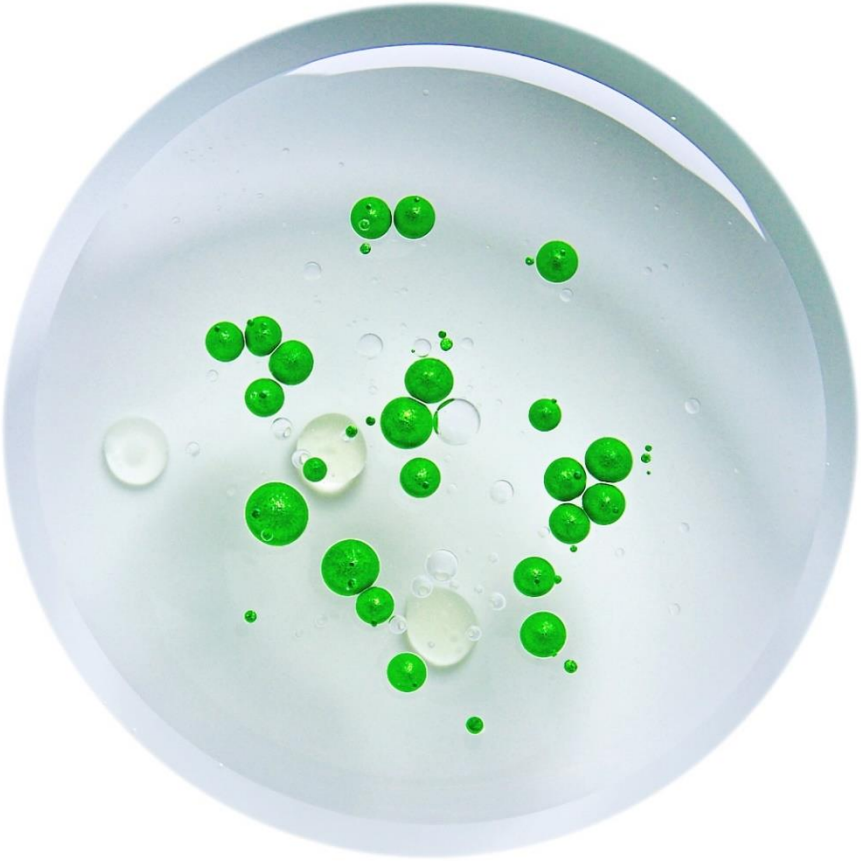
Deloitte.



# Accelerating Prosperity: The Life Sciences Sector in Ontario

February 2019

## Life Sciences Ontario (LSO)

Established 25 years ago, Life Sciences Ontario (LSO) is a business-led, member-funded, not-for-profit organization. LSO promotes the life sciences sector through a variety of activities such as networking and educational events, a vibrant mentorship program and by advocating for specific public policy action to enable research, talent development, capital investment and commercial success.

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## Study Background

Life Sciences Ontario engaged Deloitte to conduct a study of the economic contribution of the life sciences sector in Ontario along with an analysis of recent trends. The study also analyzes the sector's challenges associated with access to capital, human resources, and investments in R&D, and highlights key learnings from select international jurisdictions to consider for advancing the sector. Finally, the analysis investigates the potential economic contributions to Ontario's economy if the sector was supported to grow at a rate comparable to other advanced jurisdictions.

This report was funded by Life Sciences Ontario through support from the following members: Pfizer Canada Inc., Hoffmann-La Roche Limited, Innovative Medicines Canada, AstraZeneca, Sanofi Pasteur, Merck Canada Inc., Novartis Canada, Novo Nordisk Canada Inc., Amgen Canada Inc., and Celgene Inc.

# Contents

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# Glossary

## List of Abbreviations

| | |
|---|---|
| **AI** | Artificial Intelligence |
| **GDP** | Gross Domestic Product |
| **LSO** | Life Sciences Ontario |
| **LSI** | Life Sciences Initiative |
| **R&D** | Research and Development |
| **SMEs** | Small and Medium Sized Enterprises |
| **STEM** | Science, Technology, Engineering, & Mathematics |
| **VC** | Venture Capital |

# Foreword by Craig Alexander, Chief Economist, Deloitte Canada

### Accelerating Prosperity: The Growth Potential of Ontario Life Sciences

This report evaluates the economic contribution of the life sciences sector in Ontario, but more importantly shows its considerable growth potential. Typical of economic contribution studies, the paper is filled with statistics and analysis; but what truly matters is the implication that life sciences could play a larger role in fostering a more prosperous Ontario.

The provincial economy is being transformed by structural forces of aging demographics, globalization and technical change. The traditional manufacturing and production industries that have historically fuelled economic prosperity are facing significant headwinds on growth, difficulty in retaining investment and attracting new capital. Moreover, labour force growth is slowing due to baby boomers exiting the labour market while productivity growth has been lackluster.

The result is slower economic growth. In the 1980s and 1990s, the Ontario economy grew at an average annual pace of 3.1 percent. Since 2000, it has expanded at 2.0 percent annually and the cooling trend is likely to continue. Deloitte projects that Ontario's annual pace of growth over the next decade will be 1.7 percent. This slower rate of economic expansion will constrain income gains in the economy and limit tax revenues at a time that demand for provincially funded health care services is rising rapidly.

To address this looming problem, Ontario has to shift the source of growth toward sectors with greater expansion potential. It also needs to find ways to increase innovation to get more from its workers. As the industrial leaderboard evolves, a greater portion of economic expansion will come from services industries. What Ontario needs is growth in high-value services sectors that can create high-paying, good-quality jobs. Life sciences could be part of this progression.

Life sciences encompass six areas: medical devices and equipment, drugs and pharmaceuticals, research and medical laboratories, agriculture feedstock and chemicals, medical cannabis, and eHealth/artificial intelligence.

Deloitte estimates that the Ontario life sciences sector produces $27 billion of economic output, making it the 11th largest sector in the provincial economy. It directly employs almost 90 thousand workers in the life sciences sector, making Ontario among the top five jurisdictions in North America in terms of employment in this sector. Jobs in the life sciences sector typically have a greater earning capacity, as evidenced by wages that are 24 percent higher than the provincial average. The economic activity of the sector supports $31 billion in output from other industries due to indirect and induced contributions and close to a further 100 thousand positions. In total, roughly 1-in-13 jobs in Ontario are in life sciences or supported by its activity.

While Ontario life sciences is already a significant sector, it could be an even more powerful economic cluster. A lesson can be drawn from abroad. Massachusetts has a life sciences sector that experienced considerable growth after a US$1 billion/10-year Life Sciences Initiative was approved in 2008. If Ontario embarked on an analogous scale program and had similar outcomes, the life sciences sector could grow at a compound average annual growth rate of 4.2 percent over the next decade, creating an additional 45,600 direct jobs. Moreover, a significant portion of the output of life sciences is focused on addressing the rising health needs of Canadians.

Life sciences is also an innovative sector. Currently, 51 percent of all of Canada's research and development in life sciences happens in Ontario. Accelerating growth in the sector would create an even more vibrant innovation hub.

So what is needed to unlock the potential of Ontario life sciences? It is a capital intensive sector that requires greater access to private and public capital. There is a talent gap at the executive and higher management levels, and at the same time there are underutilized science graduates that could be employed in the sector. R&D is an important component of the sector, but commercialization needs to be enhanced. Life sciences also has many small and medium size firms that are having difficulty scaling into larger firms.

The Massachusetts' Life Sciences Initiative provides some guidance on the role of public policy. To foster stronger growth, life sciences firms need greater certainty about the policy environment in which they operate, additional public funding to help scaling and attraction of private capital, government aid in raising awareness about the opportunities in the sector, and greater measurement of policy outcomes and impacts with respect to the sector.

Ontario has the potential to build a greater, more vibrant life sciences cluster. To do so, government support can be a catalyst for accelerated growth. Capital is needed, but it is not just about money. It is about public sector support to create an environment that helps life sciences firms overcome the hurdles to growth. If successful, a stronger life sciences sector could be a significant contributor to the prosperous Ontario of the future.

# Executive Summary

## The Life Sciences Sector

The life sciences sector is broad and encompasses research, development and manufacturing operations as well as the development of diagnostics, biopharmaceuticals, pharmaceuticals and medical devices.[1] Health research institutions and research networks play an integral role in research and knowledge translation in the life sciences sector.[2]

As the demand for pharmaceuticals, medical technology and other healthcare products continues to rise, global prescription drug and medical technology sales are expected to grow.[3] Emerging technologies, including AI, cognitive technologies, automation, and computer power, are driving significant advancements within the life sciences sector that can enhance healthcare across the globe.[4]

**The life sciences sector is a significant driver of medical innovations that improve healthcare delivery and patient care in Canada and overseas.**

This study divides the life sciences sector into six segments:

1. Medical Devices and Equipment
2. Drugs and Pharmaceuticals
3. Research, Testing, and Medical Laboratories
4. Agriculture Feedstock and Chemicals
5. Medical Cannabis
6. eHealth and Artificial Intelligence

In Ontario, the life sciences sector is a significant contributor to the provincial economy. The size of the sector can be demonstrated by the associated number of establishments, sector revenues, employment, and associated wages.

[1]Government of Canada. Canadian Life Sciences Industries. Obtained from: https://www.ic.gc.ca/eic/site/lsg-pdsv.nsf/eng/home
[2] Ibid.
[3] Deloitte. 2018 Global life sciences outlook. Obtained from: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-ls-outlook-2018.pdf
[4] Deloitte. 2018 Global life sciences outlook. Obtained from: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-ls-outlook-2018.pdf

Figure 1: The Life Sciences Sector in Ontario

**Number of Life Sciences Establishments:**

There were an estimated **6,140 life sciences establishments** in Ontario (2017); approximately **80 percent** of these were in the **Medical Device and Equipment or Research, Testing and Medical Laboratories segments**.

**Size of Life Sciences Establishments:**

Employment within the industry is highly fragmented: **60 percent** of life sciences companies **employ less than 10 employees** and only **five percent** of companies employ **more than 100 people.**

**Life Sciences Sector Revenues:**

Ontario's life sciences sector generated an estimated **$56.8 billion in revenue** in 2016, making it a significant economic driver in the province.

**Life Sciences Employment:**

An estimated **employment of nearly 90,000** is supported by Ontario's large and vibrant life sciences sector in 2017.

**Life Sciences Wages:**

Approximately **$5.5 billion in wages** was generated by Ontario's life sciences sector employment in 2017.

Source(s): Refer to appendices
*Due to limitations in the availability of revenue data, the latest 2016 life sciences business revenues was used in the analysis.

## Ontario's Life Sciences Sector Economic Contributions

The economic contributions of the life sciences sector can be measured in terms of Gross Domestic Product (GDP), employment, and government revenue.

In the Ontario context, the life sciences sector makes a notable contribution to the provincial economy. Through capital investments and operations the life sciences sector **directly contributes** value added (GDP), employment, and tax revenue to the economy. The sector also supports **"indirect" contributions** by placing demand on local firms, which in turn leads to further economic activity and positive contributions to the economy. Furthermore, the labour income earned directly through the life sciences sector, or from its "indirect" economic activity, supports **"induced" economic contributions**, which refer to when people or firms spend their earnings. Overall, the economic contribution of the life sciences sector in Ontario results in $58.1 billion in GDP contribution, and supports 191,294 jobs.

Figure 2: Ontario Life Sciences Annual Sector Economic Contributions

| Total Contribution | Direct Contribution | Indirect Contribution | Induced Contribution |
|---|---|---|---|
| $58.1 billion in GDP<br>191,294 jobs | $27.4 billion in GDP<br>89,842 jobs | $11.2 billion in GDP<br>60,794 jobs | $19.5 billion in GDP<br>40,658 jobs |

The life sciences sector also contributed an estimated total of $8.8 billion in federal, provincial and municipal taxes. These estimated government contributions include corporate taxes, personal income taxes, and products and production taxes at direct, indirect and induced levels.

Figure 3: Ontario Life Sciences Annual Sector Government Revenue Contributions

| Total | Federal | Provincial | Municipal |
|---|---|---|---|
| $8.8 billion | $4.6 billion | $2.6 billion | $1.6 billion |

## Ontario's Life Sciences Sector Barriers to Growth

Despite the notable economic contributions highlighted above, Ontario's life sciences sector faces challenges to sustained growth. Within the Ontario life sciences context this can be attributed to i) below average R&D expenditure ii) challenges related to talent, and iii) limited access to Canadian based capital.

Figure 4: Overview of Life Sciences Sector Trends

| R&D Investments | Access to Capital | Talent |
|---|---|---|
| Challenges identified<br>• Total R&D expenditures as a percentage of GDP in Ontario (1.9%) is below the OECD average (2.4%).[5]<br>Significance to Ontario's life sciences sector<br>• Lack of investments in R&D can hinder innovation and the commercialization of new products and services.<br>• Without a track record of commercial success, Ontario's life sciences sector will struggle to attract investment dollars – from home and abroad to commercialize innovations in the sector. | Challenges identified<br>• Numerous stakeholders have identified lack of access to capital as the main challenge.<br>• Ontario's share of total Canadian venture capital investment was only 35 percent in 2017.[6]<br>• The life sciences segment represented less than 5% of all equity raised on the TSX/TSXV exchanges in 2017.[7]<br>• Ontario's venture capital investment per capita also lags that of many North American jurisdictions.[8]<br>Significance to Ontario's life sciences sector<br>• As a capital intensive sector, a lack of private sector investment: i) discourages entrepreneurs from considering entering into life sciences and ii) limits the capabilities of existing startups and small and medium sized firms. This leads to firms emigrating to other jurisdictions to find the needed capital. | Challenges identified<br>• Ontario's science graduates face an unemployment rate of 17.9%.[9]<br>• Sector stakeholders have identified a talent gap at executive and higher managerial levels.<br>Significance to Ontario's life sciences sector<br>• If Ontario's sciences graduates are not successful in finding employment and integrating into the workforce in Ontario, they may seek opportunities in other jurisdictions, or other sectors.<br>• Start-ups in Ontario struggle through the commercialization process and launch phase due to lack of experienced executives with deep knowledge of commercialization of products, sales and marketing, as well as lack of available mentorships. |

A holistic approach is required in order to address these challenges and create the conditions for the sustained growth of the life sciences sector in Ontario.

[5] Section 3.2
[6] Section 3.3
[7] Ibid.
[8] Ibid.
[9] Section 3.4

## Success Factors and Enablers of Growth for Life Sciences Sector

In defining what success looks like, we synthesized the key characteristics of advanced life sciences jurisdictions into the following four enablers:

1. Access to capital
2. Attracting experienced talent
3. Collaborative sector ecosystem
4. Competitive environment for companies

Within each of the four enablers, government, higher education institutions and the private sector all have the ability to contribute to improved economic outcomes for the life sciences sector. For context, a summary of practices implemented by leading life sciences jurisdictions is described below.

### Access to capital

Start-ups in the life sciences ecosystem require access to capital throughout the business lifecycle.

- The UK government announced plans to back first-time and emerging fund managers through the British Business Bank's established Enterprise Capital Fund program, supporting at least £1.5 billion of new investment.
- Germany's ProFIT project financing program provides support for R&D projects in the form of non-repayable grants and/or low-interest loans to Berlin-based businesses and research institutions. Projects can qualify for funding during all phases of the innovation process.[10]

### Attracting experienced talent

A strong life sciences ecosystem requires a mixture of leading research talent, as well as, executive and managerial talent.

- Denmark's tax scheme "forskerordning" permits foreign researchers and highly-paid employees to be placed in a low tax bracket in Denmark for a certain number of years, providing they earn more than 63,700 kroner per month.[11]
- Start-up Denmark is a start-up visa program to help talented entrepreneurs relocate and grow high-impact start-ups in Denmark. Accepted applicants obtain a residence and work permit valid for two years with the possibility of extension.[12]

### Collaborative sector ecosystem

A collaborative life sciences ecosystem can result in improved economic outcomes – for both life sciences firms and the region as a whole.

- Germany's "BioRegions" are regional initiatives dedicated to the advancement of modern biotechnology. Each of the 30 German BioRegions specialize in particular areas and facilitate collaboration between universities, R&D institutes, and private sector companies.[13]
- The San Francisco Bay Area boasts a high concentration of research universities, VC investors, and micro-clusters that are linked by networks.[14] The region's interconnected

[10] Investitionsbank Berlin. Implementing innovative ideas with grants and loans. Obtained from: https://www.ibb.de/media/dokumente/foerderprogramme/wirtschaftsfoerderung/profit/profit-projektfoerderung/profit_product_factsheet_projectfinancing_en.pdf
[11] CPH Post (2017). Denmark eyeing longer tax breaks for highly-skilled foreigners. Obtained from: http://cphpost.dk/news/business/denmark-eyeing-longer-tax-breaks-for-highly-skilled-foreigners.html
[12] Start-up Denmark. Obtained from: http://www.startupdenmark.info/about-us/
[13] GTAI. Biotechnology Clusters in Germany. Obtained from: https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Fact-sheets/Life-sciences/fact-sheet-biotechnology-clusters-en.pdf?v=10
[14] Bay Area Council BASIC (2012).The Bay Area Innovation System. Obtained from: https://www.ucop.edu/innovation-alliances-services/_files/Econ%20Impact%20Rpts/Bay%20Area%20Innovation%20System%20Rpt%202012.pdf

innovation system enables the conception, research, development and commercialization of new technologies and business models.

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**Competitive environment for companies**

Policies, regulations, and programs put in place by the government can have a significant impact on the growth and competitiveness of the life sciences sector.

- The Danish "flexicurity" model enables businesses to hire and fire employees relatively easily if business conditions change. This model is based on an active training policy and guarantees workers with sufficient income and retraining options if they lose their jobs.[15]
- The UK provides tax incentives to encourage regional or global pharmaceutical manufacturing, such as, low rates of tax, innovation incentives, comprehensive global treaty network, and up to £50 billion available to support finance and insurance for supplies from within the UK to buyers outside the UK.[16]

## Potential Economic Contributions of Enabling Growth

If Ontario's life sciences sector follows similar trends experienced in other advanced life sciences jurisdictions, the potential exists for Ontario to witness significant economic benefits as a result of an accelerated growth in the life sciences sector. Based on findings from the literature review and stakeholder consultation process, Massachusetts was identified as home to a high-performing life sciences cluster. Particularly, the US$1 billion, ten-year initiative referred to as the "Life Sciences Initiative" has helped the life sciences cluster to gain considerable employment growth since 2008.[17]

If the life sciences sector in Ontario were to experience employment growth rates similar to those in Massachusetts following the Life Sciences Initiative (LSI):

- Five-year growth rate of 25 percent
- Ten-year growth rate of 51 percent

the potential additional economic benefit to Ontario would be significant, as shown below.[18]

Figure 5: 5-Year Incremental Economic Contributions

| Total | Direct | Indirect | Induced |
|---|---|---|---|
| $14.4 billion in GDP<br>47,544 jobs | $6.8 billion in GDP<br>22,329 jobs | $2.8 billion in GDP<br>15,110 jobs | $4.8 billion in GDP<br>10,105 jobs |

Figure 6: 10-Year Incremental Economic Contributions

| Total | Direct | Indirect | Induced |
|---|---|---|---|
| $29.5 billion in GDP<br>97,147 jobs | $13.9 billion in GDP<br>45,626 jobs | $5.7 billion in GDP<br>30,874 jobs | $9.9 billion in GDP<br>20,648 jobs |

[15] BNP Paribas. Ins-and-out of the Danish flexicurity model. Obtained from: https://economic-research.bnpparibas.com/Views/DisplayPublication.aspx?type=document&IdPdf=30102
[16] UK Government. Pharmaceutical Manufacturing. Obtained from: https://invest.great.gov.uk/industries/health-and-life-sciences/pharmaceutical-manufacturing/
[17] Biotechnology Innovation Organization. State Legislative Best Practices in Support of Bioscience Sector Development. Obtained from: *https://www.bio.org/articles/state-legislative-best-practices-support-bioscience-sector-development*
[18] This is considered a conservative estimate given that potential productivity gains are not estimated in this approach.

## Key Learnings based on Characteristics of Advanced Life Sciences Jurisdictions

Though significant, the key success factors of Massachusetts' Life Sciences Initiative extend beyond the level of government funding granted to the sector. The Ontario's life sciences sector, and its stakeholders across the private sector, public sector, and academia, could consider the following examples of key learnings from other leading jurisdictions when defining a coordinated and collaborative sector strategy.

### 1. Legislated strategies can increase the level of certainty about the public policy environment for the life sciences sector.

Implementation of a legislated life sciences strategy, such as the Massachusetts Life Sciences Initiative or the Strategy for UK Life Sciences, could increase the transparency and strength of government commitments to the life sciences sector. Lowering uncertainty around the public policy environment through legislated strategies can also attract more business investment and enable higher growth.

### 2. Reviewing and prioritizing policy and program options to help bridge the commercialization gap.

The analysis revealed a lack of sufficient capital for start-ups and entrepreneurs to commercialize their innovations and scale-up in Ontario. The implementation of coordinated strategic initiatives, with involvement from all ecosystem actors, can serve to create the conditions that are necessary to address the commercialization challenge. From a government perspective, this would start with a thorough program review.

### 3. Increasing awareness of public policy initiatives and the range of supports available for start-ups and entrepreneurs in the life sciences sector could help promote opportunities within the sector.

Communicating and marketing government commitments to the local and global life sciences community can increase the effectiveness of public policy initiatives by raising awareness of the investment climate and the range of supports available for start-ups and entrepreneurs. For example, the promotion, and subsequent publicity received for Massachusetts' Life Sciences Initiative signalled to the global life sciences community that Massachusetts was "open for business" in biotech.

### 4. Measuring and reviewing policy programs to ensure desirable outcome.

Implementation of effective policies can support development of a successful life sciences sector, yet continuous review and measurement of outcomes is necessary to ensure the effectiveness of these programs in achieving the desired outcome. Examples of outcome measures that can be collected include:

- Attributes such as annual growth rates, level of private investment received to date, and research and development partnerships; and
- Information on technologies and innovations developed by life sciences companies, surveys and engagement with the sector to determine whether the program has helped them in achieving their goals.

# Section 1: Introduction and Sector Overview

## 1.1. Study Background

### The 2015 Life Sciences Sector Report

In 2015, LSO commissioned a report into the sector's economic contribution to the Province.

The report provided an analysis of the sector's structure and profile and presented results from a study into the direct, indirect and induced economic contributions of the sector to Ontario's Gross Domestic Product, employment, and taxation.

The report also identified the need for the sector and government to work together to support a robust life sciences ecosystem that can enable small and medium life sciences companies to grow in Ontario, which was supported by an analysis of the challenges and opportunities facing the sector.

### Update of the Analysis: Detailed Economic Footprint Study and Analysis of Potential Economic Impact

In updating this study, the new analysis provides further insight into the economic contribution of the life sciences sector and the range of sectors that benefit from its activities. In addition, this study expands the previous definition of the life sciences sector to include both the eHealth/artificial intelligence and medical cannabis subsectors.

Furthermore, through a study of selected international jurisdictions and a series of expert consultations, the analysis describes characteristics of a successful life sciences sector where research and innovation is transformed into successful commercial products and services. A comparison of these jurisdictions against Ontario seeks to identify opportunities that will enable the sustained growth of the sector. Finally, the analysis also investigates potential economic benefits that would accrue to Ontario if the province were to experience growth rates similar to that of other leading international life sciences jurisdictions.

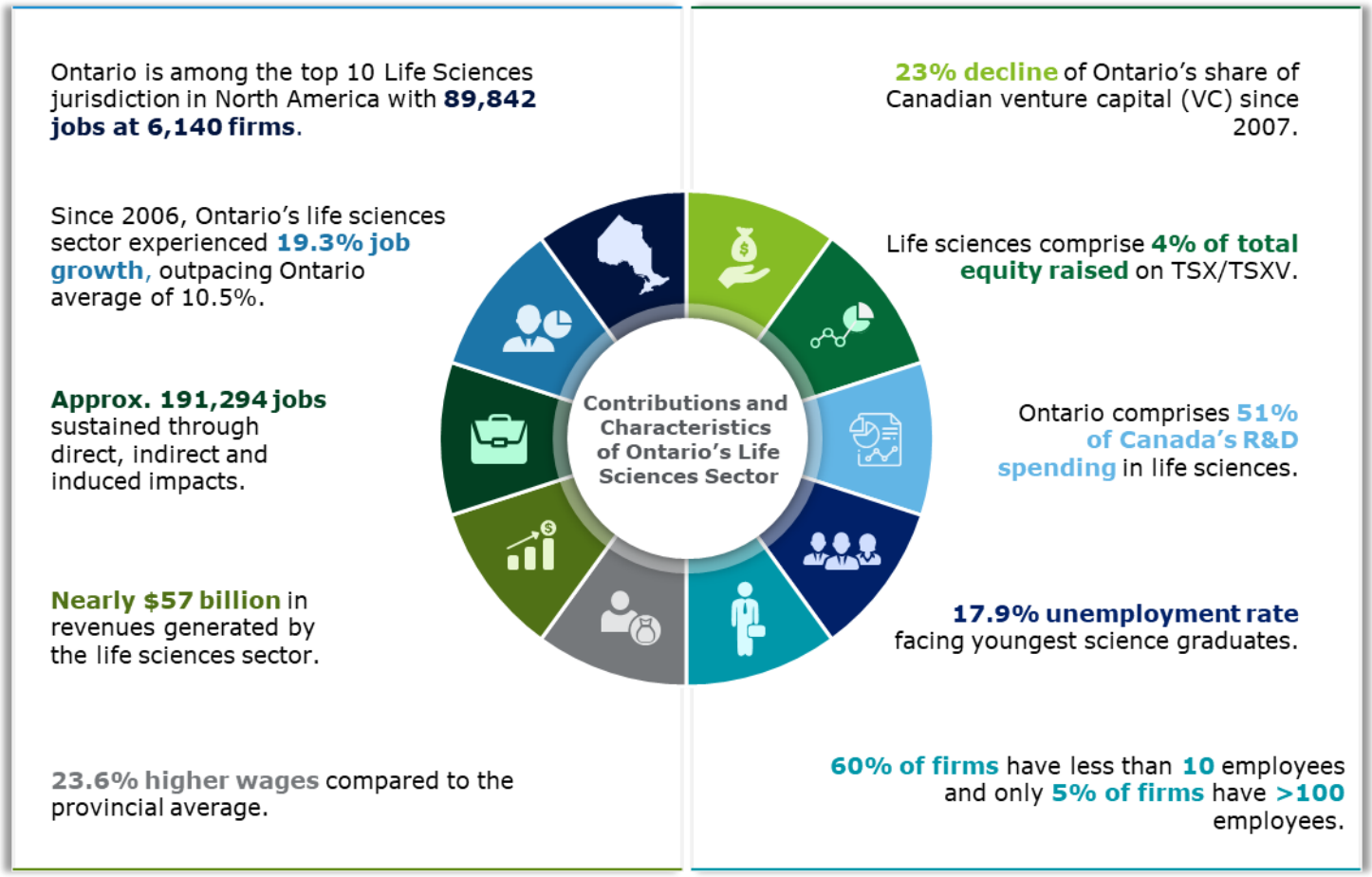
## 1.2. The Life Sciences Sector at a Glance

Figure 7: Life Sciences Sector Overview

| | | |
|---|---|---|
| DRUGS AND PHARMACEUTICALS | Featuring companies engaged in pharmaceutical and medicine manufacturing; and pharmaceuticals and pharmacy supplies merchant wholesalers | **$36.4B** Revenue<br>**684** Establishments<br>**30,371** Jobs |
| RESEARCH, TESTING AND MEDICAL LABORATORIES | Featuring companies engaged in providing physical, chemical and other analytical testing services; and medical and diagnostic laboratories | **$961M** Revenue<br>**2,592** Establishments<br>**24,844** Jobs |
| MEDICAL CANNABIS | Featuring companies engaged in the production and sale of cannabis for medical purposes | **$122M** Revenue<br>**69** Establishments |
| AGRICULTURAL FEEDSTOCK AND CHEMICALS | Featuring companies in pesticide and agricultural chemicals manufacturing, oilseed processing and other basic organic chemical manufacturing | **$7.9B** Revenue<br>**526** Establishments<br>**8,255** Jobs |
| MEDICAL DEVICES AND EQUIPMENT | Featuring companies engaged in medical equipment and supplies manufacturing, and related wholesalers | **$11.6B** Revenue<br>**2,338** Establishments<br>**26,372** Jobs |
| E-HEALTH AND ARTIFICIAL INTELLIGENCE | Features companies engaged in providing access to complete, up-to-date, and accurate digital patient records by authorized health professionals; and collection of multiple technologies enabling machines to sense, comprehend, act and learn so they can perform administrative and clinical healthcare functions | |

Source(s): Refer to appendices
* 2016 medical cannabis revenue figures do not capture rapid growth in the sector as a result of the Federal Government's legalization of cannabis for medical and non-medical purposes in 2018.

Figure 8: Key Sector Statistics




Source(s): Refer to appendices

## 1.3. Sector Definition

Often, "life sciences" is defined only in reference to human health sciences. A more accurate definition is based on its synonymous term, "bioscience" or the better-known term "biology," which is the science of all living organisms; this includes microbial, human, plant or animal.

