and to building life sciences companies in Canada.**

Four findings demonstrated the CDRD's effectiveness in providing training, drug R&D support, and launching start-up companies in Canada.

Finding 3: The **CDRD training programs contributed to addressing Canada's talent and skills gap** and were further expanded under adMare BioInnovations to build a diverse talent pipeline in Canada's health innovation ecosystem. These **training programs helped attract talent to Canada**, particularly those who have significant expertise in the commercialization of drug R&D.

Finding 4: The **CDRD training programs supported skills and knowledge development** in areas related to commercializing drug R&D and business development, as well as **retaining talent in Canada**. adMare BioInnovations continues to improve and expand the CDRD training programs, **prioritizing the training of scientists in areas including drug development, commercialization and company creation.** These training programs were effectively delivered virtually during the COVID-19 pandemic.

Finding 5: In the last few years, the CDRD tightened its criteria for selecting drug R&D projects in line with its new strategic plan, resulting in a smaller portfolio of projects. The **CDRD's R&D activities contributed to advancing promising opportunities** and its refined approach to project selection helped to identify those with a greater potential to achieve commercialization.

Finding 6: The **CDRD supported the launch of start-up companies**, as well as supported existing companies in Canada's life sciences sector that are **developing drug products with future potential health benefits to Canadians**, despite the long timelines associated with commercializing drug R&D. These companies are at different stages in the drug R&D process, with those most advanced being in the pre-clinical and clinical phases.

Summary of the Evaluation

Two findings highlighted the efficiency of the CDRD's improved program delivery model to facilitate the translation of drug R&D and its funding profile which includes private sector investments.

Finding 7: The **CDRD undertook an operational re-organization** to improve the effectiveness and efficiency of its program delivery, which includes the translation of drug R&D and company building activities. The **CDRD model can be an efficient approach to achieving self-sustainability,** but it is highly dependent on its spin-off and portfolio companies achieving commercial success, which to date is limited given the nature of drug development and Canada's health innovation ecosystem.

Finding 8: **ISED funding to the CDRD was effective in attracting funding from other sources**, thereby sharing the risk associated with commercializing drug R&D. The CDRD generated project and commercial revenue via the CDRD Ventures Inc. (CVI). Its **spin-off and portfolio companies experienced growth in private sector investments**, highlighting in part their potential for commercial outcomes.

Two recommendations were produced in the evaluation, stemming from the assessment of relevance and efficiency, and supported by at least three data collection methods.

Relevance

Recommendation 1: ISED's Science and Research Sector should work with adMare BioInnovations to **increase understanding within the academic community of its refined focus, role and objectives** in regards to advancing drug R&D projects.

Efficiency

Recommendation 2: ISED's Science and Research Sector should **engage** with adMare BioInnovations to better understand the organization's **metrics and plan towards self-sustainability.**

Appendices

- Appendix A: Logic Model
- Appendix B: Endnotes

Appendix A: Logic Model

The evaluation of ISED funding to the CDRD was based on the outcomes in the logic model below.

ACTIVITIES

INNOVATION, SCIENCE AND ECONOMIC DEVELOPMENT CANADA
- Administer Contribution Agreement
- Monitor plans and progress of CDRD

↓

CDRD
- Program design and planning
- Business and partnership development
- Tracking
- Reporting

↓

OUTPUTS

- CDRD program activities and resources
- Corporate plans and Annual Reports

OUTCOMES

SHORT TERM

Investment for CDRD's activities is leveraged

Highly qualified personnel are attracted through training opportunities

MEDIUM TERM

1 *Create a robust pipeline of health technologies capable of achieving commercial success*

Technology is developed

Technology is advanced

2 *Increase the commercial benefits gained from investments in basic health research*

Commercialization of leading-edge technologies in Canada's life sciences sector is accelerated

3 *Expand its reach to health researchers and entrepreneurs across Canada to accelerate drug development and commercialization*

New highly qualified personnel are employed in the life sciences sector

LONG TERM

Canada's life sciences sector is strengthened

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89. CDRD 2017-18 Annual Report, p.6. The Executive Institute was officially launched in 2018-19. See https://www.admarebio.com/cdrd-and-pfizer-canada-partner-to-establish-the-cdrd-life-sciences-executive-institute/.

90. CDRD 2019 Stakeholder Survey, p.9.

Appendix B: Endnotes

91. adMare BioInnovations 2021 Stakeholder Survey, p.35.

92. This calculation includes training opportunities that are in-progress and completed.

93. This calculation does not factor in participants who declined to provide information regarding their gender.

94. This calculation does not factor in participants who declined to provide information regarding their gender.

95. This calculation does not factor in participants who declined to provide information regarding their gender.

96. CDRD 2018-19 Annual Report, p.8.

97. CDRD 2019 Stakeholder Survey, p.16.

98. CDRD and adMare BioInnovations Annual Reports.

99. adMare Academy Training Strategy, 2020; CDRD Corporate Plan 2018-19, p.15.

100. adMare Academy Training Strategy, 2020.

101. adMare Pre-budget Consultations for Budget 2021, Brief #2, August 2020, p. 6.

102. adMare BioInnovations 2021 Stakeholder Survey.

103. CDRD Search and Evaluation Process FY2021, PowerPoint. According to its 2018-19 Annual Report, CDRD focused on projects in oncology, immunotherapy/immunology, anti-infectives, regenerative medicine/fibrosis and neuroscience, but opportunistically supported projects in other areas as well.

104. Foundational program documents, 2018.

105. Council of Canadian Academies. The Expert Panel on Business Innovation. Innovation and Business Strategy: Why Canada Falls Short, 2009, p.190.

106. Canada's Economic Strategy Tables Report: Digital Industries, 2018, p.5.

107. LifeArc. Progress in a Challenging Year, Annual Report, 2021. See https://www.lifearc.org/wp-content/uploads/2021/07/6340-LifeArc-AR20-27-07-26.pdf.

Appendix B: Endnotes

108. Zucara Website. Zucara Therapeutics Expands ZT-01 Development Program to Type 2 Diabetes, November 2, 2020. See https://www.zucara.ca/news/zucara-therapeutics-expands-zt-01-development-program-to-type-2-diabetes/.

109. CDRD 2017-18 Corporate Plan.

110. 2019 adMare Strategy Planning Session.

111. Evaluation of the Centres of Excellence for Commercialization and Research, 2017, p.17.

112. CDRD financial statements define project income as the income received from CVI and others to cover CDRD project personnel services and materials.

113. CDRD. Financial Statements, 2017-18 to 2020-21.

114. 2019 adMare Strategy Planning Session, p.4.

115. 2019 adMare Strategy Planning Session, p.11.

116. Please note that companies originating from the NEOMED Institute's portfolio and Accel-Rx portfolio are included in the calculation of total private capital. However, private capital secured by these companies are only counted in the years in which these organizations were a part of adMare BioInnovations.

117. Evaluation of the Centres of Excellence for Commercialization and Research, 2017, p.28.