Therefore, **Life Sciences** can be defined as[19]:

- A branch of science (as biology, medicine, or anthropology) that deals with living organisms and life processes that keeps them alive.

While **Biotechnology** can be defined as[20]:

- The manipulation (as through genetic engineering) of living organisms or their components to produce useful usually commercial products (as pest resistant crops, new bacterial strains, or novel pharmaceuticals; also any of various applications of biological science used in such manipulation).

Collectively, life sciences is an ecosystem with striking similarities to the information technology sector and fewer to traditional manufacturing or commodity-producing industries. When referring to life sciences as a sector, we propose to include companies that use biotechnology to deliver commercially viable products and services; as well as, those that directly support these activities along the entire commercial value chain.

[19] "life science." Merriam-Webster.com. 2019. http://www.merriam-webster.com/dictionary/life%20science
[20] "biotechnology." Merriam-Webster.com. 2019. http://www.merriam-webster.com/dictionary/biotechnology

This definition also aligns with that of the U.S.-based Biotechnology Sector Organization (BIO), the world's largest biotechnology association and BIOTECanada, the national biotechnology association in Canada. Both organizations view the sector as inclusive of human health, agri-food and industrial biotechnology segments. This is also supported by BioTalent Canada, the national HR partner of Canada's bio-economy.

The methodology adapted for this study (see Appendix B) divides the life sciences sector into six sectors:

1. Agricultural Feedstock and Chemicals, such as:
   a. Pesticide and Agricultural chemicals manufacturing
   b. Oilseed processing
   c. Other basic organic chemical manufacturing

2. Drugs and Pharmaceuticals, such as:
   a. Pharmaceutical and medicine manufacturing
   b. Pharmaceuticals and pharmacy supplies merchant wholesalers

3. Medical Device and Equipment, such as:
   a. Medical equipment and supplies manufacturing
   b. Related wholesalers

4. Research, Testing and Medical Laboratories, such as:
   a. Testing laboratories providing physical, chemical and other analytical testing services
   b. Medical and diagnostic laboratories

Due to limitations in the availability of data, the impacts of the following segments are described qualitatively:

1. eHealth/Artificial Intelligence, such as:
   a. Access to complete, up-to-date, and accurate digital patient records by authorized health professionals
   b. Collection of multiple technologies enabling machines to sense, comprehend, act and learn so they can perform administrative and clinical healthcare functions

2. Medical Cannabis, such as:
   a. Production and sale of cannabis for medical reasons

Although this report uses a methodology adapted from the Battelle/BIO report, significant data differences remain within the North American Sector Classification System (NAICS) that are unavoidable. This makes it difficult to directly compare Ontario's life sciences sector and individual U.S. states. Use of similar methodologies makes it possible to estimate how Ontario measures against U.S. jurisdictions to some degrees.

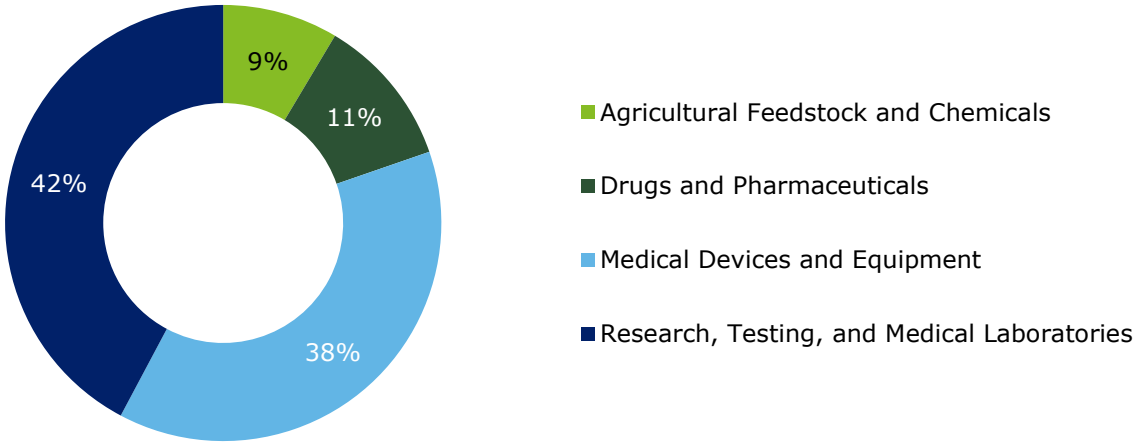
Furthermore, the definition excludes public healthcare workers and many areas of agricultural life sciences (such as wineries and breweries) that make significant contributions to Ontario's economy. For this reason, we have included separate data for an expanded definition of life sciences (see Appendix B for a breakdown of the industries included in the expanded definition). Not all data presented in the body of this report include this expanded definition unless explicitly noted.

## 1.4. Sector Structure and Profile

Currently, there are 6,140 life sciences establishments in Ontario; approximately 80 percent of which are in the Medical Device and Equipment or the Research, Testing and Medical Laboratories subsectors. Employment within the sector is highly fragmented: most life sciences companies employ less than 10 employees and only five percent of companies employ more than 100 people.[21]

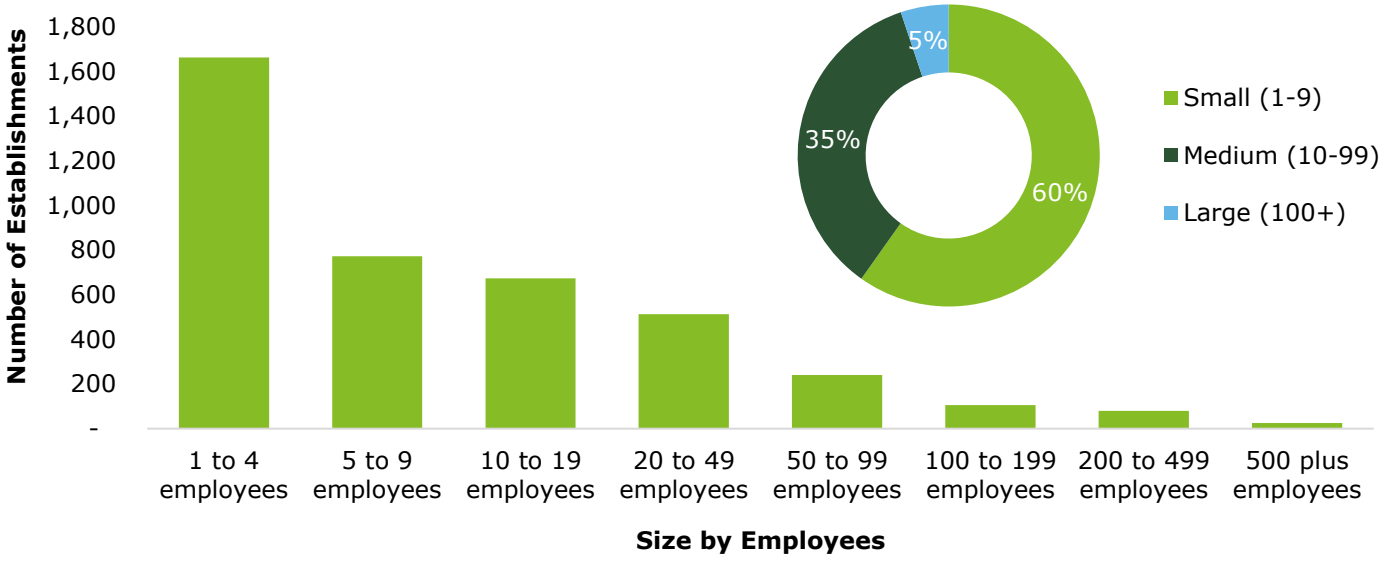
[21] See Appendix B for detailed methodology.

Figure 9: Ontario Life Sciences Segments by Establishments




Source: Statistics Canada – See Appendix B for detailed methodology.

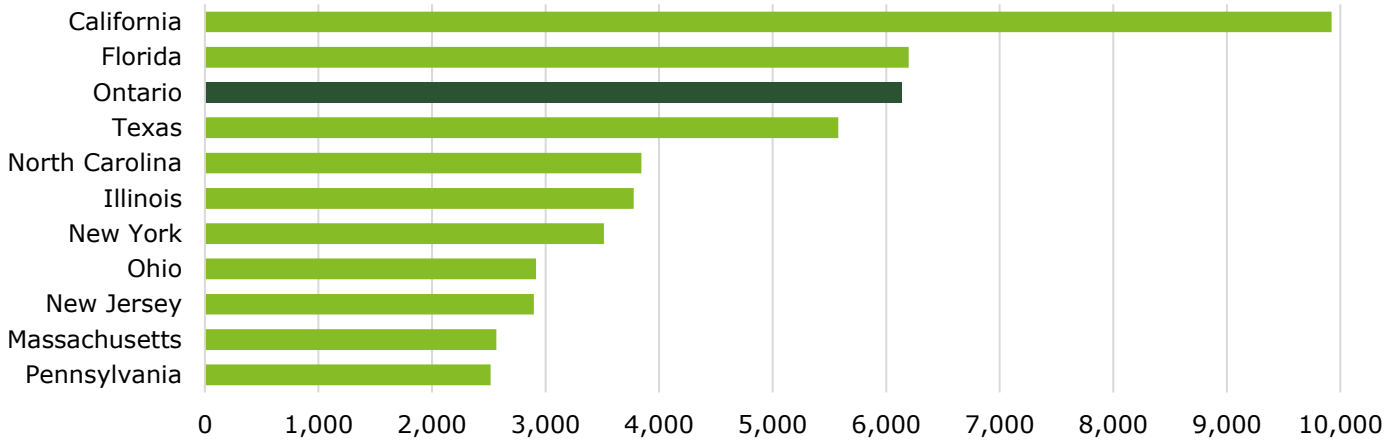
Figure 10: Life Sciences Establishments by Size




Source: Statistics Canada, CANSIM Table 551-0005, December 2013 – See Appendix B for detailed methodology.

Using this methodology and assuming a margin of plus/minus a third in variability, conservatively places Ontario among the top three U.S. jurisdictions for life sciences establishments.

Figure 11: Ranking of North American Jurisdictions by Total Life Sciences Establishments – 2016




Source: Battelle/BIO State Bioscience The Value of Bioscience Innovation in Growing Jobs and Improving Quality of Life 2018 & Statics Canada CANSIM Tables 33-10-0037-01 & 33-10-0038-01 – See Appendix B for detailed methodology.

# Section 2: Current Economic Contributions

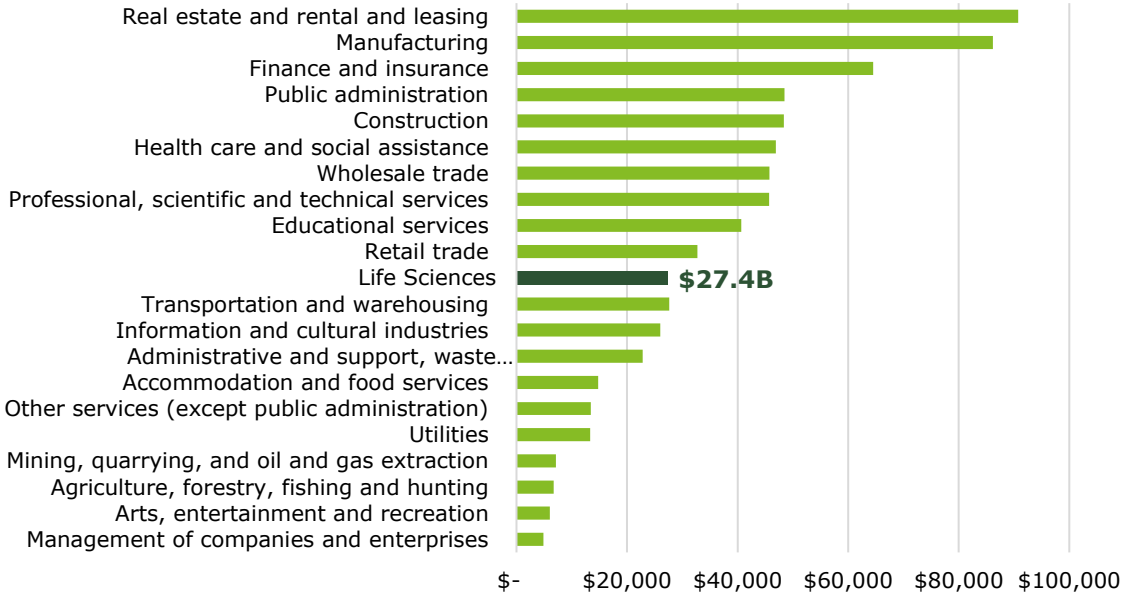
The life sciences sector contributes numerous economic benefits to Ontario. In addition to sector revenue, GDP and employment contributions, there are other important dimensions of economic benefits including labor income, government revenue, investment attraction, talent pooling, innovation, quality of life and standard of living, and many others. This section of the report quantifies and describes some of these economic benefits.

## 2.1. Sector Gross Domestic Product (GDP)

The contribution of a sector to the local economy is measured by its Gross Domestic Product (GDP)[22]. It is estimated that in 2016[23], Ontario's life sciences sector contributed $27.4 billion in direct provincial GDP[24], placing it among the top 11 highest contributors to Ontario's GDP.[25]

**It is estimated that in 2016, Ontario's life sciences sector contributed $27.4 billion in direct provincial GDP, placing it among the top 11 highest contributors to Ontario's GDP.**

Figure 12: Ontario GDP - Chained (2012) millions of dollars, 2016




[22] The GDP calculation eliminates double counting of revenue across companies within the sector (e.g., when one company sells products or services as an intermediary input to another company) as well as the value of imports from other jurisdictions that the sector consumes.
[23] The most recent year where data is available
[24] Due to unavailability of provincial GDP data by detailed six-digit NAICS codes, economic input-output multipliers were used to approximate the GDP contribution. See Appendix B for details.
[25] The life sciences sector is not a standard NAICS sector nor mutually exclusive with other industries. The GDP numbers presented in this chart, which are comprised of a number of sectors that would be classified under such industries as manufacturing, wholesale trade, and professional, scientific and technical services, are not additive.

Source: Statistics Canada Table: 36-10-0402-01 for standard NAICS sector GDP figures; Life Sciences GDP figure – See Appendix B for detailed methodology.

## 2.2. Employment and Wages

Ontario is home to a large and vibrant life sciences sector. With 6,140 companies employing 89,842 people, Ontario is comparable to some of the top U.S. jurisdictions[26]. Jobs in the life sciences sector typically offer higher earnings as evidenced by wages that are 24 percent higher than the provincial average.[27]

Table 1: Overview of Ontario Life Sciences Sector

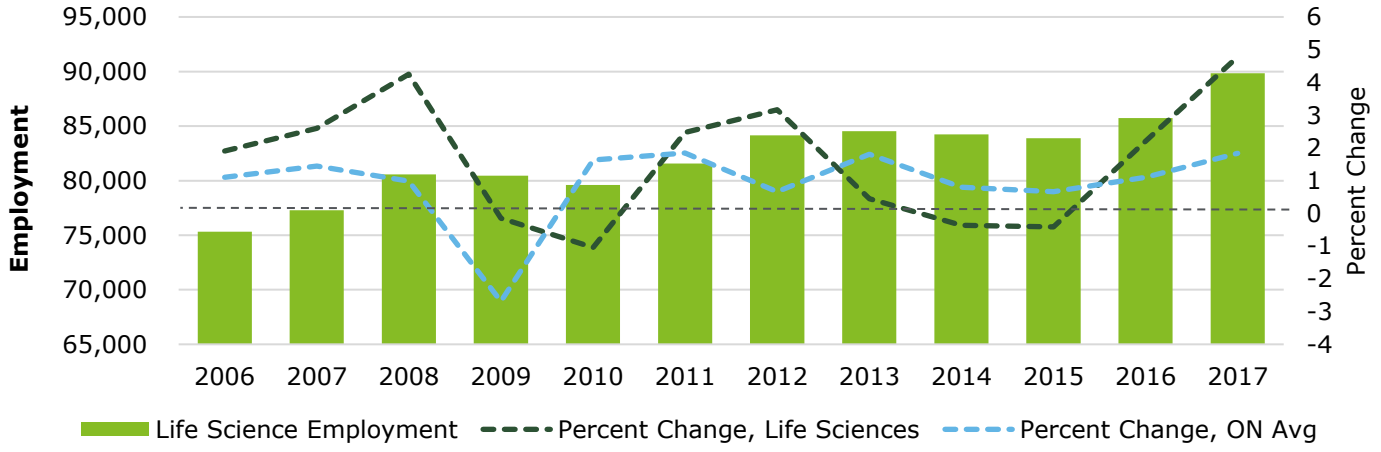
| | Life Sciences | Expanded Definition* | Total |
|---|---|---|---|
| **Establishments** | 6,140 | 89,600 | 95,740 |
| **Employment** | 89,842 | 543,840 | 633,681 |
| **Avg. Annual Salary** | $61,328 | $46,156 | $53,742 |
| **Estimated Payroll** | $5.47 B | $26.73 B | $32.20 B |

Source: Statistics Canada – See Appendices for details.
* Includes: hospitals, ambulatory health care services, health and personal care stores, fruit and vegetable preserving and specialty food manufacturing, dairy product manufacturing, bakeries and tortilla manufacturing, breweries, wineries and distilleries.

Using the expanded definition of life sciences[28], the sector's economic contributions become even more significant: approximately 543,840 workers are employed at approximately 89,600 companies, which means one in 13 Ontarians currently employed works in a job connected to the life sciences sector.[29]

**One in 13 Ontarians currently employed works in a job connected to the life sciences sector.**

Figure 13: Ontario Life Sciences Employment



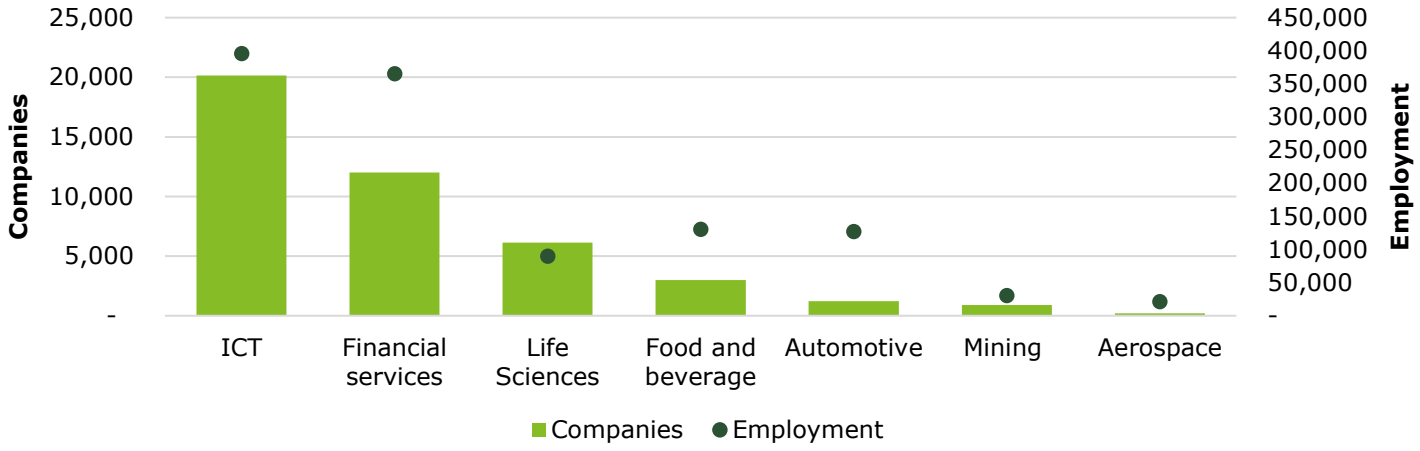

Source: Statistics Canada Tables 14-10-0202-01 & 14-10-0023-01 – See Appendix B for detailed methodology

Life sciences are also a growing sector for Ontario. Growing by 19.3 percent since 2006, employment in the life sciences sector significantly outpaced the provincial average employment growth of 10.5 percent during same time

[26] Battelle/BIO State Bioscience The Value of Bioscience Innovation in Growing Jobs and Improving Quality of Life 2018
[27] Statistics Canada Table 14-10-0204-01
[28] See Appendix B.
[29] Based on Ontario Employed Labor Force of 7,128,000. Source: Statistics Canada Table 14-10-0023-01.

period. Further, sector's employment declined only slightly during the economic downturn of 2008-09, and quickly bounced back in 2011.

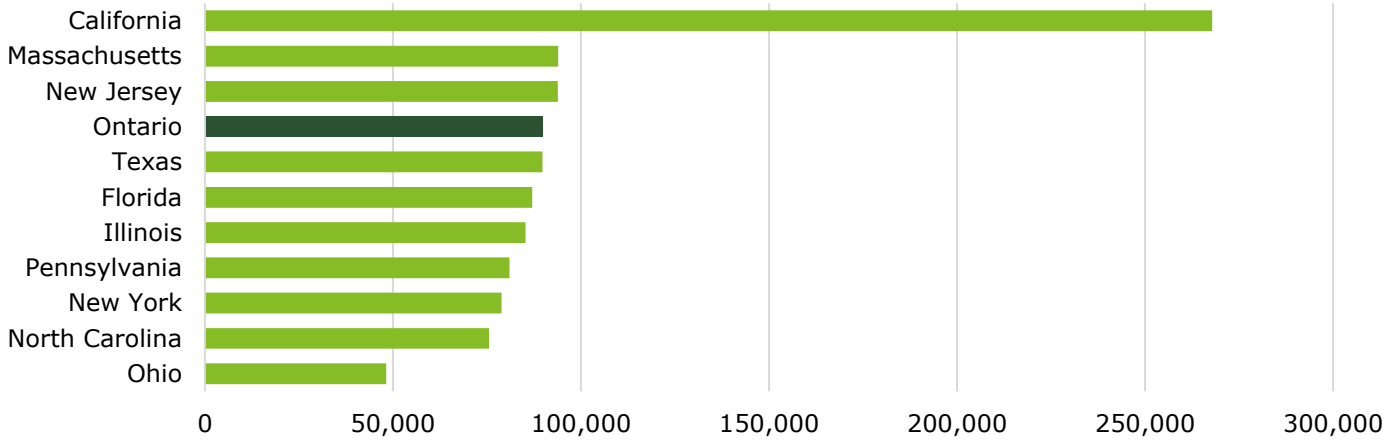
Figure 14: 2017 Ontario Sector Comparison




Source: www.oma.on.ca, www.foodandbeverageontario.ca, www.investinontario.com, www.itac.ca, www.investcanada.org, www.manufacturingalliance.ca

Based on the methodology used in this study, Ontario's life sciences employment is estimated at 89,842. Compared to leading U.S. jurisdictions in life sciences, Ontario is among the top five in terms of employment.[30]

Figure 15: Ranking of North American Jurisdictions by Total Life Sciences Employment



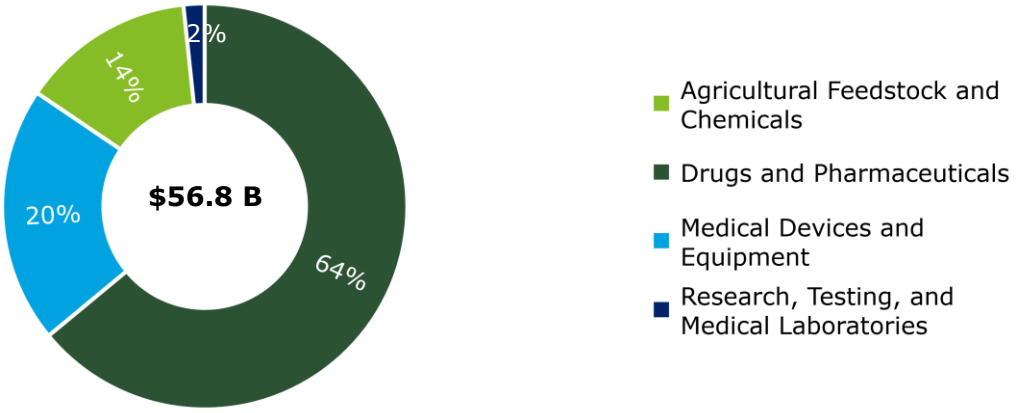

Source: Battelle/BIO State Bioscience The Value of Bioscience Innovation in Growing Jobs and Improving Quality of Life 2018

[30] Employment data from the 2018 Battelle/BIO report shows a narrow difference in life sciences employment estimates among several top U.S. jurisdictions (less than 7,000 between New Jersey, the third largest jurisdiction, and Florida, the sixth-largest jurisdiction. Given the inherent variability in the available data and adapted methodology, combined with the narrow range between the leading U.S. jurisdictions, we cannot give a specific ranking for Ontario compared to these U.S. states.

## 2.3. Revenue

Ontario's life sciences sector generated an estimated $56.8 billion in revenue in 2016,[31] making it a significant economic driver in the province. The Drugs and Pharmaceuticals sector, as the largest subsector within life sciences, generated 64% of the sector's revenue followed by Medical Devices and Equipment sector (20%), Agricultural Feedstock and Chemicals[32] sector (14%), Research, Testing and Medical Laboratories sector (2%). The lower share of revenue associated with the Research, Testing and Medical Laboratories sector can be attributed to both the nature of the activities and where they occur within the sector value chain.

Figure 16: 2016 Ontario Life Sciences Sector Revenues




Source: Statistics Canada, CANSIM Table 16-10-0117-01, Table 20-10-0077-01; (see Appendix B for detailed methodology).
Ontario's life sciences sector has witnessed significant growth of 40% between 2009 and 2016; the greatest increases in revenue was experienced within the Agricultural Feedstock and Chemicals sector (57%), followed by the Drugs and Pharmaceuticals sector (51%), Medical Devices and Equipment sector (11%), and Research, Testing and Medical Laboratories sector (7%).

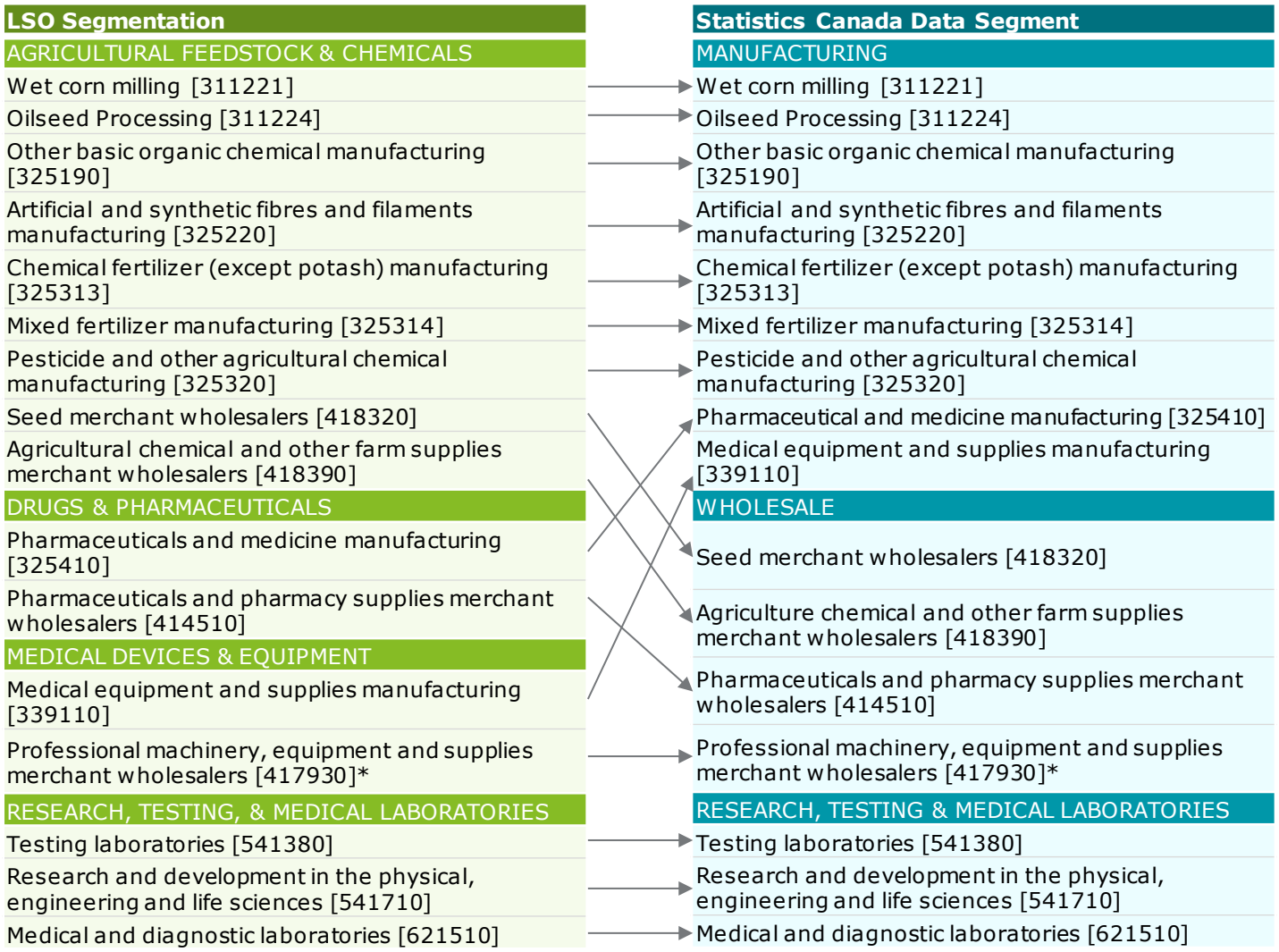
## 2.4. Expenditures

### 2.4.1. Overview of Sector Expenditure Analysis Approach

To determine the economic contributions of the life sciences sector to Ontario's GDP, life sciences sector expenditure figures were calculated as a proportion of revenue using publically available data from Statistics Canada.[33] To gather and analyze expenditure information for the life sciences sector, the individual NAICS codes are reorganized into manufacturing, wholesale, and research, testing and medical laboratories segments based on the nature of the final products or services.

[31] 2016 Data. See Appendix B for detailed methodology.
[32] Due to limitations in available data, this excludes certain industries within the defined Agricultural Feedstock and Chemicals segment.
[33] Direct employment contributions are based on calculated 2017 life sciences direct employment figures detailed in Appendix B. To calculate indirect and induced employment contributions, relationships between StatsCan direct and indirect jobs multipliers, as well as direct and induced jobs multipliers were used.

Figure 17: Segmentation differences between LSO and Statistics Canada Data Segments




Segmented this way, the proportion of operating expenditures were derived from Statistics Canada's sector surveys. Using these surveys along with IO Sector expenditure shares, expenditures were then allocated across different industries.[34]

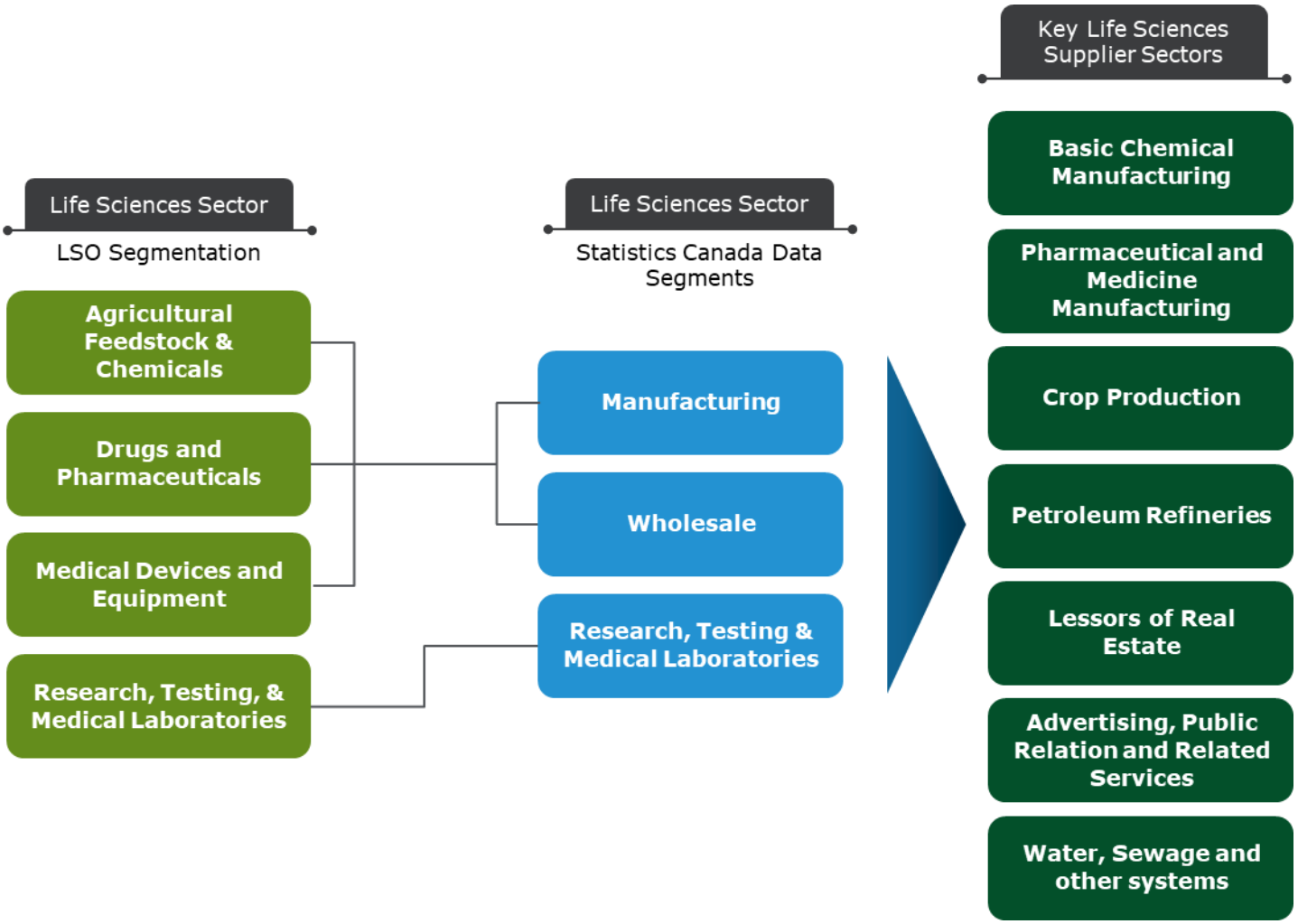
### 2.4.2. Life Sciences Sector Expenditures

Approximately $52.4 billion of total expenditures was estimated to occur within the Ontario life sciences sector in 2016.[35] These expenditures include spending from the manufacturing, wholesale and research, testing and medical laboratories sectors. The breakdown of expenditures represents the range of supplier industries providing goods and services to the life sciences sector; these include chemical manufacturing, pharmaceutical and medicine manufacturing, crop production, petroleum sector, utilities and many others. Increases in investments and spending in the life sciences sector ripples through and stimulates further economic activity across these supplier industries and the suppliers of the suppliers.

[34] For further details on how each expenditure item is estimated refer to Appendix B.
[35] It is anticipated that part of this expenditures occurs outside of Ontario or Canada; this leakage is accounted for in the sector multipliers used and are based on sector averages.

Economic activity in the life sciences sector generates impacts for the broader economy from supply chain activities. The national Input-Output (IO) tables are used to determine the range of supplier industries that are impacted by the activities in the life sciences sector.[36] These sector linkages and the supply chain are illustrated in the Figure below.

Figure 18: Sector Linkages and Supply Chain Illustration




[36] The distribution of expenditure by detail sector are based on National IO tables due to lack of availability of detailed provincial symmetric tables.

The spending pattern of the life sciences manufacturing sector is broken-down into the main expenditure categories shown in Table 2.

Table 2: Life Sciences Manufacturing Expenditures Modeled

| Account* | Cost (CAD million) | Distribution (%) |
|---|---|---|
| Labour (wages and salaries) | $3,026 | 27.9% |
| Energy and water utility | $354 | 3.3% |
| Vehicle fuel | $26 | 0.2% |
| Materials and supplies | $7,450 | 68.6% |
| **Total** | **$10,856** | **100%** |

Source(s): Statistics Canada Tables 16-10-0117-01 & 33-10-0037-01.
*Expenditures for wages and salaries, energy and water utility, vehicle fuel, and materials and supplies were allocated using shares derived from Statistics Canada table 16-10-0117-01.
**Labour and salary expenditures of $3,026M are greater than the salary expenditures calculated using methodology detailed in Appendix B due to sector expenditures allocated to non-manufacturing labour.

The distribution of life sciences manufacturing expenditures across supplier industries is presented in Table 3.

Table 3: Life Sciences Manufacturing Expenditure Distribution by Top Supplier Industries

| Sector | Distribution (%) |
|---|---|
| Basic chemical manufacturing | 23% |
| Pharmaceutical and medicine manufacturing | 19% |
| Crop Production | 9% |
| Conventional oil and gas extraction | 6% |
| Petroleum refineries | 4% |
| Architectural, engineering and related services | 3% |
| Electric power generation, transmission and distribution | 2% |
| Resin, synthetic rubber, and artificial and synthetic fibers and filaments manufacturing | 2% |
| Other | 32% |
| **Total** | **100%** |

Source: Statistics Canada. 2014 National IO Table D Level. Please refer to Appendix B for more details on Life Sciences Manufacturing sector expenditure breakdown.

The spending pattern of the Life Sciences Wholesale sector is broken-down over the main expenditure categories as shown in Table 4.

Table 4: Life Sciences Wholesale Expenditures Modeled

| Account* | Cost (CAD million) | Distribution (%) |
|---|---|---|
| Labour (wages and salaries)** | $15,668 | 38% |
| Other*** | $25,028 | 62% |
| **Total** | **$40,696** | **100%** |

Source: Statistics Canada Tables 20-10-0077-01 & 33-10-0037-01. Please refer to Appendix B for more details on Life Sciences Wholesale sector expenditure breakdown.
* Expenditures for wages and salaries, and other were allocated using shares derived from Statistics Canada table 20-10-0077-01.
**Labour and salary expenditures of $15,668M are greater than the salary expenditures calculated using methodology detailed in Appendix B due to sector expenditures allocated to non-wholesale labour.
***The remaining 62% of "Other" expenditures are allocated across different industries based on IO expenditure shares for Wholesale Trade industries.

The distribution of life sciences wholesale expenditures across supplier industries is presented in Table 5.

Table 5: Life Sciences Wholesale Expenditures Distribution by Top Supplier Industries

| Sector | Distribution (%) |
|---|---|
| Petroleum refineries | 6% |
| Lessors of real estate | 4% |
| Advertising, public relations and related services | 4% |
| Insurance carriers | 4% |
| Accounting, tax preparation, bookkeeping and payroll services | 4% |
| Office administrative services | 3% |
| Banking and other depository credit intermediation | 3% |
| Support activities for transportation | 3% |
| Food services and drinking places | 3% |
| Other | 66% |
| **Total** | **100%** |

Source: Statistics Canada. 2014 National IO Table D Level. Please refer to Appendix B for more details on Life Sciences Wholesale sector expenditure breakdown.

The spending pattern of the life sciences research, testing and medical laboratories sector is broken-down over the main expenditure categories as shown in Table 6.

Table 6: Life Sciences Research, Testing and Medical Laboratories Expenditures Modeled

| Account* | Cost (CAD million) | Distribution (%) |
|---|---|---|
| Labour (wages and salaries)** | $337 | 39% |
| Other*** | $530 | 61% |
| **Total** | **$867** | **100%** |

Source: Statistics Canada. 2014 Financial and Taxation Statistics for Enterprises. & Canadian Institute for Health Information (2019). National Health Expenditure Database. Please refer to Appendix B for more details on Life Sciences Research, Testing and Medical Laboratories sector expenditure breakdown.
* Expenditures for wages and salaries, and other were allocated using shares derived from Statistics Canada's 2014 Financial and Taxation Statistics for Enterprises.
**Since expenditure figures are based on proprietary information used to calculate sector revenues, labour and salary expenditures of $337M are less than salary expenditures calculated using methodology detailed in Appendix B.
***The remaining 61% of "Other" expenditures are allocated across different industries based on IO expenditure shares for Professional, Scientific and Technical Services industries.

The distribution of life sciences research, testing and medical laboratories expenditures across supplier industries is presented in Table 7.

Table 7: Life Sciences Research, Testing and Medical Laboratories Expenditures Distribution by Top Supplier Industries

| Sector | Distribution (%) |
|---|---|
| Dry cleaning and laundry services | 11% |
| Water, sewage and other systems | 7% |
| Steel product manufacturing from purchased steel | 6% |
| Educational services | 3% |
| Other provincial and territorial government services | 3% |
| Potash mining | 3% |
| Pesticide, fertilizer and other agricultural chemical manufacturing | 2% |
| Other | 65% |
| **Total** | **100%** |

Source: Statistics Canada. 2014 National IO Table D Level. Please refer to Appendix B for details on Life Sciences Research, Testing and Medical Laboratories sector expenditure breakdown.

## 2.5. Sector Economic Contribution

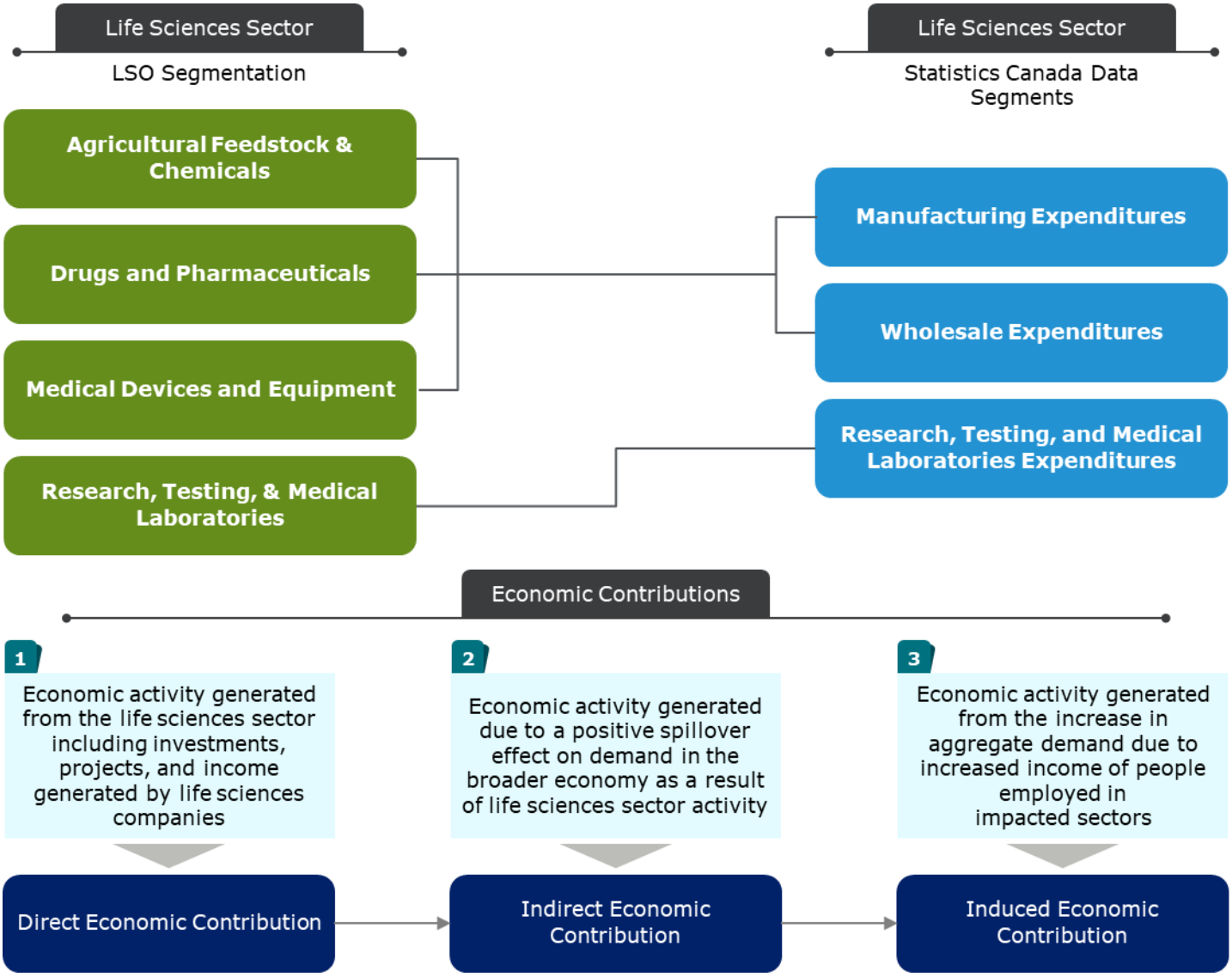
To assess the economic contribution of the life sciences sector to the economy of Ontario, an input-output methodology is used based on Statistics Canada's provincial input-output tables and sector multipliers.[37] This study estimates three levels of contributions:

[37] A limiting factor in our analysis: Canada has no standard sector code that comprehensively captures the multitude of sectors within the life sciences sector. For this reason, we have aggregated the impact of individual subsectors using their share of life sciences sector revenue as a relative weighting or contribution. For a more detailed description of our economic impact methodology, see Appendix B.

1. **Direct Economic Contributions** represent the economic effects directly associated with the spending of the life sciences sector. For example, they include the employment and income of employees and contractors working in the life sciences sector, as well as the associated product, production and income taxes paid.
2. **Indirect Economic Contributions** represent the economic value added resulting from the demand for materials and services by life sciences sector in supplier industries. They represent, for example, economic activity generated in the manufacturing, wholesale trade, utilities, professional services sectors as a result of demand for materials and services generated by the life sciences sector activities.
3. **Induced Economic Contributions** are income effects resulting from spending on goods and services by the employees who benefit from direct and indirect effects. In other words, working income generated will give rise to various personal consumer spending. Such consumer spending will in turn stimulate employment in retail businesses, service providers, leisure activities, etc.

These levels of contribution are illustrated in the following figure:

Figure 19: Economic Contribution Illustration



### 2.5.1. Summary of Economic Contributions

#### Total Gross Domestic Product Contributions

Our analysis finds that an estimated expenditure of $52.4 billion by the life sciences sector in 2016, results in a total economic contribution of $58.1 billion to Ontario's GDP, comprising of $27.4B contribution in direct GDP to Ontario's economy, an additional $11.2B indirectly (via its impact on supplier sectors). It is estimated that the sector contributes another $19.5B through induced impacts (via the re-spending of wages and salaries earned in the sector).[38]

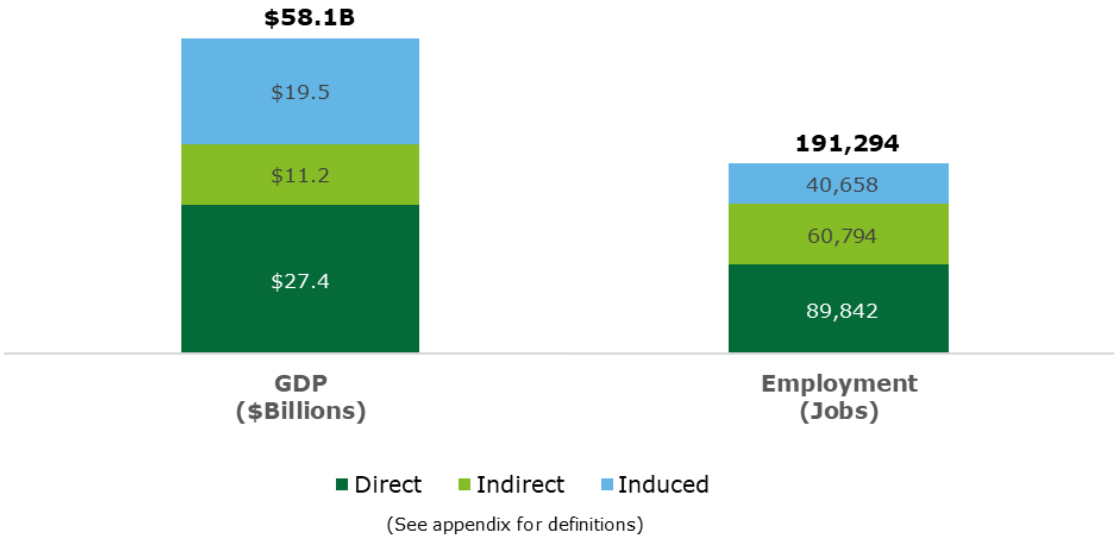
**An estimated expenditure of $52.4 billion by the life sciences sector in 2016 resulted in an estimated total economic contribution of $58.1 billion to Ontario's GDP.**

#### Total Employment Contributions

The life sciences sector directly supports 89,842 jobs in its four main subsectors in 2017. By stimulating activity in supplier industries, the sector helps sustain 60,794 jobs indirectly. It is estimated that an additional 40,658 jobs are supported through induced impacts due to economic activity driven by the re-spending of wages and salaries earned by employees in this sector and the supplier industries. This combined direct, indirect and induced contributions bring the total employment supported by the life sciences sector to 191,294 jobs for Ontarians.[39]

**Accounting for direct, indirect and induced contributions, the life sciences sector supports an estimated total employment of 191,294 jobs for Ontarians.**

Figure 20: Annual Economic Contributions in Ontario from Life Sciences Sector



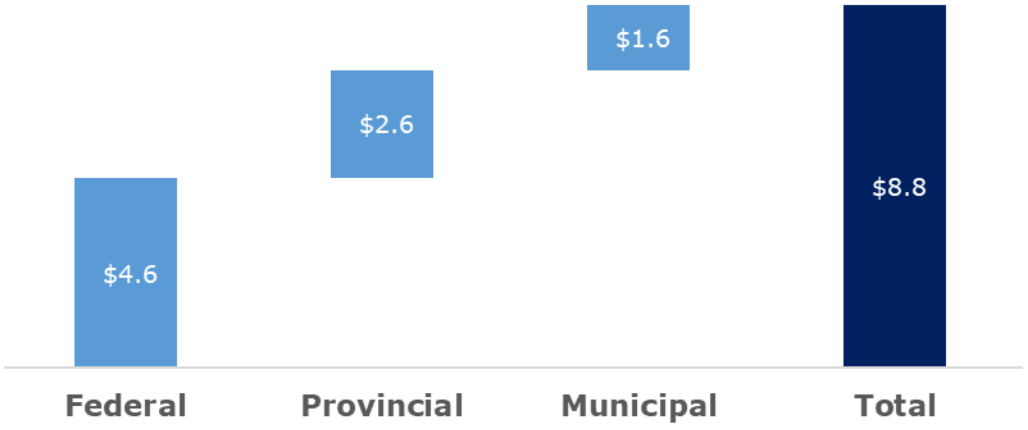

[38] This report uses estimated GDP figures for 2016, the most recent year for which revenue data is available.
[39] Note: Although raw employment data is available to the single digit; the estimated employment numbers for life sciences is based on a complex methodology involving a variety of multipliers and weighting factors. The reporting of life sciences employment (direct, indirect or induced) to the single digit not an indication of accuracy.

### 2.5.2. Contributions to Government Revenue

The life sciences sector contributed an estimated total of $8.8 billion in federal, provincial and municipal taxes in 2016. The estimated taxes include corporate income taxes, personal income taxes, export taxes, and goods and services taxes at direct, indirect and induced levels in 2016.

**The life sciences sector contributed an estimated total of $8.8 billion in federal, provincial and municipal taxes in 2016.**

Figure 21: Annual Tax Impacts from Life Sciences Sector (CAD billions)




## 2.6. eHealth/Artificial Intelligence Contributions in Ontario

A subsector of the life sciences sector include eHealth and applications of artificial intelligence. This subsector incorporates advances in technology to increase the efficiency of the healthcare system. These advances can play a role in ensuring the healthcare system is able to support the increase in demand for medical services as a result of population aging in Ontario. As an example, eHealth technologies enable access to complete, up-to-date and accurate digital patient records by authorized health professionals;[40] while, AI initiatives are a collection of multiple technologies enabling machines to sense, comprehend, act and learn so they can perform administrative and clinical healthcare functions.[41]

**The sector implements eHealth, applications of artificial intelligence, and other advancements in technology to increase the efficiency of the healthcare system.**

In 2017, employment within Ontario's healthcare and social assistance sector was approximately 869,500.[42] This sector is composed of the following four segments: hospitals (31%), ambulatory healthcare services (29%), nursing and residential care facilities (23%), and social assistance (17%).[43] However, the impact on employment within the healthcare sector of existing eHealth/artificial intelligence initiatives remains unclear. Such initiatives enable the

[40] eHealth Ontario. 2016/17 Annual Report.
[41] Accenture (2017). Artificial Intelligence: Healthcare's New Nervous System.
[42] Statistics Canada Table 14-10-0023-01
[43] Statistics Canada Table 14-10-0202-01

healthcare sector to become more efficient by reducing administrative burden and the need for certain clerical and low tech jobs.[44] However, these advancements also increase the demand for health informatics specialists required to manage and analyze medical data.[45] It is also possible that the demand for healthcare providers who are non-physician increases, as technology can potentially enable them to perform simple diagnoses and treatments.[46]

**Case Study: Innovative Patient FlowTechnology at Southlake Regional Health Centre in Newmarket**

Launched in 2012, Innovative Patient FlowTechnology was introduced at Southlake Regional Health Centre ("Southlake") in partnership with McKesson.[47] Using electronic tracking boards throughout the hospital; healthcare teams received a real-time snapshot of patient locations and their estimated time of discharge. As a result, wait times in the Emergency Department were reduced and patient flow was improved throughout the hospital.

The electronic boards also have icons that visibly classify patients who require infection control precautions and are at risk of falling. As a result, the McKesson system has contributed to a decrease of 59% in the number of falls that resulted in an injury at Southlake in 2012 alone.[48]

Southlake also collaborated with Engage Biomechanics, in 2015, to develop a pod strapped to a plush toy that tracks a bedridden patient's movements.[49] This pod helps shorten the amount of time a patient spends in the hospital by reducing pressure ulcers and falls.

**Case Study: AI Health Initiatives at the Vector Institute**

Launched in March 2017, Toronto based Vector Institute is an independent, not-for-profit corporation dedicated to research in the field of artificial intelligence ("AI"), excelling in machine and deep learning. The Vector Institute works with institutions, sector start-ups, incubators and accelerators to advance AI research and drive its application, adoption and commercialization across Canada.

In partnership with health sector leaders, machine learning researchers at Vector are beginning to transform Ontario's population wide health data into knowledge that promotes health and helps make healthcare delivery more efficient and cost-effective.[50] Vector's Health Strategy Phase 1 supports and enables the following health related AI research and innovation[51]:

- Identifying people or groups at risk of disease;
- Identifying interventions to help those at risk;
- Supporting self-management of chronic diseases through real-time remote monitoring and other methods;
- Tailoring treatment options based on an individual's genetic makeup; and
- Improving the accuracy of diagnosis based on medical images.

## 2.7. Medical Cannabis Contributions in Ontario

The Life Sciences sector also consists of companies focused on the research and development of new drugs and products utilizing cannabinoids, the active compounds within cannabis. The two main cannabinoids of medical interests are THC and CBD. THC is popular for recreational purposes and can also increase appetite, reduce nausea, decrease pain, inflammation, and muscle control problems.[52] CBD is a cannabinoid with no intoxicating properties that is useful in reducing pain and inflammation, epilepsy, and possibly treating mental illness and addictions.[53]

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[44] Statistics Canada. Healthcare and Social Assistance Sectoral Profile, Ontario Region 2016-2018.
[45] Ibid.
[46] Ibid.
[47] Registered Nurses Association of Ontario (2013). Innovative Patient FlowTechnology at Southlake Captures Minister of Health's Attention McKesson Performance Visibility project improves patient safety and flow. Obtained from: https://rnao.ca/sites/rnao-ca/ehealth-newsletter/jan-2014/2013_dec_flow_tech.html
[48] Ibid.
[49] Canadian Healthcare Technology (2015). Southlake teams with innovators to solve problems, boost economy. Obtained from: https://www.canhealth.com/2015/10/30/southlake-teams-with-innovators-to-solve-problems-boost-economy/
[50] Vector Institute. Annual Report 2018. Obtained from: *https://vectorinstitute.ai/wp-content/uploads/2018/11/vector_annual_11.8.18.pdf*
[51] Vector Institute: Health Strategy Phase 1. Obtained from: *https://vectorinstitute.ai/wp-content/uploads/2018/10/vector-health-strategy-phase-i-28sep18-track-changes.pdf*
[52] National Institute on Drug Abuse (2018). Marijuana as Medicine. Obtained from: *https://www.drugabuse.gov/publications/drugfacts/marijuana-medicine*
[53] Ibid.

Recent survey data of Medical Cannabis producers presents a snapshot of the Canadian medical cannabis sector in 2015-16 when there were only 55 licensed producers.[54] Sales revenue of medical cannabis totaled $239.4 million in 2016 with Ontario comprising the major portion of Canadian sales revenue (51%). The 55 licensed Canadian producers reported total employment of 2,399 persons in 2017. The major job categories are summarized in the table below.

**Sales revenue of medical cannabis totaled $239.4 million in 2016 with Ontario comprising the major portion of Canadian sales revenue (51%).**

Table 8: Medical Cannabis Sector Employment Breakdown in Canada, 2017

| Employment by Job Category, 2017 | Number of Persons |
|---|---|
| Cultivation and harvesting | 749 |
| Administration | 330 |
| Sales | 280 |
| Processing and manufacturing | 251 |
| Quality assurance | 165 |
| Packaging | 126 |
| Branding, consultation and other marketing | 96 |
| Shipping, delivery and transportation | 75 |
| Research and development | 63 |
| Security | 61 |
| Engineering | 34 |
| Other job categories | 169 |
| **Total** | **2,399** |

Source: Statistics Canada, Medical Cannabis Producers Survey 2016, survey no. 5252 and Canada Revenue Agency payroll deduction records.

The Federal Government's legalization of cannabis for medical and non-medical purposes in 2018 has led to rapid growth in the sector. As of October 2018, there are approximately 132 licensed facilities in Canada authorized to produce and sell medical cannabis to eligible persons.[55] Ontario comprises the largest share (52%) of licensed facilities followed by British Columbia (23%) and Quebec (8%).[56]

[54] Statistics Canada (2018). A snapshot of licensed cannabis producers. Obtained from: https://www150.statcan.gc.ca/n1/pub/13-605-x/2018001/article/54961-eng.htm
[55] Statistics Canada. Cannabis Stats Hub – Economy. Obtained from: https://www150.statcan.gc.ca/n1/pub/13-610-x/cannabis-eng.htm
[56] Ibid.

# Section 3: Sector Trends Analysis

A robust life sciences sector is dependent on level of R&D investment, talent, and access to capital. This section analyzes how the life sciences sector in Ontario has performed over time across selected factors relative to other Canadian provinces and international jurisdictions. By collecting and analyzing data on sector trends, we endeavor to highlight collaboration opportunities for sector, government and academia to catalyze conditions for economic growth of the sector.

## 3.1. Overview of Life Sciences Sector Trends

Figure 22: Overview of Life Sciences Sector Trends

### R&D Investments

Challenges identified

- Total R&D expenditures as a percentage of GDP in Ontario (1.9%) are below the OECD average (2.4%).[57]

Significance to Ontario's life sciences sector

- Lack of investments in R&D can hinder innovation and the commercialization of new products and services.
- Without a track record of commercial success, Ontario's life sciences sector will struggle to attract investment dollars – from home and abroad.

### Access to Capital

Challenges identified

- Numerous stakeholders have identified lack of access to capital as the main challenge.
- Ontario's share of total Canadian venture capital investment was only 35 percent in 2017.[58]
- The life sciences segment represented less than 5% of all equity raised on the TSX/TSXV exchanges in 2017.[59]
- Ontario's venture capital investment per capita also lags that of many North American jurisdictions.[60]

Significance to Ontario's life sciences sector

- As a capital intensive sector, a lack of private sector investment: i) discourages entrepreneurs from considering entering into life sciences and ii) limits the capabilities of existing startups and small and medium size firms

### Talent

Challenges identified

- Ontario's science graduates face a 17.9% unemployment rate.[61]
- Sector stakeholders have identified a talent gap at executive and higher managerial levels.

Significance to Ontario's life sciences sector

- If Ontario's science graduates are not successful in finding employment and integrating into the workforce in Ontario, they may seek opportunities in other jurisdictions
- Start-ups in Ontario struggle through the commercialization process and launch phase due to lack of experienced executives with deep knowledge of commercialization of product, sales and marketing.

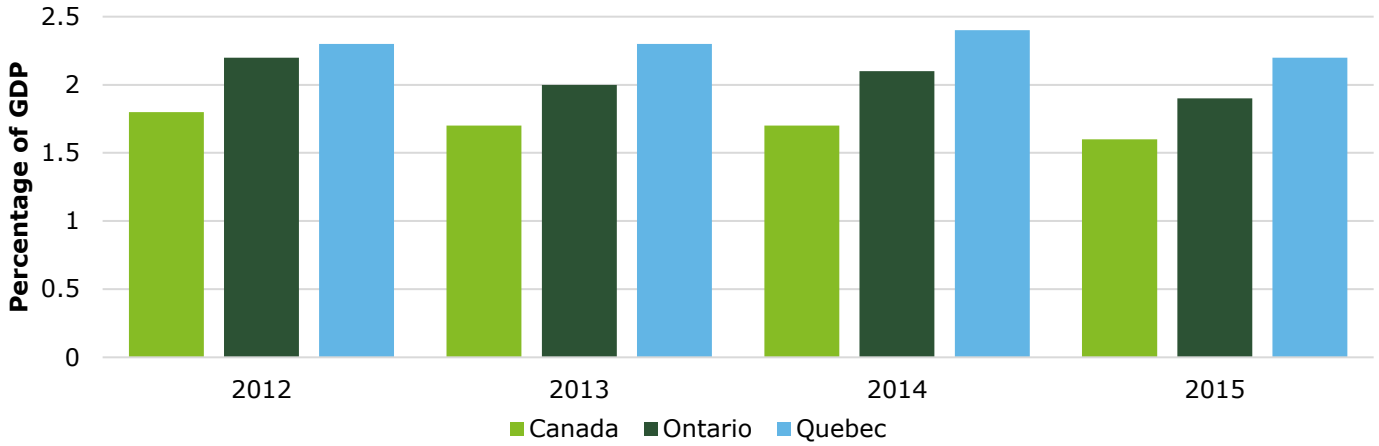
[57] Section 3.2
[58] Section 3.3
[59] Ibid.
[60] Ibid.
[61] Section 3.4

## 3.2. R&D Investments and Intellectual Capital[62]

R&D expenditure is the long-term investment in a sector's future economic performance. It measures a sector's commitment to using innovation and knowledge creation to enhance productivity and improve competitiveness.

Ontario spends 1.9 percent of its GDP on R&D, outperforming the Canadian average but lagging Quebec's investment in this area.

Figure 23: Research and Development as a Percentage of GDP




Source: Statistics Canada Table 27-10-0359-01

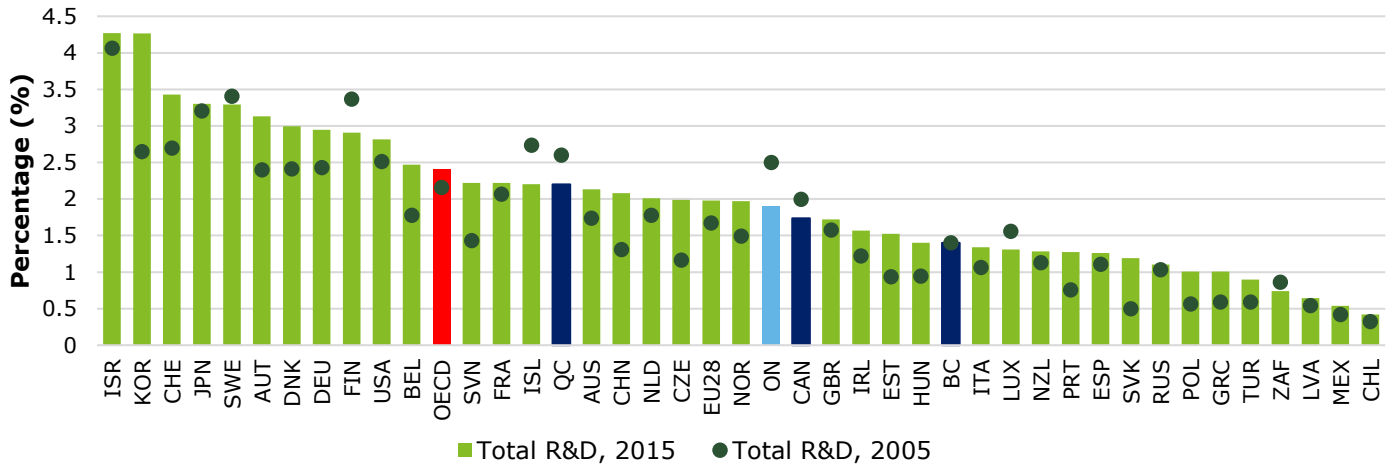
Ontario also attracts a significant share of Canada's life sciences R&D funding (51%), and is subsequently home to 51% of the life sciences R&D personnel.[63] Furthermore, the province contains 24 research hospitals which have invested $1.4 billion in R&D and employs 18,000 researchers.[64] As a result of the province's world-class research hospitals and strong R&D funding, many clinical studies are conducted in Ontario. Stakeholders indicated that the diverse population of Ontario makes the province an attractive jurisdiction for clinical trials. Canada ranks 4th in the world for the number of clinical trials, and Ontario makes up approximately 36% of Canada's research trials.[65]

**Ontario attracts a significant share of Canada's life sciences R&D funding (51%), and is subsequently home to 51% of the life sciences R&D personnel.**

While Ontario fares relatively well in Canada, from a global perspective Ontario is far behind many of the leading OECD countries in its R&D intensity (i.e., R&D expenditure as a percentage of GDP). Ontario's R&D intensity has also declined since 2005 while the leading countries have generally improved along this metric. A comparison of R&D spending as a share of GDP in Ontario and top OECD countries is presented in Figure 24.

[62] Patents and R&D data in this section are not specific to life sciences unless explicitly stated.
[63] Invest in Ontario. Obtained from: https://www.investinontario.com/life-sciences
[64] Ibid.
[65] McDougal Scientific. Conducting Clinical Trials in Canada, A World Leading Destination. Obtained from: http://www.mcdougallscientific.com/wp-content/uploads/Canadian-Clinical-Trials-Sector-Infographic.pdf

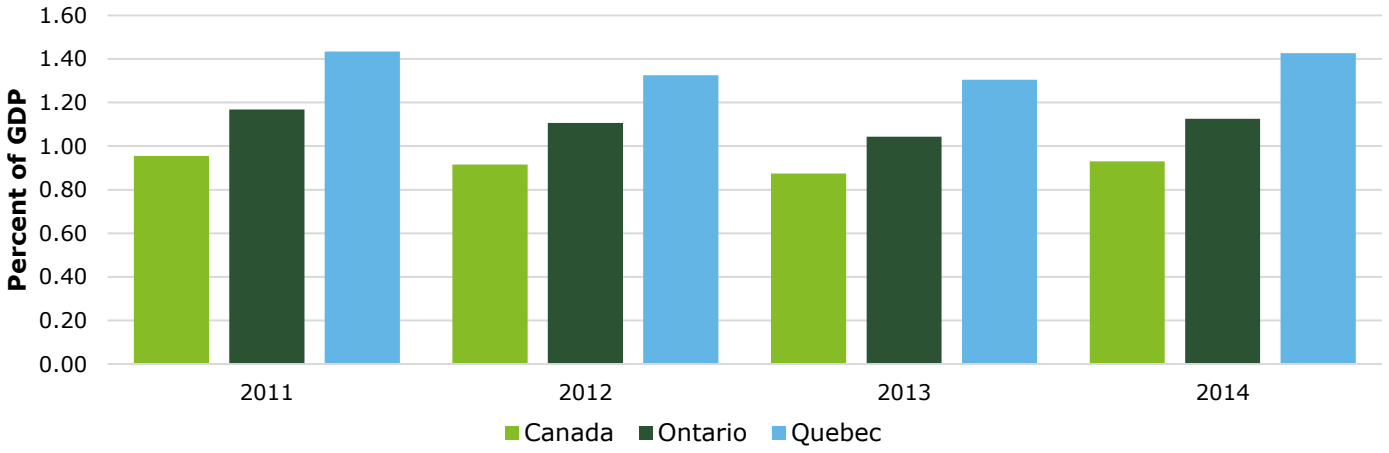
Figure 24: Research and Development Expenditure as a Percentage of GDP (2015 and 2005)




Source: OECD Science Technology and Sector Scorecard; Statistics Canada Table 27-10-0359-01

Business expenditure on R&D is consistent with the overall R&D assessment, whereby Ontario outperforms the Canadian average but lags Quebec. This difference is likely attributable to Quebec policies, such as the 15-year rule for reimbursement of branded pharmaceutical products[66], which recognize the value of innovative life sciences products.

Figure 25: Business Expenditure on Research and Development as a Percent of GDP



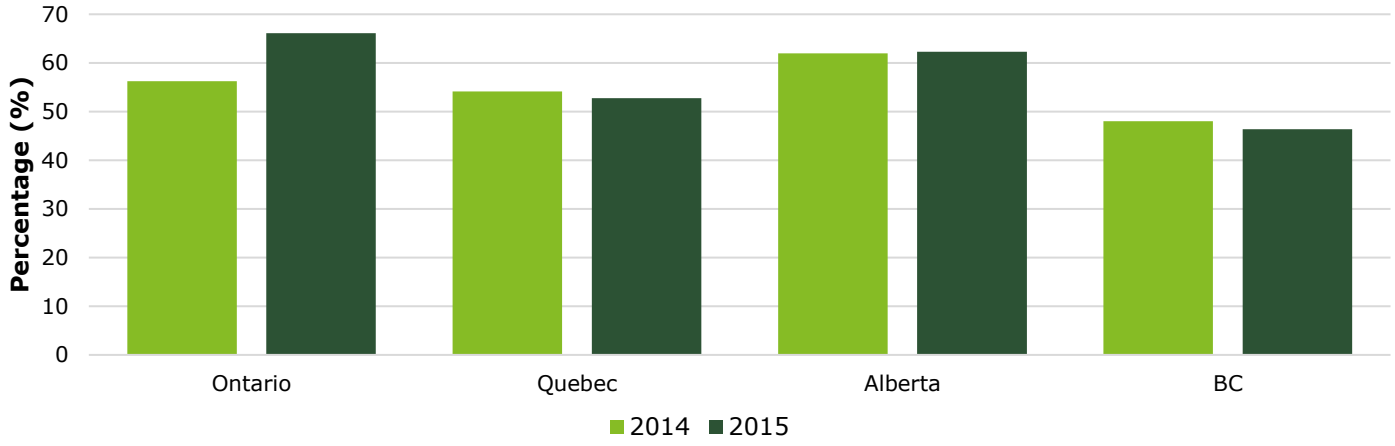

Source: BC Stats, Input Indicators of the BC High Technology Sector 2017 Edition.

The granting of intellectual property rights is one measure of R&D investment's commercial success. The number of patent applications submitted and granted provides an indication of the competitiveness of the life sciences sector.

Nationally, Ontario leads the country in patents granted as a percent of patent application (66%), followed by Saskatchewan (62%), Alberta (62%), and the Canadian average (60%).

[66] Refers to BAP-15 which is the acronym for Best Available Price for 15 years. It is a Quebec policy through which the Quebec government continues to reimburse the brand name drugs for a 15-year period from the listing of the drug on the formulary, even if generic products become available.

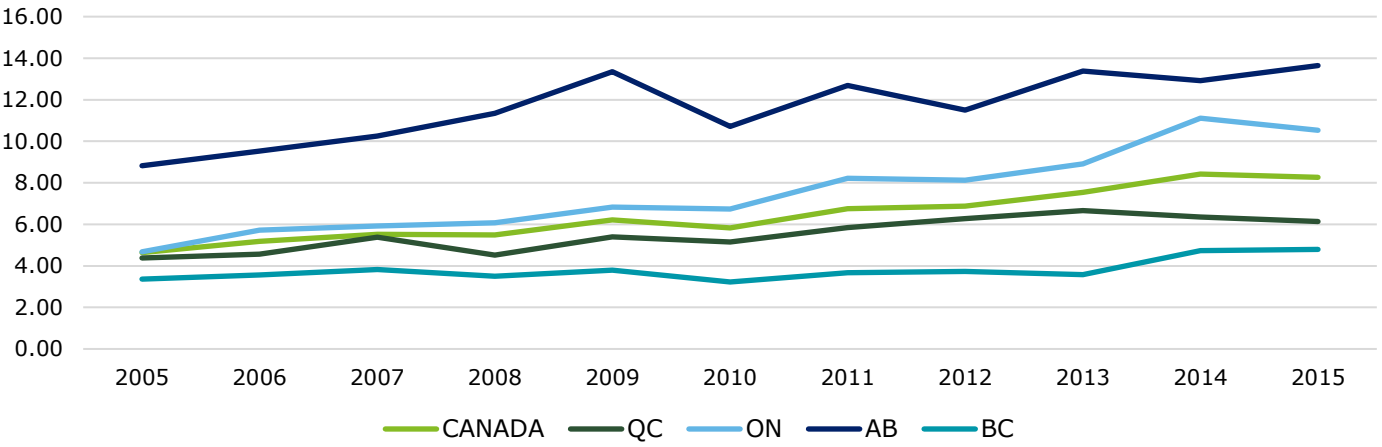
Figure 26: Patents Granted as a Percent of Patent Applications




Source: BC Stats, Input Indicators of the BC High Technology Sector 2017 Edition.

On a per capita basis, Ontario performs relatively well compared to the rest of Canada in patents awarded, lagging only Alberta.

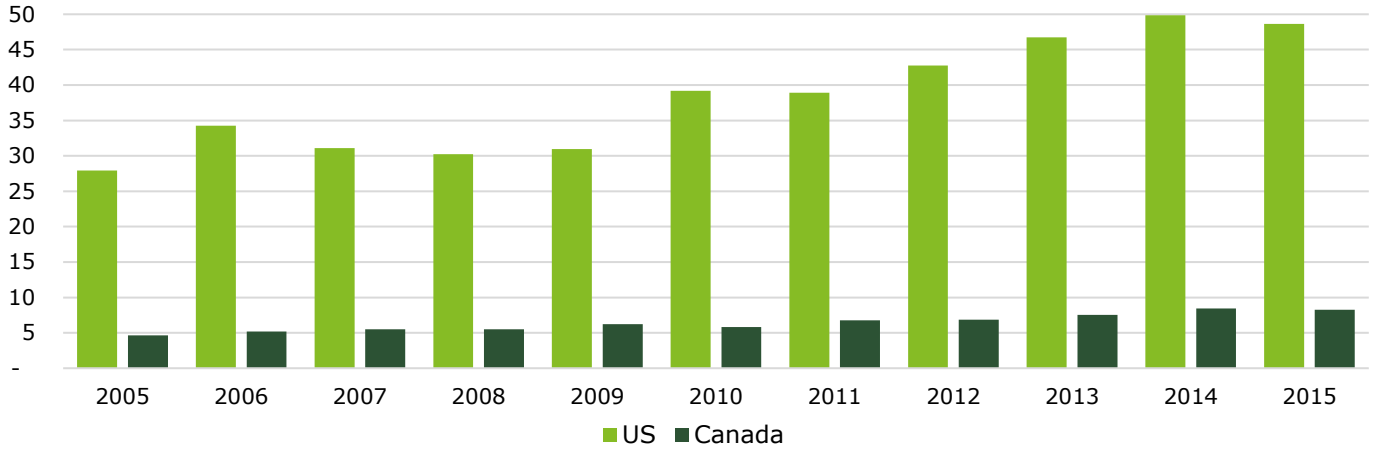
Figure 27: Patents Awarded per 100,000 People – Canada




Source: BC Stats, Input Indicators of the BC High Technology Sector 2017 Edition.

However, Canada lags significantly behind the US in terms of patents granted per capita. This may be attributable to a more supportive culture and environment for entrepreneurs in the US and more capital available to support innovation.

Figure 28: Patents Awarded per 100,000 People – Canada and US




Source(s): BC Stats, Input Indicators of the BC High Technology Sector 2017 Edition; U.S. Census Bureau, Population Division; US Patent and Trademark Office

## 3.3. Access to Capital and related Challenges[67]

Among the many technology industries that engage in R&D processes before achieving commercial success, life sciences stands out as a relatively high-risk sector given the capital intensity of its R&D phases and lengthy payback periods. Access to capital is therefore essential for companies to bridge the gap between innovative research and commercial viability. Both the timing and source of venture capital financing are also significant growth drivers for entities in this sector.

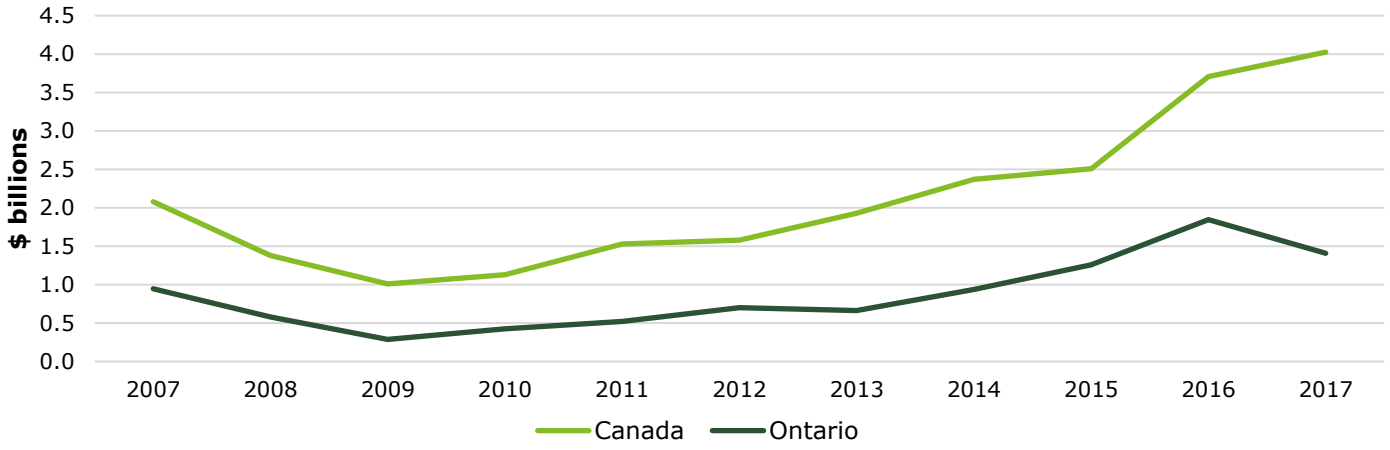
### 3.3.1. Total Venture Capital (VC) Investment in Ontario Compared to Rest of Canada

An upward trend of Canadian total venture capital investment was experienced over the 2009-2017 period. Ontario's total venture capital resources have followed this trend despite experiencing a decline over the last year. In recent years, venture capital investment has improved following the creation of support programs designed to improve access to venture capital, such as the Venture Capital Catalyst Initiative (VCCI), and the Ontario Capital Growth Corporation (OCGC). However, the impact of these investments on the life sciences sector is still unclear; the data and information gathered from the stakeholder consultation process indicates that the sector's overall access to capital remains a key challenge.

**Research and consultations with stakeholders indicate that the sector's overall access to capital remains a key challenge.**

[67] VC and Equity Capital data in this section are not specific to life sciences unless explicitly stated.

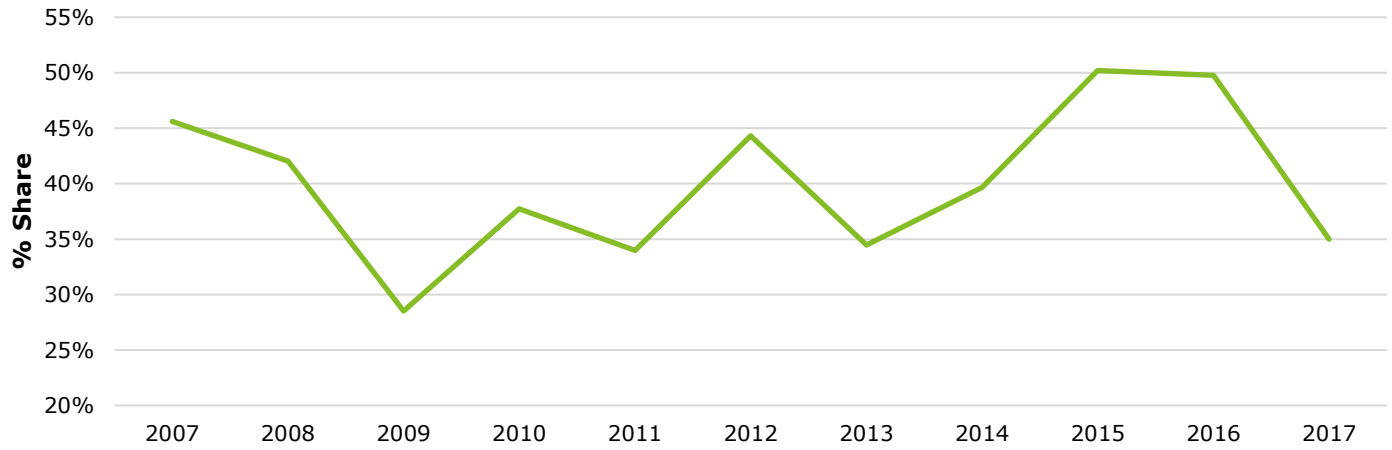
Figure 29: Canadian Total Venture Capital Investment




Source(s): BC Stats, Input Indicators of the BC High Technology Sector 2013 Edition; Thomson Reuters, Canadian Venture Capital Review Full Year 2016-2017; Thomson Reuters, Canadian Venture Capital & Private Equity Review Preliminary Results – Full Year 2015

Although Ontario comprises a considerable share of total available Canadian venture capital investment, Ontario's share of that funding dropped significantly from 50 percent in 2016 to 35 percent in 2017.

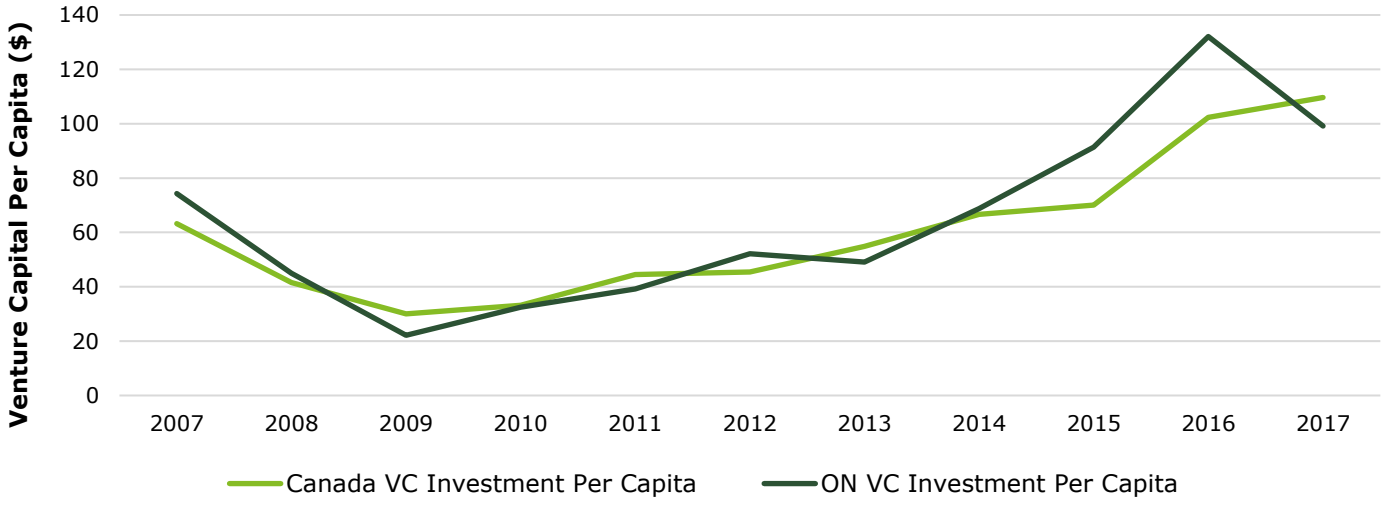
Figure 30: Ontario's Share of Canadian Total VC Investment




Source(s): BC Stats, Input Indicators of the BC High Technology Sector 2013 Edition; Thomson Reuters, Canadian Venture Capital Review Full Year 2016-2017; Thomson Reuters, Canadian Venture Capital & Private Equity Review Preliminary Results – Full Year 2015

Ontario's share of overall Canadian venture capital investment, on a per capita basis, surpassed the Canadian average from 2013-16 and fell below that average after experiencing a decline in VC investment in 2017.

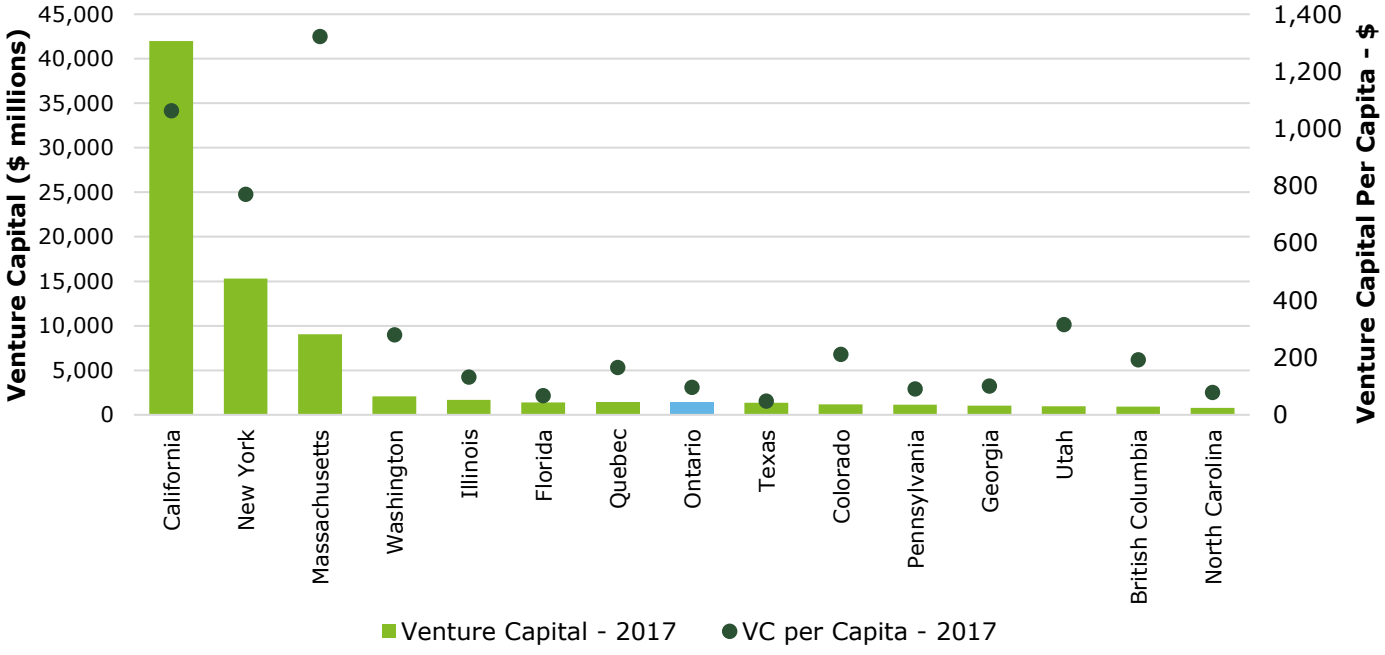
Figure 31: Venture Capital Investment Per Capita




Source(s): BC Stats, Input Indicators of the BC High Technology Sector 2013 Edition; Thomson Reuters, Canadian Venture Capital Review Full Year 2016-2017; Thomson Reuters, Canadian Venture Capital & Private Equity Review Preliminary Results – Full Year 2015; Statistics Canada Table 17-10-0005-01

In comparison to other North American jurisdictions, Ontario's performance was mediocre in terms of venture capital investment per capita in 2017.

Figure 32: Venture Capital Investment in North America (2017)




Source(s): Thomson Reuters, Canadian Venture Capital Review Full Year 2017; Statistics Canada Table 17-10-0005-01; U.S. Census Bureau, Population Division

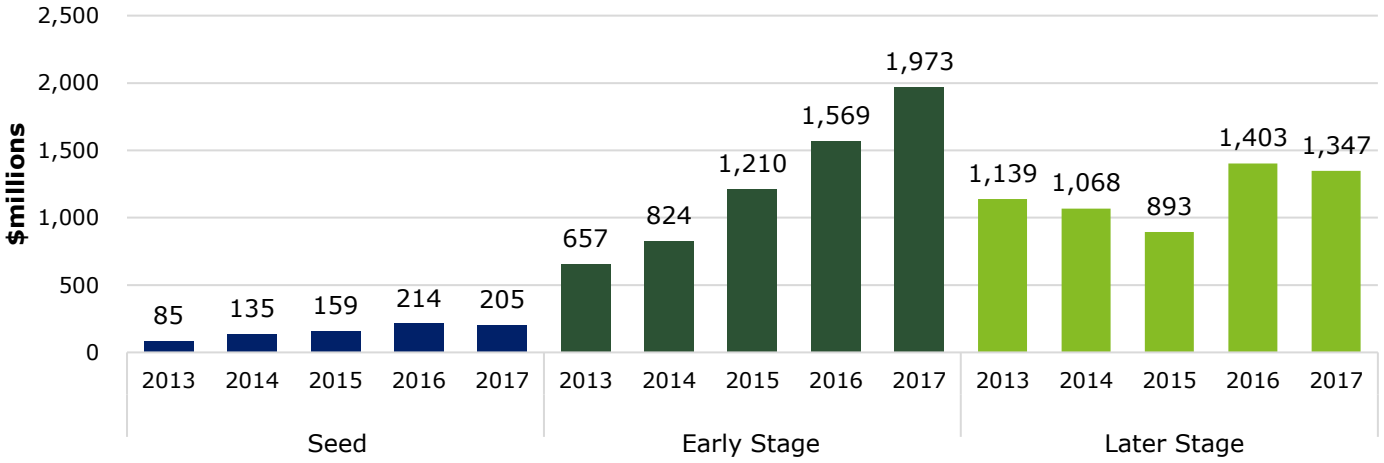
### 3.3.2. Venture Capital Investment by Stage of Growth

In BIOTECanada's 2018 Biotechnology Sector data survey, access to capital was identified as the top issue facing the biotechnology sector by the majority of survey respondents (57%).

In 2017, more than half (56%) of total Canadian VC investment was directed at companies in early-stage development. Companies in later stage and seed stages of development captured the remaining 38% and 6% of VC investment, respectively. VC investments were lowest for seed stage companies, capturing less than ten percent of total VC investment.

**Access to capital was identified as the top issue facing the biotechnology sector by majority (57%) of respondents in BIOTECanada's 2018 Biotechnology Sector survey.**

Figure 33: Canadian Venture Capital Investment by Stage of Development

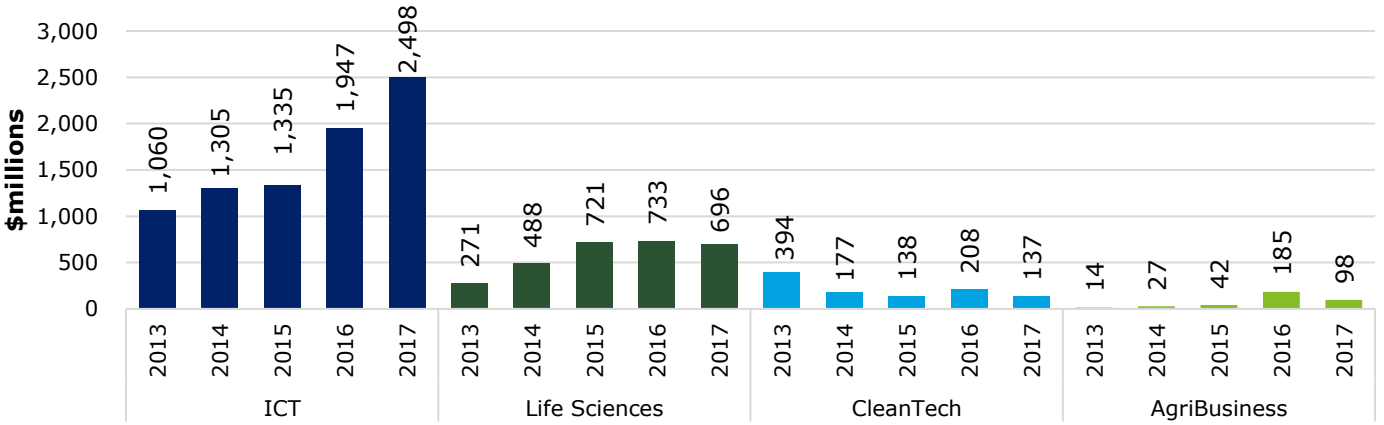



Source(s): Canadian Venture Capital Private Equity Association, VC & PE Canadian Market Overview // 2017

### 3.3.3. Venture Capital Investment by Sector

Venture capital investments in life sciences have slightly declined from $721 million in 2015 to $696 million in 2017; life sciences are only surpassed by investments in the ICT sector.

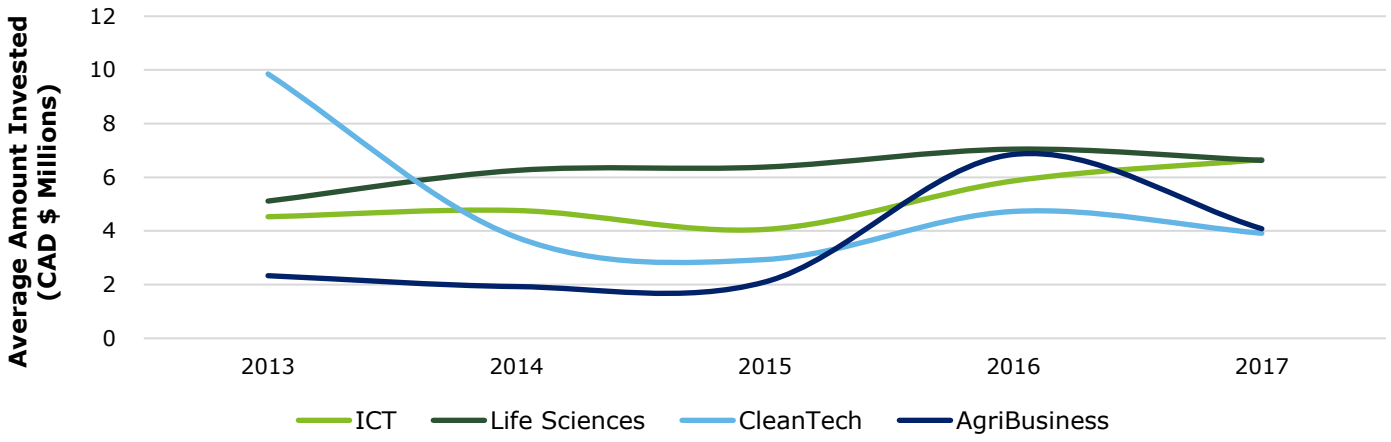
Figure 34: Canadian Venture Capital Investment by Sector



Source(s): Canadian Venture Capital Private Equity Association, VC & PE Canadian Market Overview // 2017

The amount of venture capital invested per financing (or the average size of venture capital investments) differs somewhat across various sectors. The life sciences sector commanded increasing amounts of investment per financing within the 2013-16 period, with only a slight decline in the average size of venture capital investment in 2017.

Figure 35: Average Amount Invested per Financing, By Sector

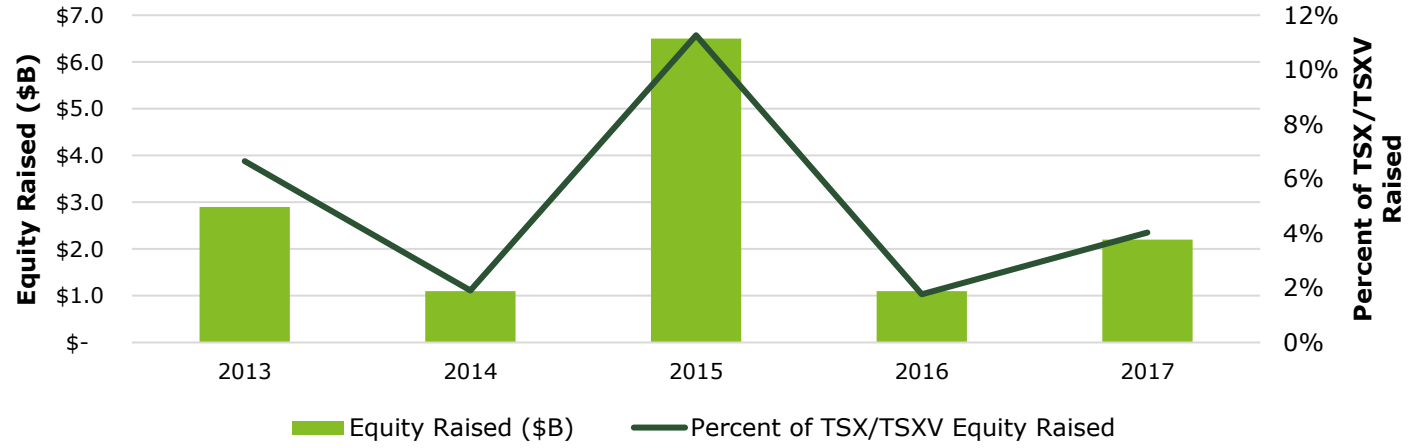



Source(s): Canadian Venture Capital Private Equity Association, VC & PE Canadian Market Overview // 2017

### 3.3.4. Life Sciences in the Public Equity Market

On the TSX and TSXV exchanges from 2013 to 2017, the life sciences segment represented between 2 and 11 percent of the total equity raised. This figure jumped to nearly 11 percent in 2015 due to Endo International plc's $2.8 billion private placement in June 2015 and Valeant Pharmaceuticals International Inc.'s $1.8 billion private placement in March 2015.[68]

Figure 36: Life Sciences Equity Raised on TSX/TSXV



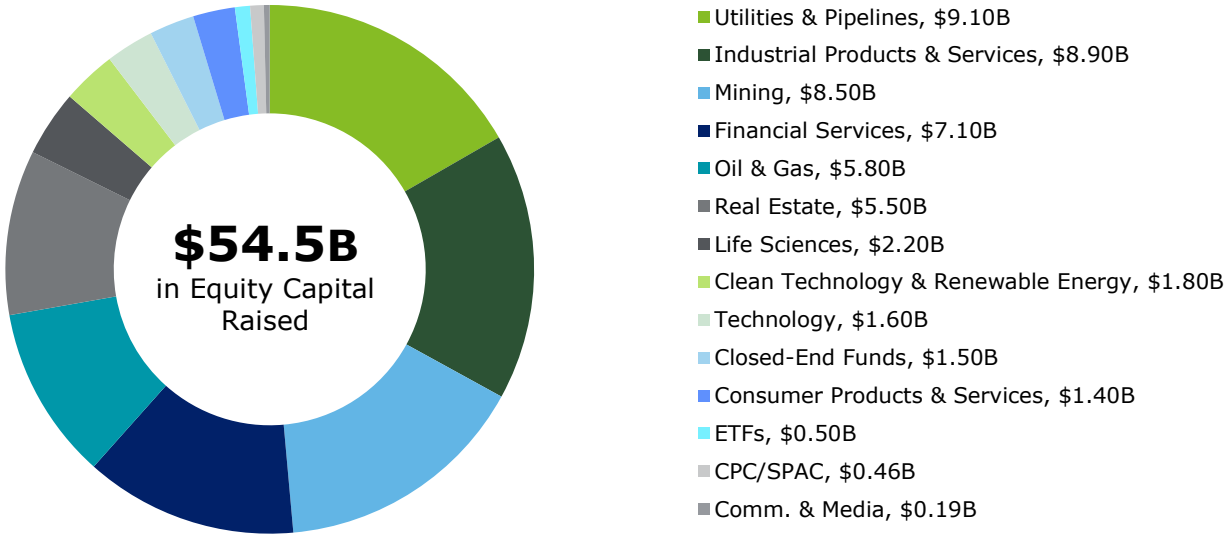

Source(s): The MiG Report, December 2013-17, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group.

An analysis of the TSX/TSXV up to Q4 2017 shows that life sciences investments raised $2.2 billion to date and representing 4 percent of the total equity raised during the same time period.[69] In comparison to other sectors, the

[68] The MiG Report, December 2015, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group.
[69] The MiG Report, December 2017, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group

life sciences sector represents the seventh largest industrial sector by equity raised on the TSX/TSXV, although it still lags far behind financial services, natural resource-related sectors and the real estate sector.

Figure 37: Equity Capital Raised by Sector YTD December 2017 (TSX/TSXV)




Source(s): The MiG Report, December 2017, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group.

## 3.4. Access to Talent Pool and Related Challenges

Being a sector that relies on ideas and innovations to grow, educated and specialized talent is a critical resource in the life sciences sector. The technical skills in demand are mainly developed at universities and higher education institutions and further refined with experience in the sector. The number of graduates in related fields within the province can be a useful measure of the technical talent pool available for companies to draw upon. While the talent pool to meet the life sciences sector requirements could be developed at universities, colleges, and other training institutions, for the purposes of this report we use university science degrees awarded as a measure of available talent pool for life sciences companies.

While the technical talent is a crucial source for sector advancements, it needs to be coupled with managerial and entrepreneurship skills, and deep knowledge and diverse experience in business management and product commercialization. Managerial skills are often mentioned as a critical talent gap faced by the life sciences sector in Ontario. In a 2018 survey of the biotechnology sector by BIOTECanada, respondents identified clinical and medical development, business development, and regulatory affairs executives as the most challenging positions to fill. Furthermore, skills shortages are not a new issue in the biotechnology sector. The proportion of companies that have reported skills shortages among staff within the 2008 and 2017 period were 34% and 33%, respectively.[70]

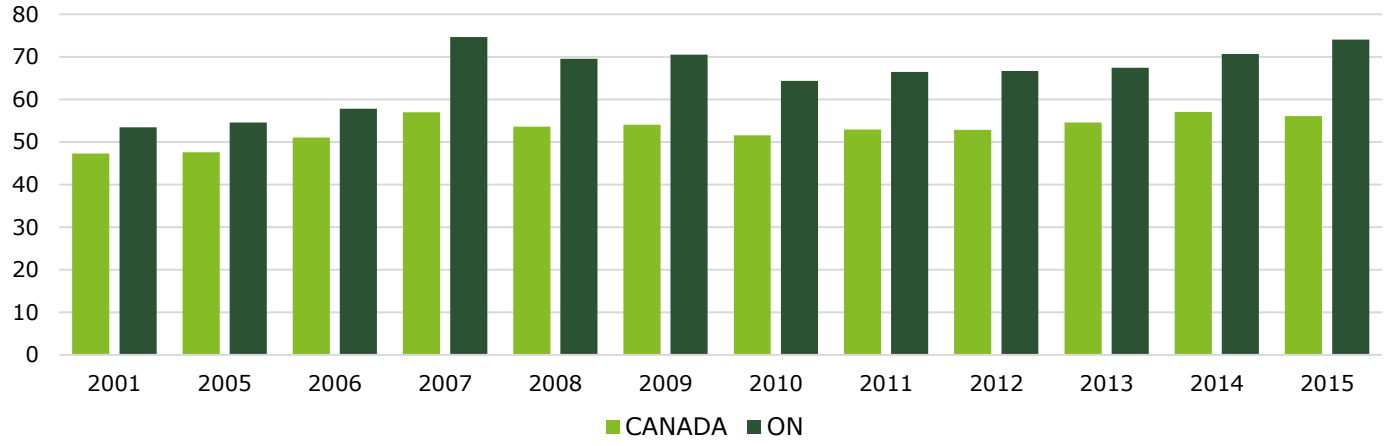
**Managerial skills are often mentioned as a critical talent gap faced by the life sciences sector in Ontario.**

### 3.4.1. Enrolment in Life Sciences Disciplines

Over the last decade, Ontario has outperformed the Canadian average in terms of per capita enrollment in the physical and life sciences at the undergraduate level.

[70] BIOTECanada, Biotechnology Sector Data Survey 2018.

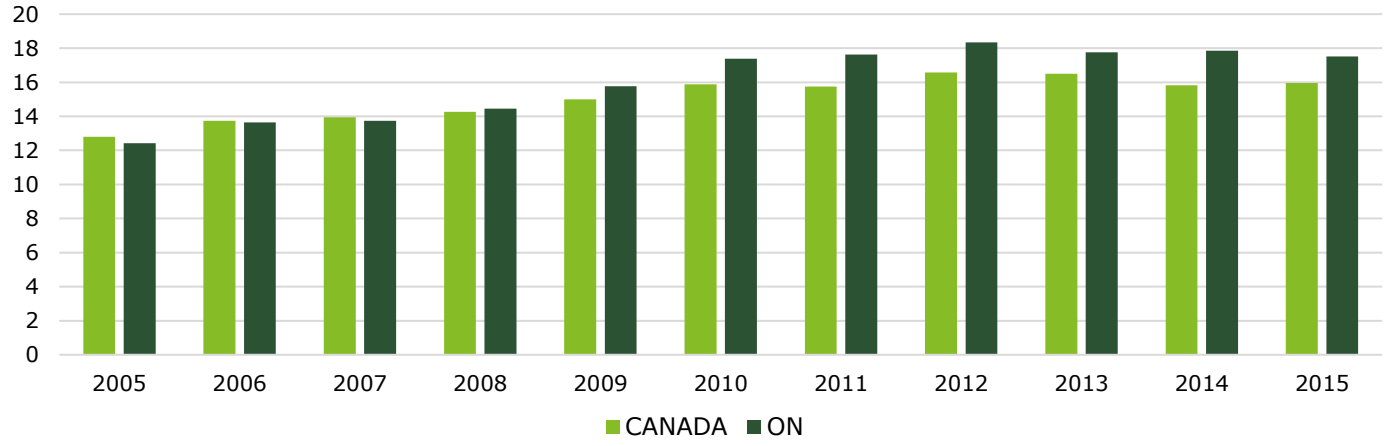
Figure 38: Physical and Life Sciences Undergraduate Degrees per 100,000 persons




Source: Input Indicators of the BC High Technology Sector 2017 Edition, BC Stats.

At the graduate level, Ontario has outpaced the Canadian average in its per capita enrollment of physical and life sciences graduate students since 2008. Canada is also tied with the United Kingdom as having the second most PhD graduates in life sciences per capita, second only to New Zealand.[71]

Figure 39: Physical and Life Sciences Graduate Degrees per 100,000 persons




Source: Input Indicators of the BC High Technology Sector 2017 Edition, BC Stats.

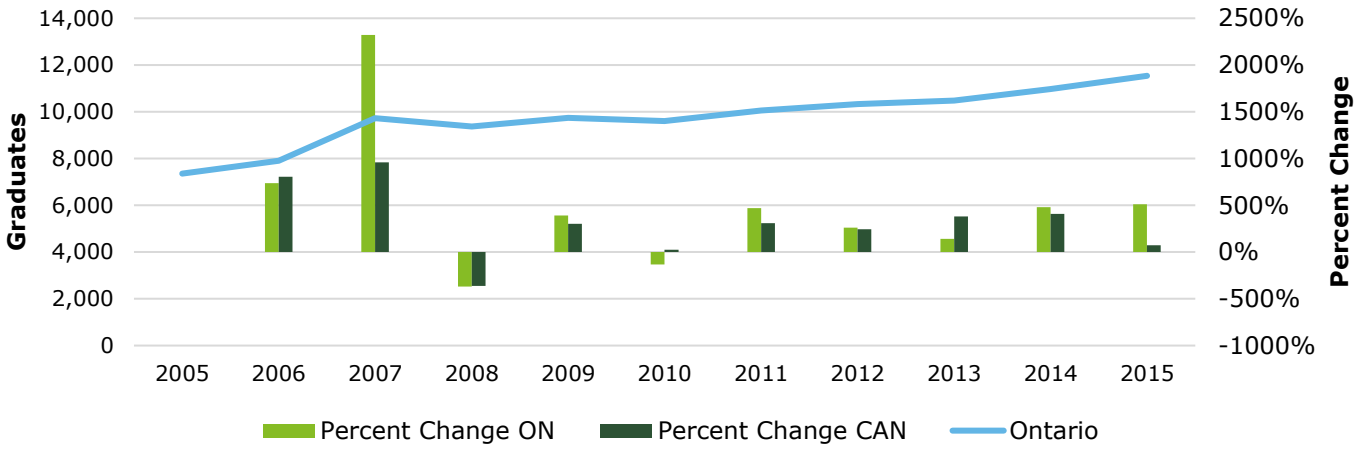
In 2015, postsecondary graduates from physical, life sciences and technologies[72] programs in Ontario totaled 11,538 (comprising 48% of the national total). The majority of graduates were from universities (91%) versus colleges (9%).[73] Growth in the number of graduates over the 2010-15 period was 20% in Ontario compared to only 15% for all of Canada during the same period.

[71] Scientific America Worldview – A Global Biotechnology Perspective, 2016 Worldview Scorecard.

[72] This category includes: physical sciences, biological and biomedical sciences, biological and physical sciences, natural sciences, nutrition sciences, neuroscience, and science technologies and technicians. It does not include agricultural sciences, dental, medical and veterinary programs or health professions and related clinical sciences.

[73] Statistics Canada Table 37-10-0012-01

Figure 40: Ontario Life Sciences Graduates




Source: Statistics Canada Table 37-10-0012-01

Figure 41: Ontario Life Sciences Graduates by Gender


Source: Statistics Canada Table 37-10-0012-01

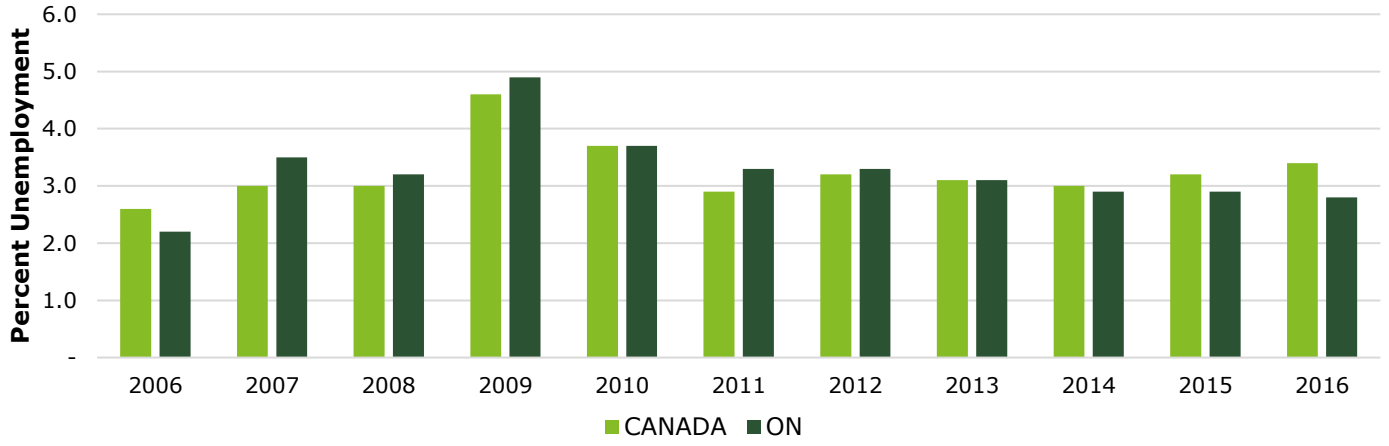
Women comprise the majority of life sciences graduates (56 percent in 2015) in Ontario. Data from the latest 2016 census indicate both male and female university graduates aged 15 to 34 from science programs have an unemployment rate of 6.9%.[74] However, this dominance of female graduates is not reflected in wages as the median wages for female university graduates from science programs was 19% less than male wages.[75]

### 3.4.2. Unemployment in Life Sciences Occupations

After the economic slowdown in 2008, unemployment rates in the natural and applied sciences occupations rose across Canada, and climbed at a higher rate in Ontario. However, as the Ontario economy recovered, the unemployment rate for natural and applied sciences occupations dropped below the Canadian average over the 2014-16 period.

[74] Statistics Canada - 2016 Census. Catalogue Number 98-400-X2016251.
[75] Statistics Canada - 2016 Census. Catalogue Number 98-400-X2016254. Note: median wages for all wage groups was used in analysis

Figure 42: Unemployment Rate for Natural and Applied Sciences Occupations




Source: Input Indicators of the BC High Technology Sector 2017 Edition, BC Stats.

Unemployment for all science graduates is slightly higher compared to other Science, Technology, Engineering and Mathematics (STEM) disciplines, such as engineering and computer sciences. However, the highest unemployment rates are experienced by young science graduates.

In 2016, the unemployment rate for Ontario science graduates with a minimum university bachelor's degree between the ages of 15 and 24 was a troubling 17.9 percent.[76] The unemployment rate drops for older age groups to 6.4 percent for ages 25 to 34 then to 3.6 percent for ages 35 to 44. The disproportionate higher rates of unemployment for young science graduates highlight a significant gap in transitioning these graduates into the workforce. The implementation of financial support provided by wage subsidy programs, such as the federal Career Focus program, encourage businesses to hire new graduates. The integration of apprenticeships into higher education programs in Germany have also proven highly successful to tackle youth unemployment. [77]

Figure 43: Unemployment Rates by Age Group in the Sciences


Source: 2016 Census Data Tables, Catalogue no. 98-400-X2016251

[76] 2011 National Household Survey: Data tables, STEM Groupings, Major Field of Study, Catalogue no. 99-012-X2011043.

[77] Source: Mowat Centre, TLDR – Sept. 12, 2014, "Youth unemployment in Germany is much lower than in Canada. How do they do it and what can we learn?"

# Section 4: Advancing the Life Sciences Sector in Ontario

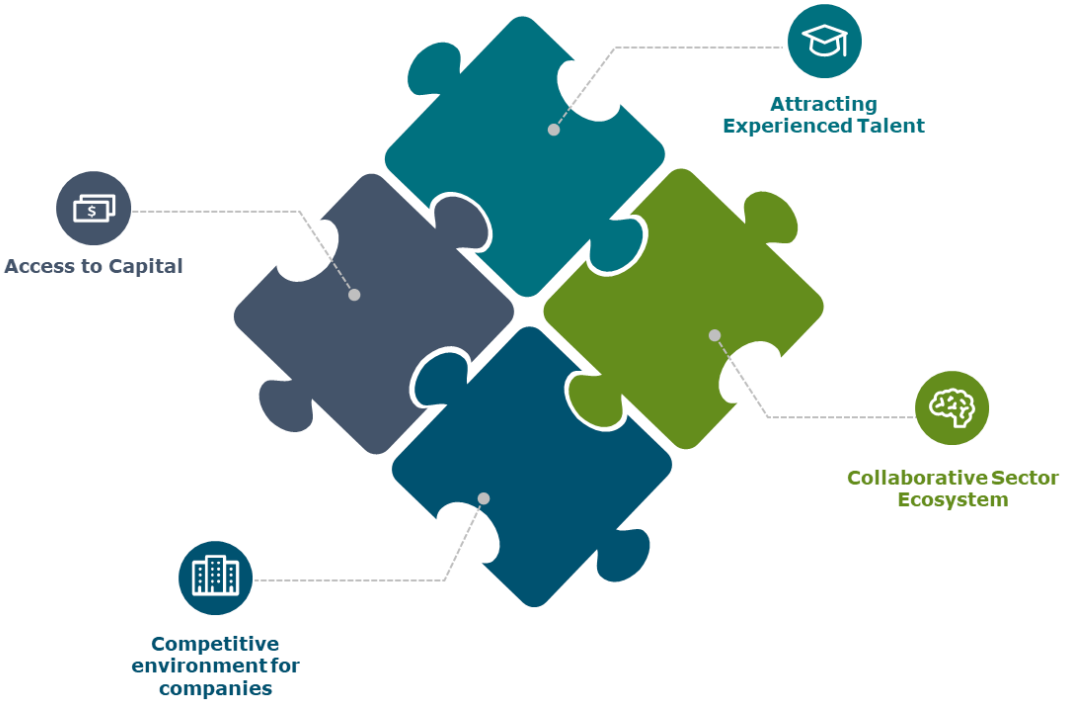
The following section contains an overview of life sciences jurisdictions that have successfully transformed research and innovation into commercialization. The analysis identifies key characteristics of advanced life sciences jurisdictions and compares these characteristics against Ontario's current state based on findings from the consultations. Finally, this section concludes with an illustration of the potential economic contributions that would occur to Ontario if it were to address the challenges faced by the sector and experienced a growth trajectory similar to that of these advanced jurisdictions.

## 4.1. Key Characteristics of Advanced Life Sciences Sectors

In order to grow the life sciences sector in Ontario, our entrepreneurs, start-ups, and other local companies require an environment that provides support from ideation and innovation through to commercialization and scaling. This environment would strengthen the life sciences ecosystem, encouraging the establishment of more life sciences firms, increasing the employment opportunities within the sector, and the revenue generated by the sector within the province.

Through our research and executive consultations, we were able to synthesize the key characteristics of advanced life sciences jurisdictions into the following four enablers:

Figure 44: Characteristics of a Successful Life Sciences Sector



Within each of the four enablers, there is an opportunity for government, academia and the sector to collaborate in improving the economic outcomes of both the sector and local region. Tables 9-12 below present a description of these four key enablers and their significance with respect to the life sciences sector. These descriptions are based on a synthesis of the consultation results and stakeholders' views on Ontario's current position.

Table 9: Access to Capital Analysis

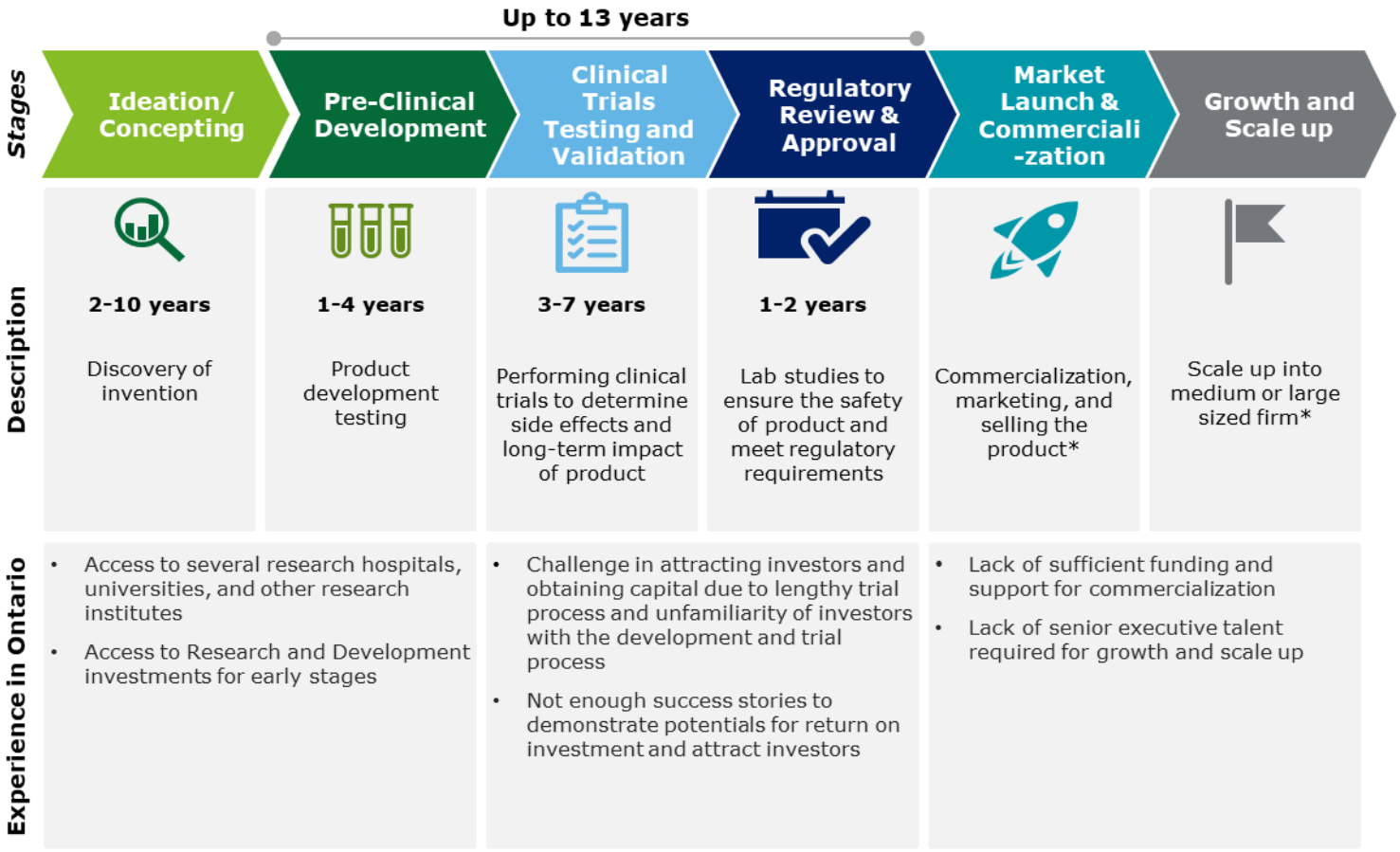
| **Key Enabler: Access to Capital** | |
|---|---|
| Significance to the life sciences sector | • The process of turning an invention into a commercialized product requires extensive research and clinical trials, and thus can be extremely lengthy and expensive.<br>• As a result, start-ups in the life sciences ecosystem require a significant amount of funding and investment over the course of the commercialization process. |
| Stakeholders' views on Ontario's current position | • Ontario lags behind other North American jurisdictions in terms of venture capital investment per capita.[78]<br>• Stakeholders attribute the lack of sufficient capital for start-ups and entrepreneurs in Ontario to the following factors:<br>– The limitation of capital in Ontario stems from the lack of capital investment from private investors, pension funds, and the government.<br>– Start-ups may be able to find angel investments when the companies are still young, but they have difficulty finding later-stage funding further along on the commercialization process (figure 45).<br>• This lack of sufficient capital hinders the ability of companies to commercialize their innovations and scale-up in Ontario; this leads to companies seeking capital in other jurisdictions and leaving Ontario and Canada.[79] |

**The lack of sufficient capital in Ontario hinders the ability of companies to commercialize their innovations and scale-up in Ontario.**

[78] Thomson Reuters, Canadian Venture Capital Review Full Year 2017; Statistics Canada Table 17-10-0005-01; U.S. Census Bureau, Population Division

[79] A Summary of the Workshop Held March 1, 2016 Vancouver, BC. Delphi Group and Globe Series. http://delphi.ca/wp-content/uploads/2016/05/05-04-GLOBE-CCTI-Workshop-Report.pdf

Figure 45: Commercialization Process




Source(s): http://www.aqbioforum.org/v8n1/v8n1a03-elbehri.htm; https://lifesciencesbc.ca/wp-content/uploads/2015/06/LifeSciences-BC-Sector-Report-2015.pdf; https://steveblank.files.wordpress.com/2013/08/drug-discovery-pipeline.jpg
*Time frame unavailable

Table 10: Attracting Experienced Talent Analysis

| **Key Enabler: Attracting Experienced Talent** | |
|---|---|
| Significance to the life sciences sector | • A strong life sciences ecosystem requires a mixture of leading research talent, as well as experienced executive and managerial talent.<br>• Companies and start-ups not only need strong researchers to perform the clinical trials, but they also require executives with experience in raising capital, marketing, and the overall business aspect of taking a product through the process of commercialization and into sales and revenue generation.. |
| Stakeholders' views on Ontario's current position | • In Ontario, there are strong researchers and academics, but the sector lacks experienced executives and managerial talent, relative to other leading life sciences jurisdictions.<br>• Consulted stakeholders suggested that this talent shortage is due to limited opportunities for individuals to obtain experience within Canada and Ontario as a result of few domestic high-growth companies in the sector. Additionally, due to limited capital in Ontario's life sciences sector, talented entrepreneurs may choose to emigrate to other jurisdictions to seek funding for their start-up.<br>• Another challenge related to talent is that Ontario seems to have difficulty attracting experienced and managerial level international professionals, to the province, or experienced Canadians who have moved abroad. Based on stakeholders' views, this may be attributable to Ontario's challenge in competing with international remuneration offered in other jurisdictions; this could be due to the relatively small size and low investment returns of Ontario-based companies compared to large multi-national companies based in other jurisdictions. |

**In Ontario, there are talented researchers and academics, but the sector lacks experienced executives and managerial talent relative to other leading life sciences jurisdictions.**

Table 11: Collaborative Sector Ecosystem Analysis

| **Key Enabler: Collaborative Sector Ecosystem** | |
|---|---|
| Significance to the life sciences sector | • A collaborative support ecosystem for entrepreneurs could better enable start-ups to grow and manufacture commercialized products.<br>• Ready access to education materials and mentorship programs provides entrepreneurs with the resources to learn how to navigate the commercialization process as well as the life sciences sector.<br>• Collaboration and interaction with other start-ups and sectors also encourages innovation through the transfer of ideas. |
| Stakeholders' views on Ontario's current position | • Ontario's life sciences sector benefits from a variety of different support programs targeted at start-ups:<br>– The MaRS innovation lab provides support to start-ups within the life sciences and technology industries in areas of business development, intellectual property, financial management, and marketing. Acting as a commercialization agent, MaRS also offers funding to start-ups and researchers.<br>– Ontario is also home to the first JLABS incubator located outside of the US.77F80 The JLABS incubator, established in 2015, supports start-ups with lab space, programs and potential investment partners.<br>– The Ontario Network of Entrepreneurs is a province-wide network that supports innovation-based entrepreneurs and businesses as they launch and grow globally competitive companies.<br>– The Ontario Centres of Excellence is a link between the sector and academia, offering business leaders access to top research talent to help address innovation challenges.<br>• Despite the current levels of support, stakeholders have expressed the need for more collaboration and support such as incubators and accelerators to encourage growth within the life sciences sector. |

**A collaborative support ecosystem for entrepreneurs could better enable start-ups to grow and develop commercialized products.**

[80] Financial Post (2016). Johnson & Johnson's first JLABS incubator outside the U.S. opens at Toronto's MaRS. Obtained from: https://business.financialpost.com/entrepreneur/fp-startups/johnson-johnsons-first-jlabs-incubator-outside-the-u-s-opens-at-torontos-mars

Table 12: Competitive Environment for Companies

| **Key Enabler: Competitive environment for companies** | |
|---|---|
| Significance to the life sciences sector | • Fostering a competitive life sciences environment can attract (and retain) leading life sciences entities to Ontario. Policies, regulations, and programs put in place by the government can have a significant impact on the growth and competitiveness of the life sciences sector |
| Stakeholders' views on Ontario's current position | • Significant policy and regulatory barriers have been identified that impact the development of Ontario's life sciences sector.<br>• The lack of certainty, transparency, and consistency within government policies for the sector could limit Canada's ability to create a competitive life sciences environment. The lack of predictability within the market may be deterring international companies and investors from Canada.[81]<br>• Considerations can be given to implementing a national strategic plan for the life sciences sector, which is cohesive with provincial plans. This would demonstrate to international players that Canada is making a commitment to grow their life sciences sector and create greater confidence in the market, which can help attract talent and investment into Canada.[82]<br>• Regulatory requirements implemented by Health Canada, the federal price regulator (the PMPRB) and the provincial health and insurance system limit the effectiveness of recent government initiatives undertaken by Innovation, Science and Economic Development Canada (ISED). These ISED measures include the implementation of tax policy, direct funding programs and incentives for capital to spur innovation.[83]<br>• Several stakeholders consulted have identified the public sector procurement process as a barrier to the growth of the life sciences sector in Ontario.<br>– Compared to other developed nations, access to the Canadian market usually takes over two years longer for innovative firms and processes are particularly difficult to navigate for SMEs.[84]<br>– Due to the length of the process as well as the strict rules and standards around procurement, many life sciences companies find it difficult to find a local market for their pharmaceuticals or medical devices within the province.<br>– Multi-national and Ontario-based companies might not choose to manufacture their products in Ontario because they may find it challenging to sell their products in the local market. |

**Policy uncertainty and regulatory barriers could hinder investment and effective development of Ontario's life sciences sector.**

[81] Ontario Bioscience. How Canada should be engaging in a $9 trillion dollar heath economy. Obtained from: https://static1.squarespace.com/static/55bbf3f3e4b08b3622073685/t/57363d8ef8baf3384ab6af38/1463172496762/ConsultationReport.pdf
[82] Public Policy Forum. Bringing Innovation to Life: Innovation-Based Growth In Canadian Life Sciences. Obtained from: https://ppforum.ca/publications/bringing-innovation-life-innovation-based-growth-canadian-life-sciences/
[83] Public Policy Forum. Bringing Innovation to Life: Innovation-Based Growth In Canadian Life Sciences. Obtained from: https://ppforum.ca/publications/bringing-innovation-life-innovation-based-growth-canadian-life-sciences/
[84] Ontario Chamber of Commerce. 2018 Ontario Economic Report. Obtained from: https://occ.ca/wp-content/uploads/2018-Ontario-Economic-Report-8.pdf

## 4.2. Success Factors of Life Sciences Sectors in Selected Advanced Jurisdictions

As Ontario considers how to address the challenges faced by the life sciences sector, there are several examples of successful practices employed elsewhere to consider. Below, we examine these successful practices, each of which correspond to the identified key characteristics of a successful life sciences sector described in section 4.1. It should be noted that these examples do not reflect the full breadth of potential practices, and should be viewed as illustrative examples from other jurisdictions.

### Massachusetts

#### Context

The Greater Boston Area is home to the Life Sciences Corridor which is the world's largest cluster of life sciences and biotech companies. The life sciences cluster is supported by world-class universities, medical facilities and talent. The Greater Boston area also has the largest concentration of life sciences researchers in the United States, and has been ranked as the top US life sciences cluster due to levels of innovation growth, talent, and life sciences employment.

#### Examples of Key Learnings

- In 2008, Massachusetts Governor Deval Patrick signed off on a 10-year US$1 billion initiative to strengthen the life sciences sector in Massachusetts. Over the course of the 10-year funding period, the initiative directly assisted 115 companies, and Massachusetts rose from the state with the fourth highest employment to the second highest employment in the life sciences sector. Key components of the initiative include the following:
  - The **Massachusetts Life Sciences Center ("MLSC")** was created to invest government funds into innovation, education, research & development, and commercialization.
  - The MLSC offers a variety of support for start-ups and life sciences firms including a **six-week program** that teaches entrepreneurs about the whole process of product development and commercialization.
  - The MLSC also offers an **"Angel Tax Credit"** program for investors. Under this program, investors in early-stage companies within eHealth, information technology, and health sectors are eligible for a tax credit equal to 20% of their investment.

#### Considerations for Ontario

- The life sciences eco-system in Massachusetts is supported by government funding.
- Ontario could consider working with the sector and government to create coordinated strategic initiatives and provide further funding and support to entrepreneurs. The province could also consider incentives for investors in order to grow the region's life sciences sector.

### California

#### Context

California has one of the most successful life sciences sectors in the world with approximately 3,249 life sciences firms generating US$169 billion in revenue. San Francisco is at the heart of California's life sciences sector, and is considered the "birthplace" of the biotechnology sector after two scientists discovered "gene splicing" in the 1970s. This discovery was a launching point for the life sciences sector, as genetic engineering contributed to the production of new drugs in subsequent years.

#### Examples of Key Learnings

- The commercialization process is supported through a **highly developed system of incubators and accelerators** that are supported by local and foreign governments, universities, corporations, federal laboratories or may be independent. There are over 80 incubators and accelerators in San Francisco alone in 2012. These facilities provide flexible office space, networking opportunities, legal and consulting advice, and access to venture capital for thousands of start-up companies.
- The level of **educational excellence is a major driver of federal funding** in the Bay Area region. The Bay Area received over $3 billion in funding from the National Institute of Health (NIH) in Q2 2017. The largest recipients of this funding, University of California San Francisco and Stanford University, received over US$1 billion combined.
- The San Francisco Bay Area boasts a **high concentration of research universities, VC investors, and micro-clusters that are linked by networks**. The region's interconnected innovation system composed of these diverse sets of institutions and actors enable the conception, research, development and commercialization of new technologies and business models.

#### Considerations for Ontario

- The San Francisco Bay Area's highly collaborative environment between sector and academia contributes to the success of the region's life sciences sector.
- Initiatives that increase the level of collaboration and support available to entrepreneurs could more effectively enable growth in Ontario's life sciences sector.

### Denmark

#### Context

Denmark is ranked number 2 in the world for developing biotechnology and is home to one of Europe's strongest life sciences supercluster, Medicon Valley, which is located in the eastern part of Denmark (along with the southern part of Sweden). The cluster employs 90 percent of Scandinavia's life sciences graduates and is home to 350 companies.

#### Examples of Key Learnings

- Denmark is one of six countries in the world that **invests more than three percent of its GDP on R&D**. The Danish government ensures at least one percent of GDP is spent on state funded research, combined with private research investments which accounted for approximately two percent of GDP in 2013.
- Denmark's low corporate tax rate, competitive business costs and flexible labour market policies make it an attractive destination for foreign investment.
  - The Danish "**flexicurity**" model enables business to hire and fire employees relatively easily if business conditions change. This model is based on an active training policy and guarantees workers with sufficient income and retraining options if they lose their jobs.
  - Among European countries, Denmark has a **low corporate tax rate** of 22%. There is also a unique tax provision **that prevents double taxation** as Danish companies are not taxed on income from foreign branches.
- **Start-up Denmark** is a start-up visa program to help talented entrepreneurs relocate and grow high-impact start-ups in Denmark. Accepted applicants obtain a residence and work permit valid for two years with the possibility of extension.
- To increase access to skilled labour, Denmark's business minister has expressed intentions to expand "forskerordning" – a **tax program that permits foreign researchers and highly-paid employees to be placed in a low tax bracket** in Denmark for a certain number of years, providing they earn more than 63,700 kroner per month.
- There exist **four government-funded incubators** in Denmark for innovation start-ups, where entrepreneurs can obtain counselling, pre-seed and seed capital. The innovation incubators operate at the earliest stage of the investment chain to encourage venture capitalists and other private investors to engage.
- **The Hub** is a free platform that provides visibility to all Danish start-ups. The platform provides assistance with recruitment of talent, connection with investors and access to best practice tools (i.e. employment contracts and pitch decks).

#### Considerations for Ontario

- Denmark's business environment encourages investment in the region's life sciences sector, with the start-up visa and tax schemes increasing access to experienced talent, and government-funded incubators providing support to start-ups.
- Implementing similar policies, regulations, and programs that increase the competitiveness of Ontario's life sciences sector can attract (and retain) leading life sciences entities to Ontario.
- Streamlining the immigration process for international hires can speed up and simplify the immigration process and facilitate attracting international talent to Ontario's life sciences sector, and allow these professionals to integrate into Ontario's life sciences workforce faster.
- Ontario could consider providing tax incentives to internationally hired professionals in the form of a reduced tax rate for the first few years of living in Canada to help increase Ontario's competitiveness with international compensation.
- Ontario could also consider increasing the number of incubators and accelerators available for start-ups to support and accelerate the creation of successful life sciences companies.

### Germany

#### Context

Germany has one of the leading life sciences ecosystem, and specializes in biotechnology, pharmaceuticals, and medical devices. The country's capital, Berlin, is one of the top three European tech start-up cities employing 360,000 people in over 700 firms (includes 300 medical technology, 240 biotechnology, 30 pharmaceutical companies, and 130+ clinics).

#### Examples of Key Learnings

- Germany's **"BioRegions"** are regional initiatives dedicated to the advancement of modern biotechnology. Over the past 30 years, these biotechnology clusters have grown into some of the leading R&D hubs in Europe.
  - Each of the **30 German BioRegions** specialize in particular areas and facilitate collaboration between universities, R&D institutes, and private sector companies. These BioRegions are active members of AK Bioregio ("Council of German BioRegions"). AK BioRegio advances the exchange between regional initiatives and relays its expertise to policy decision makers.
  - BioRegions also include technology parks known as **"BioParks."** These parks are tailored to the specific needs of biotechnology companies and offer infrastructure (such as lab space and clean rooms) as well as a range of services for both start-ups and well-established companies. Investors also benefit from easy access to networks and funding for research projects.
- To encourage commercialization, the German government has put forth a wide array of supports **focused on increasing access to capital**. Key examples include:
  - **New state-owned fund** in 2018, which will provide start-ups with access to VC funding. The company will be a subsidiary of the Kreditanstalt für Wiederaufbau (KfW), the state-owned development bank, and is set to provide an estimated €500 million to €600 million in VC funding.
  - **ProFIT project financing program** provides support for R&D projects in the form of non-repayable grants and/or low-interest loans to Berlin-based businesses and research institutions. Projects can qualify for funding during all phases of the innovation process.
  - **Central Innovation Program SME (ZIM)** is an initiative of the Federal Ministry for Economic Affairs and Energy (BMWi) and provides grants for ambitious R&D projects. ZIM is the largest program to support innovative SMEs in Germany, with a €548 million budget in 2017.

#### Considerations for Ontario

- Germany's BioRegions encourage collaboration and innovation across the country and provide technology parks that offer infrastructure and services to start-ups and well established companies. There are also a range of government support that focus on increasing access to capital.
- Encouraging collaboration among Ontario's life sciences sector through R&D clusters can enable further innovation and growth.
- The promotion of private investment by the Ontario government, and increasing government support for funding can provide life sciences companies with the needed capital to commercialize their innovations and scale-up.

### United Kingdom

#### Context

The United Kingdom has an advanced life sciences sector, centered mainly around their leading universities (Oxford and Cambridge). The country has Europe's largest cluster in biotechnology therapeutics and pharmaceuticals, and is the third largest global hub for biosciences. More than £64 billion in revenue is generated by the UK life sciences sector, and more than 233,000 scientists and staff are employed.

#### Examples of Key Learnings

- The UK government's "**Strategy for UK Life Sciences**" in 2011 contains public policy initiatives designed to make the UK a global hub for life sciences. Since the launch of the strategy, the following policies have been carried out:
  - £2 billion in **public investment in health life sciences research** via the Research Councils and National Institute for Health Research Program.
  - Over £250 million awarded to 318 early stage companies and university ventures under the **Biomedical Catalyst**, attracting £120 million of further private sector investment and over £1 billion in post-project financing through licensing deals and acquisitions.
  - Over £200 million dedicated to **sequence 100,000 whole genomes**, with a commitment to further funding made in the recent Spending Review.
  - £55 million to develop the Cell Therapy Manufacturing Centre.
- There are **over 100 Science Parks** in the UK that encourage and support the startup and incubation of innovation-led, high-growth, knowledge-based businesses. These parks support collaboration among larger and international businesses with a particular centre of knowledge creation. Formal and operational links also exist among the Science Parks and centres of knowledge creation such as universities, higher education institutes and research organizations.
- The UK government's **Life Sciences Industrial Strategy** in 2017 put forward recommendations to promote the sector's long-term success. The Strategy includes:
  - Plans to establish a new £2.5 billion **investment fund incubated in the British Business Bank**, unlocking £7.5 billion through investing with the private sector. The UK government also announced **backing first-time and emerging fund managers** through the British Business Bank's established Enterprise Capital Fund program, supporting at least £1.5 billion of new investment. Approximately, £1 billion of new investment is also expected to be released from the UK government's plans of **backing overseas investment in UK venture capital**.
  - Recommendations to **enable high-skilled immigration** through changing immigration rules to enable world-leading scientists under the Tier 1 route to apply for settlement after three years, reduce red tape in hiring international researchers, and make it quicker for highly-skilled students to apply to work in the UK after finishing their degrees.
- The UK also provides **tax incentives** to encourage regional or global pharmaceutical manufacturing, including:
  - Low rates of tax, with headline corporate tax rates falling to 17% by 2020.
  - Innovation incentives (R&D tax relief and Patent Box) which can be used by product developers and their R&D, clinical or manufacturing partners.
  - Comprehensive global treaty network.
  - Up to £50 billion available to support finance and insurance for supplies from within the UK to buyers outside the UK. This support takes the form of guarantees, insurance and loans issued by its export credit agency.

#### Considerations for Ontario

- The UK's life sciences sector is supported by a range of initiatives that increase access to capital, collaboration, talent attraction and competitiveness of the business environment.
- Ontario could consider de-risking private investment by insuring first time and emerging fund managers. Incentives that have matching schemes with the private sector could also help unlock additional private capital.
- Implementation of Science Parks across the province can also enable start-ups to grow and manufacture commercialized products more easily.
- UK government's willingness to reduce corporate tax rates and ease immigration requirements can be considered in Ontario to encourage capital and talent attraction.

## 4.3. Potential Impacts of Sector Advancements in Ontario

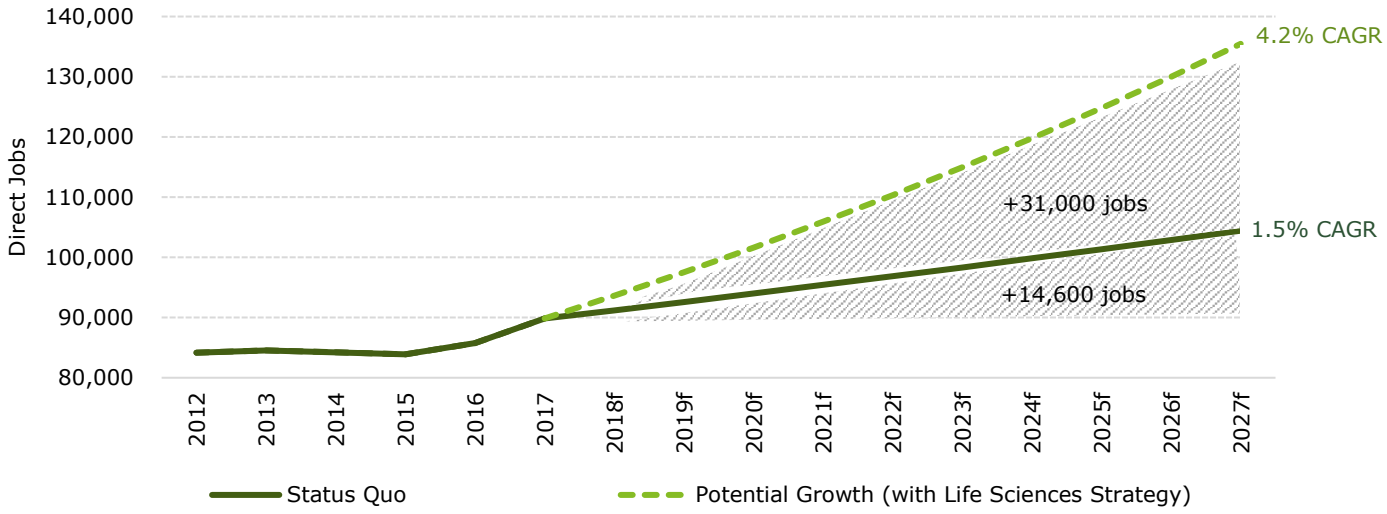
If Ontario's life sciences sector follows similar trends to those in other advanced life sciences jurisdictions, the potential exists for Ontario to witness significant economic benefits as a result of an accelerated growth in the life sciences sector.

Based on findings from the literature review and stakeholder consultation process, Massachusetts was identified as the top Life Sciences cluster. The life sciences eco-system in Massachusetts is supported by government funding, such as the US$1 billion/ten-year initiative known as the Life Sciences Initiative ("LSI") approved in 2008.[85] Highlights of the Initiative include[86]:

- $500 million in capital funding to be spent over a ten-year period;
- $25 million each year for ten years for the Massachusetts Life Sciences Investment Fund;
- $25 million each year for ten years in tax incentives to be awarded to certified life sciences projects;
- Creation of the Massachusetts Life Sciences Investment Program to expand employment in the life sciences sector; and
- Creation of five Regional Technology and Innovation Centers.

As a result of this initiative, employment in Massachusetts' life sciences cluster increased significantly over the funding period. Using data obtained from Battelle's biannual biotechnology jobs reports, employment within Massachusetts' life sciences sector was declining prior to the creation of the initiative by 8 percent over the 2001-06 period. After the initiative, employment steadily increased by 25 percent over the 2006-10 period, and increased by 51 percent over the 2006-16 period.[87] Employment growth in Ontario's life sciences sector, over the same time period, was only 6 percent and 14 percent respectively. To illustrate the potential outcomes that could be realized with a coordinated life sciences strategy, the graph below projects potential direct employment outcomes using Ontario's historical ten-year life sciences job growth rate (status quo) against a potential similar ten-year employment growth rate based on Massachusetts experience following the LSI.[88]

Figure 46: Projected 10-Year Life Sciences Direct Jobs Outcomes




Source: Status quo employment growth data obtained from Statistics Canada Tables 14-10-0202-01 & 14-10-0023-01 – See Appendix B for detailed methodology; Potential growth data obtained from 2008, 2012 and 2018 editions of Batelle's biannual biotechnology jobs reports

[85] Biotechnology Innovation Organization. State Legislative Best Practices in Support of Bioscience Sector Development. Obtained from: *https://www.bio.org/articles/state-legislative-best-practices-support-bioscience-sector-development*

[86] Ibid.

[87] 2008, 2012 and 2018 editions of Batelle's biannual biotechnology jobs reports were used to conduct the analysis. Note: Batelle's 2008 report is missing 2006 employment information for three of Massachusetts' biotechnology subsectors (agricultural feedstock and chemicals, drugs and pharmaceuticals, and bioscience-related distribution). Employment shares derived from Batelle's 2018 report were used to allocate 2006 employment within these subsectors.

[88] Projections are based on Ontario's Life Sciences employment growth over the 2007-2017 period (1.5 percent CAGR) and Massachusetts' Life Sciences employment growth over the 2006-2016 period (4.2 percent CAGR).

Thus, evidence from Massachusetts suggest that the potential could exist for Ontario to witness transformative economic benefits as a result of a thriving life sciences sector.

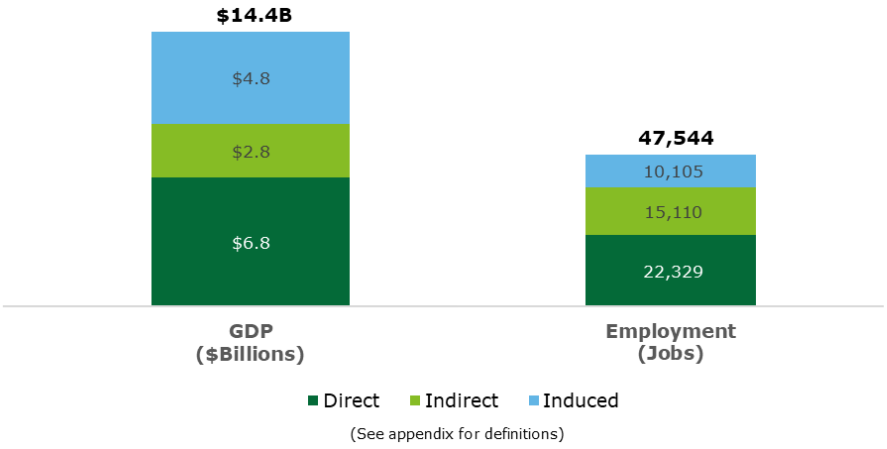
If biotechnology adoption in Ontario followed similar trends to those in Massachusetts, the potential economic returns could be significantly higher for the province. This potential economic return is estimated based on five and ten-year employment growth rates experienced in Massachusetts following the LSI:

- Five-year growth rate of 25 percent
- Ten-year growth rate of 51 percent

Based on these growth rates and using the latest (2014) Statistics Canada Input-Output multipliers, projected direct, indirect and induced GDP and employment impacts in the Ontario context are derived. Potential productivity gains are not estimated in this approach.[89]

If the sector in Ontario were supported to experience a similar 25 percent employment growth from its 2017 base over a five-year period, the Ontario life sciences sector could have the potential to create an incremental 47,544 total jobs, accounting for direct, indirect and induced contributions. The potential contributions to total cumulative GDP could be an estimated $14.4 billion over a five-year period.

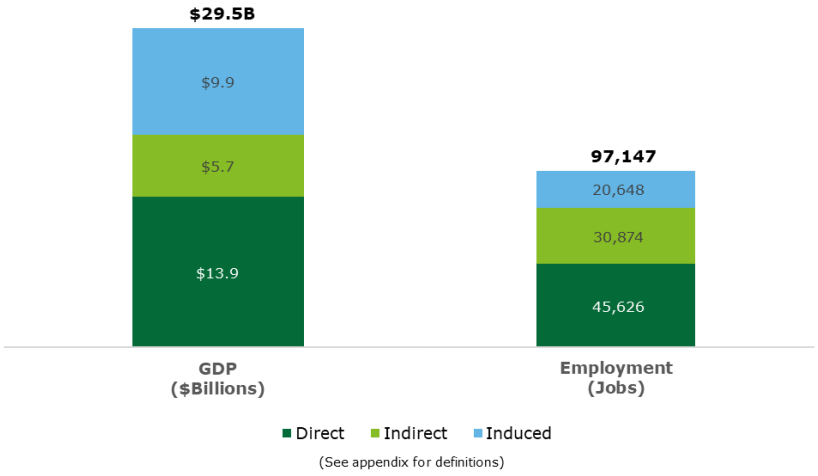
Figure 47: Potential Incremental Economic Contributions of a Growth Rate of 25 Percent




Over a ten-year period, if the Ontario life sciences sector were to experience 51 percent employment growth from its 2017 base, the sector could have the potential to create an incremental 97,147 total jobs, accounting for direct, indirect and induced contributions. The potential contributions to total cumulative GDP could be an estimated $29.5 billion over a ten-year period.

[89] The development of clusters depends on the sequence of investments and first-mover advantages. i.e., the fact that Boston is currently further ahead compared to other North American jurisdictions may limit available market to these jurisdictions.

Figure 48: Potential Incremental Economic Contributions of a Growth Rate of 51 Percent




## 4.4. Key Learnings based on Characteristics of Advanced Life Sciences Jurisdictions

Though significant, the key success factors of Massachusetts' Life Sciences Initiative extend beyond the level of government funding granted to the sector. The Ontario's life sciences sector, and its stakeholders across the private sector, public sector, and academia, could consider the following examples of key learnings from other leading jurisdictions when defining a coordinated and collaborative sector strategy.

1. Legislated strategies can increase the level of certainty within the public policy environment for the life sciences sector.

   The implementation of a legislated life sciences strategy, such as the Massachusetts Life Sciences Initiative or the Strategy for UK Life Sciences, could increase the transparency and strength of government commitments to the life sciences sector. Lowering uncertainty around the public policy environment through legislated strategies can also enable greater business investment, attraction, and growth.

2. Reviewing and prioritizing policy and program options to help bridge the commercialization gap.

   The analysis revealed a lack of sufficient capital for start-ups and entrepreneurs to commercialize their innovations and scale-up in Ontario. The implementation of coordinated strategic initiatives, with involvement from all ecosystem actors, can serve to create the conditions that are necessary to address the commercialization challenge. From a government perspective, this would start with a thorough program review.

3. Increasing awareness of public policy initiatives and the range of supports available for start-ups and entrepreneurs in the life sciences sector could help promote opportunities within the sector.

   Communicating and marketing government commitments to the local and global life sciences community can increase the effectiveness of public policy initiatives by raising awareness of the investment climate and the range of supports available for start-ups and entrepreneurs. For example, the promotion, and subsequent publicity received for Massachusetts' Life Sciences Initiative signaled to the global life sciences community that Massachusetts was "open for business" in biotech.

4. Measuring and reviewing policy programs to ensure desirable outcomes are attained and policies are assessed.

   Implementation of effective policies can support the development of a successful life sciences sector, yet continuous review and measurement of outcomes is necessary to ensure the effectiveness of these programs in achieving the desired outcome. Examples of outcome measures that can be collected include:

   - Attributes such as annual growth rates, level of private investment received to date, and research and development partnerships; and
   - Information on technologies and innovations developed by life sciences companies, surveys and engagement within the sector to determine whether the program has achieved its original intent

# Section 5: Summary of Results

Ontario's life sciences sector already contributes a notable impact to the provincial economy. As the life sciences sector continues to evolve, and as stated earlier, a holistic approach to addressing sector challenges with collaboration of government, higher education institutions and the private sector can catalyze the conditions for incremental, sustained economic growth – for both the life sciences sector and the province of Ontario.

This section outlines a summary of the current and potential sector contributions to Ontario's economy. The results are presented at the direct, indirect, and induced levels.

Table 13: Ontario Life Sciences Sector Economic Contributions

| | | |
|---|---|---|
| **GDP ($,Billions)** | **Direct** | $27.4 |
| | **Indirect** | $11.2 |
| | **Induced** | $19.5 |
| | **Total** | **$58.1** |
| **Jobs** | **Direct** | 89,842 |
| | **Indirect** | 60,794 |
| | **Induced** | 40,658 |
| | **Total** | **191,294** |

Table 14: Ontario Life Sciences Sector Government Revenue Contributions

| | | |
|---|---|---|
| **Government Revenue ($,Billions)** | **Federal** | $4.6 |
| | **Provincial** | $2.6 |
| | **Municipal** | $1.6 |
| | **Total** | **$8.8** |

Table 15: 5-Year Potential Incremental Economic Contributions of 25 Percent Growth

| | | |
|---|---|---|
| **GDP ($,Billions)** | **Direct** | $6.8 |
| | **Indirect** | $2.8 |
| | **Induced** | $4.8 |
| | **Total** | **$14.4** |
| **Jobs** | **Direct** | 22,329 |
| | **Indirect** | 15,110 |
| | **Induced** | 10,105 |
| | **Total** | **47,544** |

Table 16: 10-Year Potential Incremental Economic Contributions of 51 Percent Growth

| | | |
|---|---|---|
| **GDP ($,Billions)** | **Direct** | $13.9 |
| | **Indirect** | $5.7 |
| | **Induced** | $9.9 |
| | **Total** | **$29.5** |
| **Jobs** | **Direct** | 45,626 |
| | **Indirect** | 30,874 |
| | **Induced** | 20,648 |
| | **Total** | **97,147** |

# Appendices

## Appendix A: Subsector Analysis

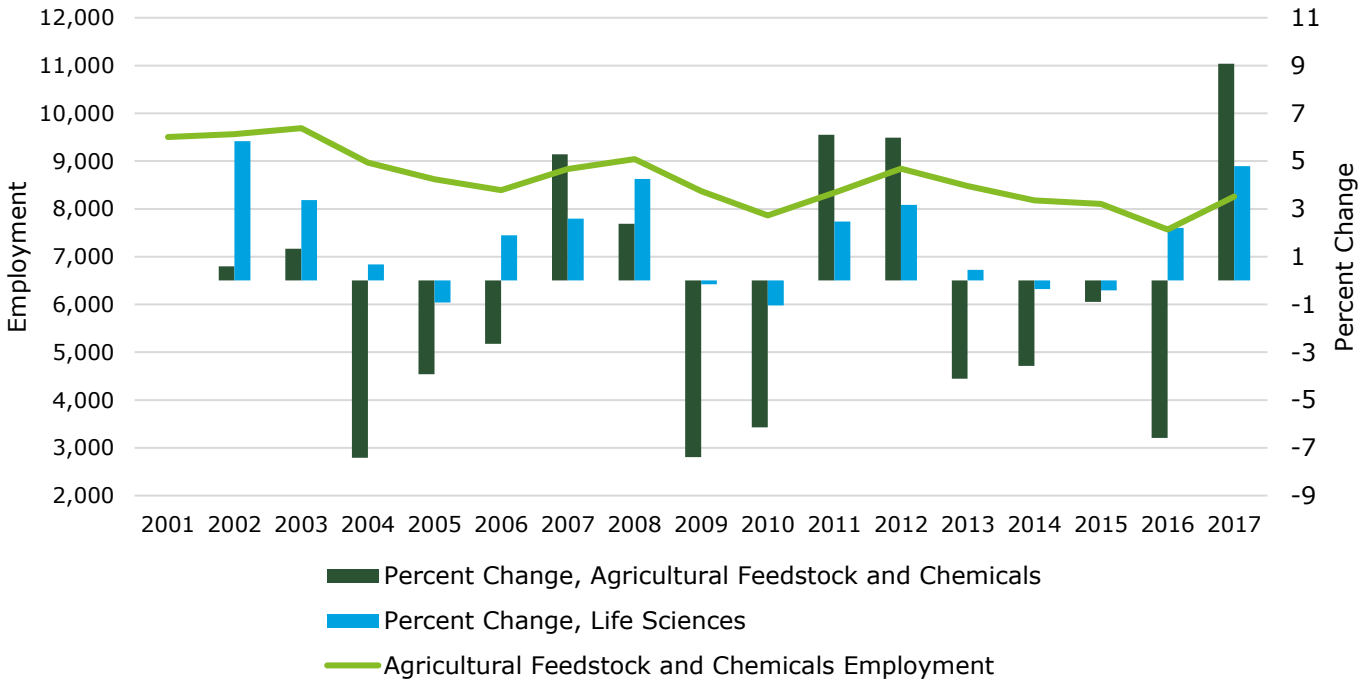
### A.1 Agricultural Feedstock and Chemicals

Table 17: Agricultural Feedstock and Chemicals Subsector Overview

| | Agricultural Feedstock and Chemicals | Life Sciences | Percent of Life Sciences |
|---|---|---|---|
| **Establishments** | 526 | 6,140 | 9% |
| **Employment** | 8,255 | 89,842 | 9% |
| **Avg. Annual Wage** | $57,971 | $61,328 | 95% |
| **Estimated Payroll** | $481M | $5,469M | 9% |

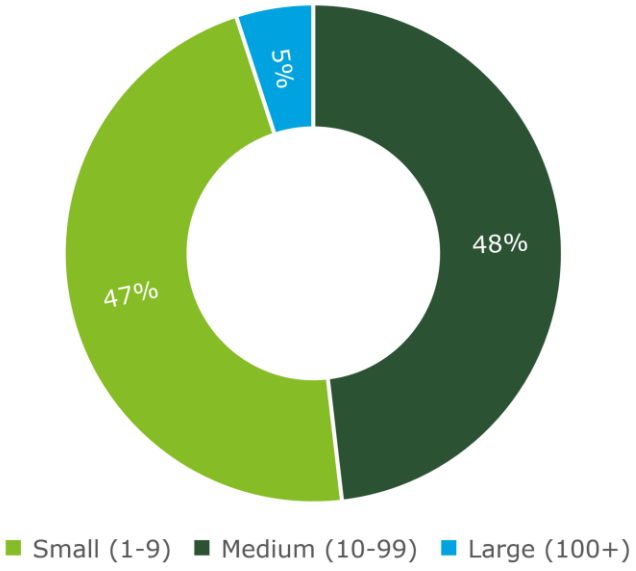
This subsector's employment growth has fluctuated over time. This may be in part due to the subsector's sensitivity to external forces, as the subsector is linked to traditional agriculture, it is significantly impacted by commodity prices and extreme weather events.

Figure 49: Ontario Agricultural Feedstock and Chemicals Employment




The agriculture subsector is dominated by small and medium sized establishments, and has the largest percentage of medium-sized enterprises within Ontario's life sciences sector.

Figure 50: Ontario Agricultural Feedstock and Chemicals Establishments by Size




### A.2 Drugs and Pharmaceuticals

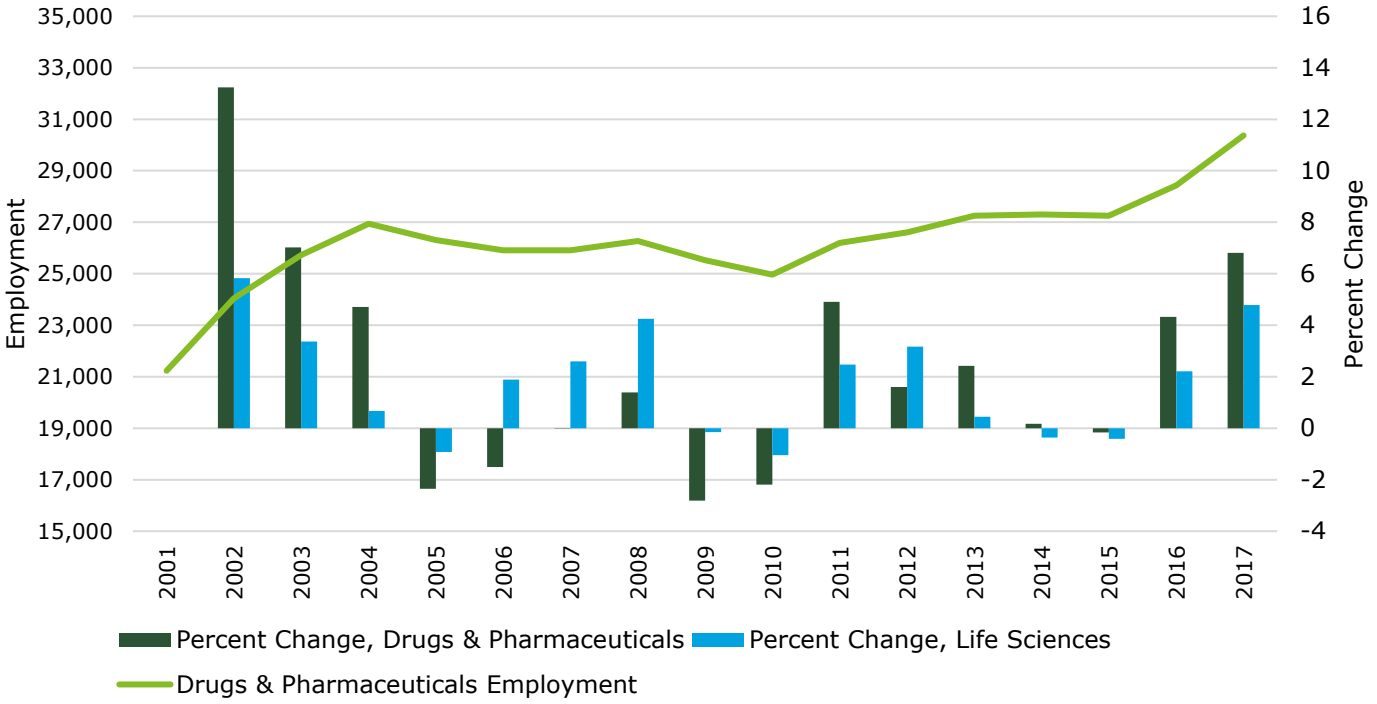
Table 18: Drugs and Pharmaceuticals Subsector Overview

| | Drugs & Pharmaceuticals | Life Sciences | Percent of Life Sciences |
|---|---|---|---|
| **Establishments** | 684 | 6,140 | 11% |
| **Employment** | 30,371 | 89,842 | 34% |
| **Avg. Annual Wage** | $62,820 | $61,328 | 102% |
| **Estimated Payroll** | $1,910M | $5,469M | 35% |

The drugs and pharmaceuticals subsector is one of the most significant life sciences sectors in Ontario. It contains a third of all the life sciences employment in Ontario, with only about a tenth of the establishments. The subsector is also responsible for approximately 64% of the sector's revenue in 2016.

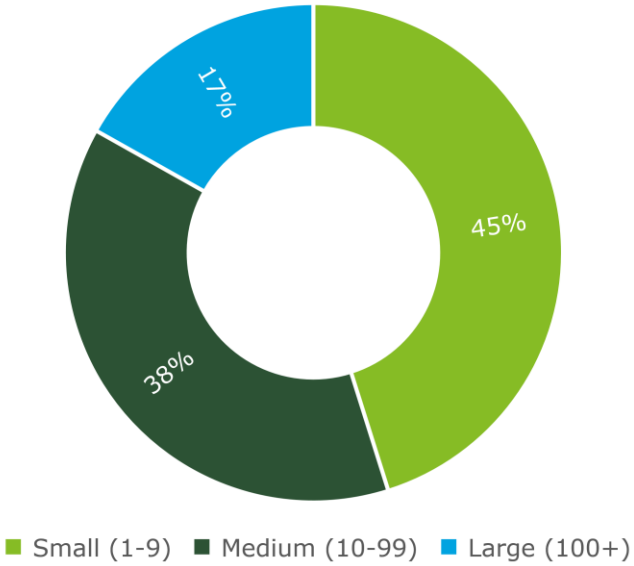
Employment in this subsector has significantly increased from 2001 to 2017. Employment growth has fluctuated over time, with most of the growth occurring from 2001-04 and 2015-17.

Figure 51: Drugs and Pharmaceuticals Employment




The drugs and pharmaceuticals subsector is mainly comprised of medium and large sized companies, and has the largest percentage of large-sized enterprises within Ontario's life sciences sector.

Figure 52: Ontario Drugs and Pharmaceutical Establishments by Size



### A.3. Medical Devices and Equipment

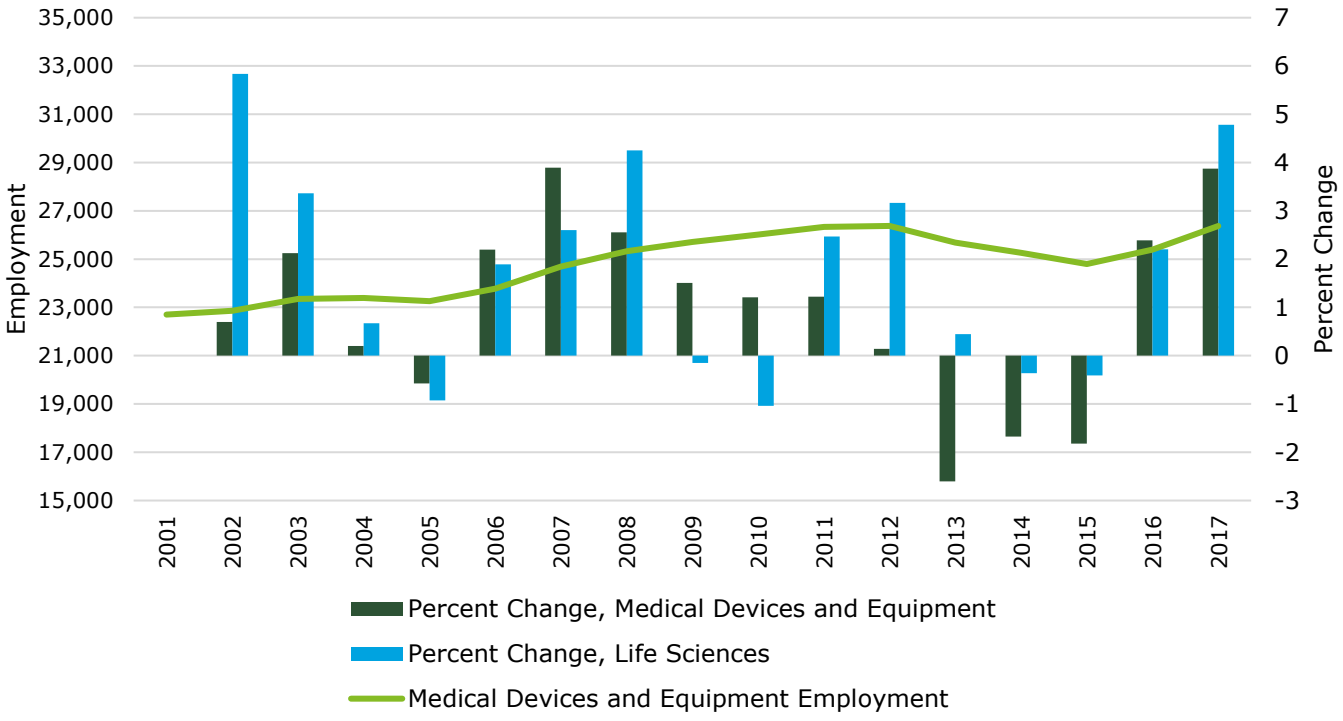
Table 19: Medical Devices and Equipment Subsector Overview

| | Medical Devices and Equipment | Life Sciences | Percent of Life Sciences |
|---|---|---|---|
| **Establishments** | 2,338 | 6,140 | 38% |
| **Employment** | 26,372 | 89,842 | 29% |
| **Avg. Annual Wage** | $58,506 | $61,328 | 95% |
| **Estimated Payroll** | $1,626M | $5,469M | 30% |

Medical devices and equipment is one of the largest the subsectors, contributing to a third of the employment and payroll of the life sciences sector. Additionally, the subsector is the second largest revenue generator, adding approximately one fifth of the sector's revenue.

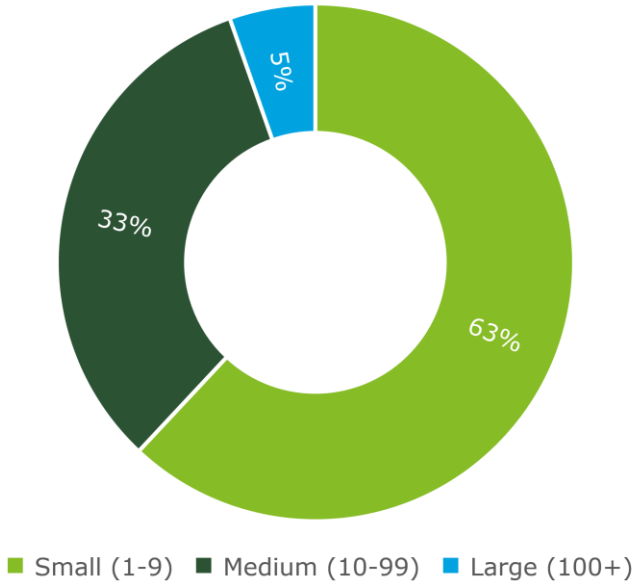
There has been moderate employment growth in this subsector. Even with the economic downturn in 2008, the subsector still experienced employment growth. From 2015 to 2017, the subsector was able to rebound and gain the employment lost from 2013 to 2015.

Figure 53: Medical Devices and Equipment Employment




The medical devices and equipment subsector is made up of mostly small-sized firms, which employ less than 10 people.

Figure 54: Ontario Medical Devices and Equipment Establishments by Size



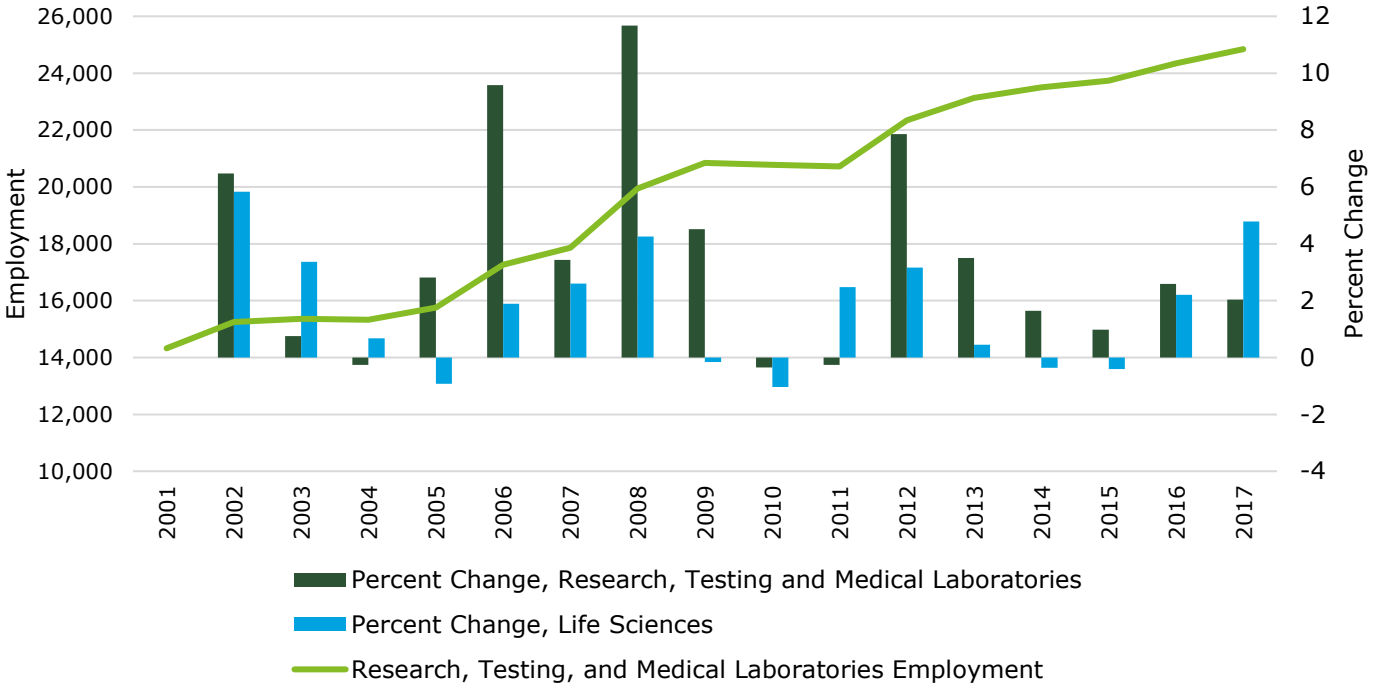

### A.4. Research, Testing, and Medical Laboratories

Table 20: Research, Testing, and Medical Laboratories Subsector Overview

| | Research, Testing, and Medical Laboratories | Life Sciences | Percent of Life Sciences |
|---|---|---|---|
| **Establishments** | 2,592 | 6,140 | 42% |
| **Employment** | 24,844 | 89,842 | 28% |
| **Avg. Annual Wage** | $66,017 | $61,328 | 108% |
| **Estimated Payroll** | $1,453M | $5,469M | 27% |

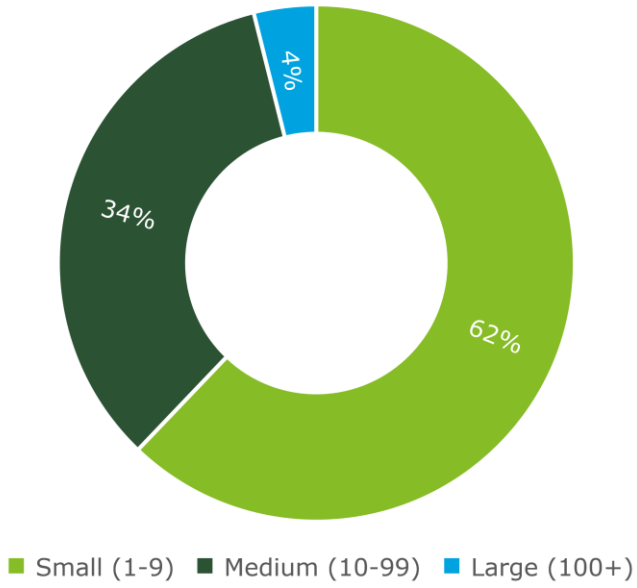
Research, testing, and medical laboratories contains the largest number of establishments in the life sciences sector, and accounts for 28% of the sector's employment. It also has the highest average salary across the segments, at $66,017. This subsector witnessed significant employment growth since 2011.

Figure 55: Research, Testing, and Medical Laboratories Employment




The subsector is mainly comprised of small and medium sized firms.

Figure 56: Research, Testing, Medical Laboratories Establishments by Size



## Appendix B: Detailed Assumptions and Data Sources

### B.1 Economic Contributions Analysis

Economic Contributions Analysis measures the gross change in economic activity associated with a sector, event, or policy in an existing regional economy. The economic model examines direct, indirect and induced economic contributions in terms of GDP, employment, and government revenue as defined below:

| Measures | Description |
|---|---|
| **Direct Impacts** | Direct economic contributions represent the economic value added directly associated with capital investments and associated operations. For example, they include the employment and income of employees and contractors directly involved in the life sciences sector, as well as the associated product, production taxes and property taxed paid. |
| **Indirect Contributions** | Indirect economic contributions represent the economic value added resulting from the demand for materials and services that the life sciences sector generates in supplier industries. They represent, for example, economic activity generated in the manufacturing, wholesale trade, transportation and professional service sector as a result of demand for materials and services generated by the life sciences sector. |
| **Induced Contributions** | Induced contributions are income effects resulting from spending on goods and services by the employees who benefit from direct and indirect effects. In other words, working income generated will give rise to various personal consumer spending. Such consumer spending will in turn stimulate employment in retail businesses, service providers, leisure activities, etc. |
| **Gross Domestic Product (GDP)** | GDP is the total unduplicated value of goods and services produced in the economic territory of a country or region during a given period. GDP includes household income from current productive activities (wages, salaries and unincorporated business income) as well as profits and other income earned by corporations. In the context of our study, GDP serves as a measure of the total economic value-added resulting from the spending associated with the categories of expenditure identified. |
| **Employment** | In this study employment contributions are estimated in terms of jobs (i.e. employment contribution associated with annual expenditures). |
| **Government Revenue** | In this study, government revenue is only partially accounted for, specifically including federal, provincial, and municipal product and production taxes such as sales taxes, property tax, and environment taxes as well as personal income tax and corporate income tax as applicable. |

### Economic Contribution Analysis – I-O Modeling Approach Chart

Deloitte has quantified the economic contributions of life sciences sector expenditures using an I-O based quantitative model:


Operations expenditures:

- Spending on ongoing operations by subsector

Input-Output based model capturing the structure of the Canadian economy:

- An I-O model developed based on Statistics Canada's provincial Input-Output tables and multipliers
- Assumptions and parameters

Direct, indirect and induced contributions in terms of the following:

- GDP
- Employment
- Government revenue

## B.2 Economic Contribution Assumptions

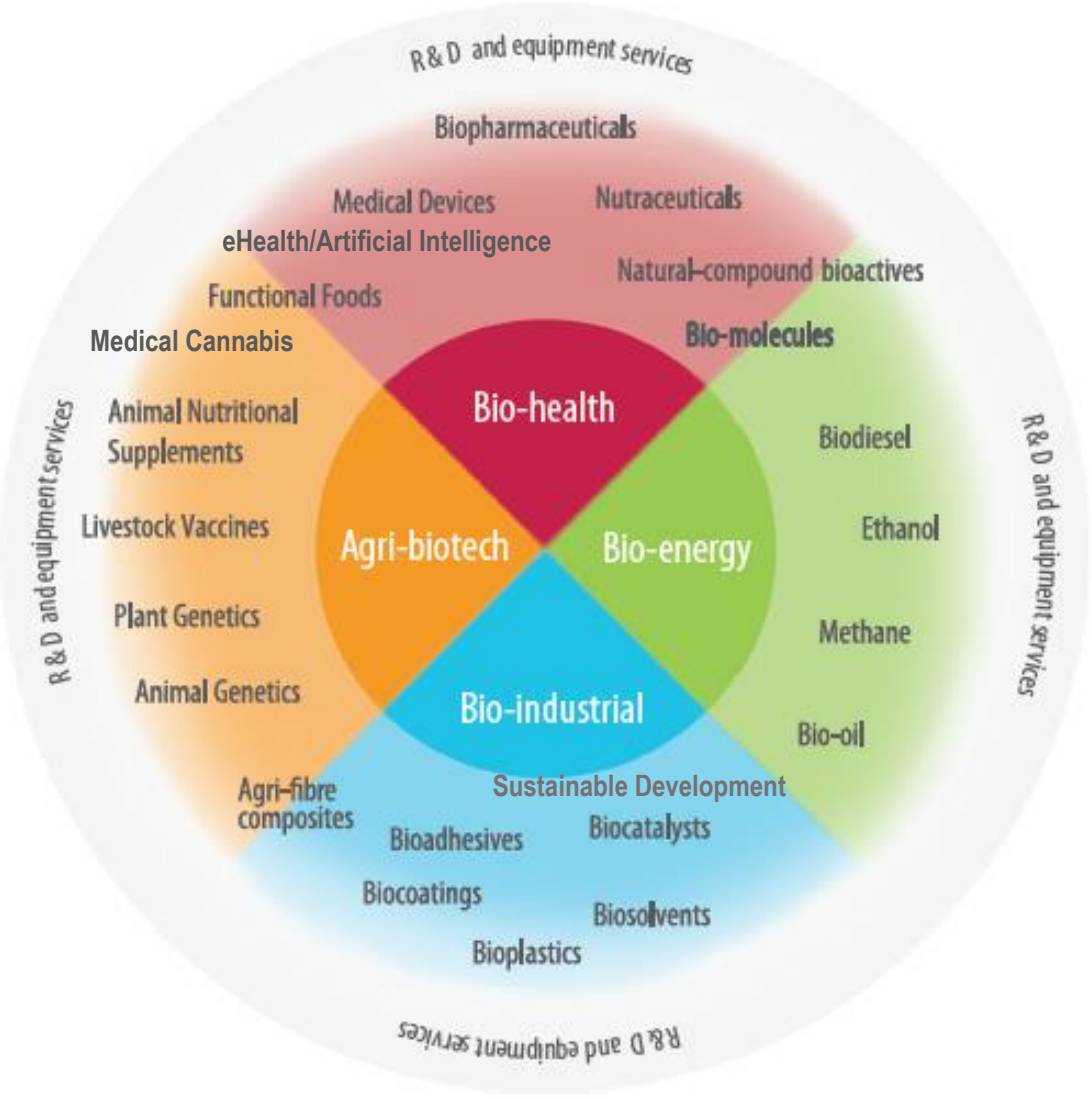
### *B.2.1 Industry Definitions*

#### Defining the Sector

The sector definition in this report is based on the definitions from the following sources:

- **Province of Ontario** — Historically, the provincial government defines Life Sciences as human health sciences only.
- **Battelle-BIO** — The Biotechnology Industry Association (BIO) is the world's largest trade association representing biotechnology companies, academic institutions, state biotechnology centers and related organizations across the United States and in more than 30 other nations. BIO members are involved in the research and development of innovative healthcare, agricultural, industrial and environmental biotechnology products. In collaboration with Battelle, the world's largest nonprofit independent research and development organization, BIO issues a biennial State BioScience Industry Development report that includes data from each of the 50 states, the District of Columbia, and Puerto Rico. The report uses a NAICS-based definition and includes agri-food and human health biotechnology as well as their related distribution.
- **Life Sciences Ontario**'s definition of the life sciences is aligned with that of BIO, the world's largest biotechnology association, and with BIOTECanada, Canada's national biotechnology association. Both organizations include human health, agri-food and industrial biotechnology segments in the sector. This view also aligns with BioTalent Canada, the national HR partner of Canada's bio-economy. BioTalent created an infographic that captures this inclusive definition.

Figure 57: Defining life sciences




*Source: BioTalent Canada*

### *B.2.2 Data Challenges*

An inconsistent definition of the sector as well as the sector's diverse nature makes it difficult to find and collect Canadian life sciences data since it is spread across many industrial classifications.

Many life sciences organizations collect their own data through targeted data segments from Statistics Canada or directly through memberships and surveys. This makes aggregating the data across multiple sources challenging when trying to assess the entire life sciences sector.

In this study we have used and adjusted available Canadian NAICS data to be representative of Ontario's life sciences sector (see Table 21). A segment of data is also identified to account for an expanded definition of life sciences. This expanded dataset includes hospitals and other health services along with dairies, distilleries and other food processes that extensively use biotechnology.

A NAICS-based approach is used that further aligns with the Battelle/BIO report and the province's methodology, as applied to human health sciences. This definition was adapted to the available Canadian NAICS Data. Table 21 shows a comparison of this definition to that used by Battelle/BIO.

Table 21: Comparison of NAICS-based definitions from Batelle/BIO and LSO

| Six-digit NAICS | Battelle/BIO (2014)[90] | LSO |
|---|---|---|
| **Agricultural Feedstock and Chemicals** | | |
| 311221 - Wet Corn Milling | ✓ | ✓ |
| 311222 - Soybean processing | ✓ | |
| 311223 - Other Oilseed Processing | ✓ | |
| 311224 - Oilseed processing CAN | | ✓ |
| 325190 - Other basic organic chemical manufacturing | | ✓ |
| 325193 - Ethyl Alcohol Manufacturing | ✓ | |
| 325220 - Artificial and synthetic fibres and filaments manufacturing | | ✓ |
| 325221 - Cellulosic Organic Fiber Manufacturing | ✓ | |
| 325311 - Nitrogenous Fertilizer Manufacturing | ✓ | |
| 325312 - Phosphatic Fertilizer Manufacturing | ✓ | |
| 325313 - Chemical fertilizer (except potash) manufacturing | | ✓ |
| 325314 - Mixed fertilizer manufacturing | ✓ | ✓ |
| 325320 - Pesticide and other agricultural chemical manufacturing | ✓ | ✓ |
| 418320 - Seed merchant wholesalers | | ✓ |
| 418390 - Agricultural chemical and other farm supplies merchant wholesalers | | ✓ |
| 424910* - Farm Supplies Merchant Wholesalers | ✓ | |
| **Drugs and Pharmaceuticals** | | |
| 325410 - Pharmaceutical and medicine manufacturing CAN | | ✓ |
| 325411 - Medicinal and Botanical Manufacturing | ✓ | |
| 325412 - Pharmaceutical Preparation Manufacturing | ✓ | |
| 325413 - In-Vitro Diagnostic Substance Manufacturing | ✓ | |

[90] *Battelle/BIO State Bioscience Jobs, Investments and Innovation 2014.*

| Six-digit NAICS | Battelle/BIO (2014)[90] | LSO |
|---|---|---|
| 325414 - Biological Product (except Diagnostic) Manufacturing | ✓ | |
| 414510 - Pharmaceuticals and pharmacy supplies merchant wholesalers CAN | | ✓ |
| 424210* - Drugs and Druggists' Sundries Merchant Wholesalers | ✓ | |
| **Medical Devices and Equipment** | | |
| 334510 - Electromedical and Electrotherapeutic Apparatus Manufacturing | ✓ | |
| 334516 - Analytical Laboratory manufacturing | ✓ | |
| 334517 - Irradiation Apparatus manufacturing | ✓ | |
| 339110 - Medical equipment and supplies manufacturing | | ✓ |
| 339112 - Surgical and Medical Instrument Manufacturing | ✓ | |
| 339113 - Surgical Appliance and Supplies Manufacturing | ✓ | |
| 339114 -Dental Equipment and Supplies Manufacturing | ✓ | |
| 417930* - Professional machinery, equipment and supplies merchant wholesalers CAN | | ✓ |
| 423450 - Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers | ✓ | |
| **Research, Testing, and Medical Laboratories** | | |
| 541380* - Testing laboratories | ✓ | ✓ |
| 541710* - Research and development in the physical, engineering and Life Sciences | ✓ | ✓ |
| 621510 - Medical and diagnostic laboratories CAN | ✓ | ✓ |
| 621511 - Medical Laboratories | ✓ | |

* *Includes only the portion of these industries engaged in relevant life sciences activities*

### Expanded definition of Life Sciences

The above definition is considered the closest Canadian equivalent to what is used in the Battelle/BIO report by LSO. However, although useful for tracking industry trends and benchmarking jurisdictional performance, this methodology does exclude key components of the life sciences sector. To capture some of the missing components, a data section for related industries are developed. These related industries include segments of the life sciences sector, such as some areas of public healthcare and food processing that use biotechnology but are not included within the above core definition. Table 22 below shows a summary of the NAICS included in the expanded definition of related industries.

Table 22: Expanded definition of life sciences by NAICS

| Additional industries included in the expanded definition |
|---|
| 3114 - Fruit and vegetable preserving and specialty food manufacturing |
| 3115 - Dairy product manufacturing |
| 3118 - Bakeries and tortilla manufacturing |
| 31212, 31213, 31214 - Breweries, Wineries and Distilleries |
| 446 - Health and personal care stores |
| 621 - Ambulatory health care services |
| 622 - Hospitals |

### *B.2.3 Employment Analysis, Data Sources and Methodology*

#### Raw Employment Data

The Survey of Employment, Payroll and Hours (SEPH) is used to estimate sector employment. SEPH data is correlated to NAICS codes to the four-digit level in Statistics Canada Table 14-10-0202-01. Table 23 below summarizes the historical employment data for the relevant four-digit NAICS categories.

Table 23: Historical Employment Data for Life Sciences Industries by Four-Digit NAICS

| NAICS | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grain and oilseed milling [3112] | 3,826 | 3,888 | 3,685 | 3,684 | 3,738 | 4,003 | 4,188 | 4,133 | 4,243 | 4,360 | 4,374 | 2,972 | 2,863 |
| Basic chemical manufacturing [3251] | 5,249 | 5,247 | 5,661 | 6,612 | 5,332 | 5,166 | 5,341 | 6,139 | 5,338 | 4,703 | 4,577 | 4,988 | 5,453 |
| Resin, synthetic rubber, and artificial and synthetic fibres and filaments manufacturing [3252] | 7,439 | 6,718 | 6,967 | 6,640 | 6,313 | 5,730 | 5,321 | 5,824 | 5,332 | 4,229 | 3,946 | 3,868 | 4,235 |
| Pesticide, fertilizer and other agricultural chemical manufacturing [3253] | 1,120 | 1,068 | 1,161 | 1,056 | 951 | 776 | 962 | 964 | 975 | 1,031 | 1,214 | 1,030 | 1,177 |
| Pharmaceutical and medicine manufacturing [3254] | 15,375 | 15,477 | 15,423 | 15,556 | 15,323 | 14,803 | 14,923 | 14,913 | 15,690 | 15,028 | 15,067 | 15,345 | 15,859 |
| Medical equipment and supplies manufacturing [3391] | 7,377 | 7,382 | 7,720 | 8,123 | 8,376 | 8,580 | 8,505 | 8,589 | 8,341 | 8,291 | 8,194 | 8,494 | 8,950 |
| Pharmaceuticals, toiletries, cosmetics and sundries merchant wholesalers [4145] | 17,122 | 16,343 | 16,420 | 16,777 | 15,987 | 15,924 | 17,654 | 18,325 | 18,116 | 19,227 | 19,098 | 20,507 | 22,733 |
| Other machinery, equipment and supplies merchant wholesalers [4179] | 29,238 | 30,169 | 31,251 | 31,669 | 31,905 | 32,101 | 32,823 | 32,737 | 31,931 | 31,232 | 30,565 | 31,103 | 32,074 |
| Agricultural supplies merchant wholesalers [4183] | 4,266 | 4,221 | 4,543 | 4,630 | 4,542 | 4,191 | 4,603 | 4,786 | 4,763 | 4,885 | 4,654 | 4,584 | 5,084 |
| Architectural, engineering and related services [5413] | 45,485 | 47,090 | 50,643 | 55,769 | 54,530 | 55,640 | 57,111 | 61,472 | 61,212 | 60,819 | 60,961 | 62,249 | 67,018 |
| Scientific research and development services [5417] | 16,984 | 21,264 | 21,482 | 20,261 | 23,043 | 24,140 | 25,114 | 27,693 | 28,862 | 29,227 | 29,530 | 24,985 | 19,242 |
| Medical and diagnostic laboratories [6215] | 7,275 | 7,956 | 8,046 | 9,625 | 10,291 | 9,912 | 9,522 | 10,199 | 10,848 | 11,228 | 11,395 | 12,491 | 13,178 |

*Red figures indicate data suppressed to meet the confidentiality requirements of the Statistics Act; employment was estimated using the method described below. Source: Statistics Canada Table 14-10-0202-01.*

#### Approximating Missing Employment Data

To form a complete historical data set, where there are missing entries, a linear progression between the last known annual employment entry before the missing data and the next known annual employment entry following the missing data was assumed.

#### Weighting Factors for Estimating Six-Digit NAICS Employment

The employment is estimated to the six-digit NAICS level to extract the relevant life sciences portion from the four-digit levels. To do so, a weighting factor is derived from available establishment and by employment size data in Statistics Canada Table 33-10-0037-01. From each employment range, a centroid value was established and

multiplied by the number of establishments to get a Total Employee Estimate. The Total Employee Estimate was then divided by the sub-total Employee Estimate for the entire four-digit NAICS category to determine the Employment Weighting Factor. Table 24 provides an example of how this weighting factor was derived for NAICS 311211 [Flour milling] and NAICS 311224 [Oilseed processing].

Table 24: Sample Calculation of Employment Weighting Factors for Six-Digit NAICS

| North American Industry Classification System (NAICS) | Number of Establishments by Employee Size Range (Centroid) | | | | | | | | Total Employee estimate | Employment Weighting Factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 - 4 (2.5) | 5 - 9 (7) | 10 - 19 (14.5) | 20 - 49 (34.5) | 50 - 99 (74.5) | 100 - 199 (149.5) | 200 - 499 (349.5) | 500 and plus (500) | | |
| Flour milling [311211] | 0 | 3 | 5 | 6 | 3 | 0 | 0 | 0 | 524 | 0.23 |
| Rice milling and malt manufacturing [311214] | 1 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 112 | 0.05 |
| Wet corn milling [311221] | 1 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 343 | 0.15 |
| Oilseed processing [311224] | 3 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 350 | 0.15 |
| Fat and oil refining and blending [311225] | 2 | 1 | 0 | 2 | 2 | 1 | 0 | 0 | 380 | 0.17 |
| Breakfast cereal manufacturing [311230] | 3 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 548 | 0.24 |
| **SUB-TOTAL Employment for NAICS [3112]** | | | | | | | | | **2,256** | |

*Source: Statistics Canada Table 33-10-0037-01.*

For NAICS categories where the entire four-digit level is included in the life sciences definition, such as 3254 - Pharmaceutical and medicine manufacturing, no weighting factor was required.

**Weighting Factor for estimating life sciences-related employment for NAICS 5417**

NAICS 5417 – Scientific research and development services posed a unique problem in terms of estimating life sciences-related employment. At the five-digit level, the industry segment is split into two categories:

- 54171 - Research and development in the physical, engineering and life sciences
- 54172 - Research and development in the social sciences and humanities.

Using the methodology described in the previous section, it is estimated that majority of the employment was contained in NAICS category 54171. This broad category includes many industries unrelated to life sciences. To more accurately estimate the employment weighting for NAICS 5417, a customized order from Statistics Canada was developed to provide a breakdown of employment data by National Occupation Code (NOC). The table below shows how this data was used to calculate the Employment Weighting Factor for NAICS 5417.

Table 25: Calculating Employment Weighting Factor for NAICS 5417 Using NOC Data

| 5417 Scientific research and development services | Employment (Ontario) |
|---|---|
| All occupations | 21,025 |
| 031 Managers in health care | 15 |
| 082 Managers in agriculture, horticulture and aquaculture | 25 |
| 2112 Chemists | 860 |
| 212 Life science professionals | 760 |
| 2211 Chemical technologists and technicians | 495 |
| 222 Technical occupations in Life Sciences | 345 |
| 311 Physicians, dentists and veterinarians | 30 |
| 313 Pharmacists, dietitians and nutritionists | 40 |
| 321 Medical technologists and technicians (except dental health) | 450 |
| Life Sciences Sub-Total | 3,020 |
| Employment Weighting Factor | 0.144 |

*Source: Statistics Canada – Customized Report from 2016 Census.*

### *B.2.4 Revenues Analysis, Data Sources and Methodology*

The life sciences sector, as defined in this report, consists of 16 NAICS codes organized into four subsectors:

- Agricultural Feedstock and Chemicals
- Drugs and Pharmaceuticals
- Medical Devices and Equipment
- Research, Testing and Medical Laboratories.

To gather revenue information for these subsectors, the individual NAICS codes can be slightly reorganized into manufacturing, wholesale and research, testing and medical laboratories, based on the nature of the final product or service.

Table 26: Segmentation differences between LSO and Statistics Canada Data Segments

| LSO Segmentation | Statistics Canada Data Segment |
|---|---|
| AGRICULTURAL FEEDSTOCK & CHEMICALS | MANUFACTURING |
| Wet corn milling [311221] | Wet corn milling [311221] |
| Oilseed Processing [311224] | Oilseed Processing [311224] |
| Other basic organic chemical manufacturing [325190] | Other basic organic chemical manufacturing [325190] |
| Artificial and synthetic fibres and filaments manufacturing [325220] | Artificial and synthetic fibres and filaments manufacturing [325220] |
| Chemical fertilizer (except potash) manufacturing [325313] | Chemical fertilizer (except potash) manufacturing [325313] |
| Mixed fertilizer manufacturing [325314] | Mixed fertilizer manufacturing [325314] |
| Pesticide and other agricultural chemical manufacturing [325320] | Pesticide and other agricultural chemical manufacturing [325320] |
| Seed merchant wholesalers [418320] | Pharmaceutical and medicine manufacturing [325410] |
| Agricultural chemical and other farm supplies merchant wholesalers [418390] | Medical equipment and supplies manufacturing [339110] |
| DRUGS & PHARMACEUTICALS | WHOLESALE |
| Pharmaceuticals and medicine manufacturing [325410] | Seed merchant wholesalers [418320] |
| Pharmaceuticals and pharmacy supplies merchant wholesalers [414510] | Agriculture chemical and other farm supplies merchant wholesalers [418390] |
| MEDICAL DEVICES & EQUIPMENT | Pharmaceuticals and pharmacy supplies merchant wholesalers [414510] |
| Medical equipment and supplies manufacturing [339110] | |
| Professional machinery, equipment and supplies merchant wholesalers [417930]* | Professional machinery, equipment and supplies merchant wholesalers [417930]* |
| RESEARCH, TESTING, & MEDICAL LABORATORIES | RESEARCH, TESTING & MEDICAL LABORATORIES |
| Testing laboratories [541380] | Testing laboratories [541380] |
| Research and development in the physical, engineering and life sciences [541710] | Research and development in the physical, engineering and life sciences [541710] |
| Medical and diagnostic laboratories [621510] | Medical and diagnostic laboratories [621510] |

Segmented this way, data was gathered and analyzed as follows:

1. Data for the manufacturing codes at the four-digit NAICS level was sourced from Statistics Canada Table 16-10-0117-01. Data for the wholesale sectors was estimated using Statistics Canada Table 20-10-0077-01. The latest year for which data is available for all NAICS codes is 2016.
2. The employment weights calculated in the previous exercise of employment estimation were used to apportion revenues from the larger four-digit NAICS bucket to the individual six-digit sectors that are included in the life sciences sector definition. We assume that revenue is proportional to the employment level, and that revenue per employee is constant within the four-digit NAICS bucket.

Table 27: Estimating Revenues for Wholesale Sectors

| WHOLESALE | Revenues (2016) Statistics Canada Table 20-10-0077-01 | Employment Weight | Estimated Revenues |
|---|---|---|---|
| Agricultural supplies wholesaler-distributors [4183] | $5,569.4M | | |
| Seed merchant wholesalers [418320] | | 0.16 | $866.3M |
| Agricultural chemical and other farm supplies merchant wholesalers [418390] | | 0.50 | $2,775M |
| Pharmaceuticals and pharmacy supplies merchant wholesalers [414510] | $29,297.4M | | |
| Other machinery, equipment and supplies wholesaler-distributors [4179] | $17,761.2M | | |
| Professional machinery, equipment and supplies merchant wholesalers [417930] * | | 0.54 | $9,647.3M |

Revenue information for the research, testing and medical laboratories industry codes was not available through Statistics Canada. Based on primary research, including all major private medical laboratories in Ontario, the 2015 market size of the research, testing and medical laboratories subsector is estimated to be at least $2.5 billion in Canada. The growth rate of national healthcare spend (2015-2016 CAGR) was used to obtain 2016 figures.[91] To derive the Ontario number, we have used Ontario's share of national healthcare spend as a factor (37 per cent).[92] Our estimate for Ontario's revenues from research, testing and medical laboratories is $961 million.

### *B.2.5 Expenditure Analysis, Data Sources and Methodology*

The proportion of operating expenditures from sector revenues were derived using Statistics Canada's sector surveys. Using these surveys along with IO sector expenditure shares, expenditures were then allocated across different industries.

- Data for the manufacturing codes at the four-digit level were obtained from Statistics Canada Table 16-10-0117-01. This table provides a breakdown of manufacturing industry expenditures including expenses as a share of revenues, as well as expenditure shares for labour, utilities, fuel, materials and supplies.
- Data for wholesale codes at the four-digit level were obtained from Statistics Canada Table 20-10-0077-01. This table provides a breakdown of wholesale industry expenditures including expenses as a share of revenues, as well as expenditure shares for labour, and other. "Other" expenditures are allocated across different industries based on Statistics Canada's 2011 Provincial IO Table for Wholesale Trade industries.
- Data for research, testing and medical laboratories industry codes at the three-digit level were obtained from Statistics Canada's Financial and Taxation Statistics for Enterprises (2014). This report provides a breakdown of industry expenditures including expenses as a share of revenues, as well as expenditure shares for labour, and other. "Other" expenditures are allocated across different industries based on Statistics Canada 2011 Provincial IO Table for Professional Scientific and Technical Services industries.

Due to the lack of available provincial tables at the D level, 2014 National IO Tables D Level was used instead to determine the distribution of expenditures across supplier industries. Due to the lack of a single industry classification within the NAICS, expenditure shares of individual NAICS industries were applied to determine the supplier industries most impacted by associated life sciences subsector expenditures.

### *B.2.6 Economic Analysis, Data Sources and Methodology*

Economic contributions analysis uses industry contribution multipliers developed from previous runs of a statistical input-output economic model. Using this model, the direct, indirect and induced contributions of an industry can be estimated.

[91] Canadian Institute for Health Information. Obtained from National Health Expenditure Database.
[92] Ibid.

For the life sciences sector, there is no single industry classification within the North American Industry Classification System (NAICS) that comprehensively captures all relevant subsectors. For this reason, there is no single set of economic contribution multipliers that reflect the life sciences sector's contribution either provincially or nationally. Due to this limitation, contribution multipliers for the NAICS codes were sourced using the expenditure distribution of the life sciences sector.

### *B.2.7 Establishment Analysis, Data Sources and Methodology*

We determined the total number of Life Sciences establishments using Statistics Canada Tables 33-10-0037-01 & 33-10-0038-01. The number of establishments reported is the total number and includes those that have not reported employment. In addition, for NAICS category 5417, we estimated the number of establishments by applying the employment-weighting factor. This method provides an estimate of the life sciences-related establishments within this category.

Table 28: Number of Life Sciences Establishments

| North American Industry Classification System (NAICS) | | Establishments Total, all sizes |
|---|---|---|
| **Agricultural Feedstock and Chemicals** | | |
| Wet corn milling [311221] | | 6 |
| Oilseed processing [311224] | | 18 |
| Other basic organic chemical manufacturing [325190] | | 63 |
| Artificial and synthetic fibres and filaments manufacturing [325220] | | 14 |
| Chemical fertilizer (except potash) manufacturing [325313] | | 16 |
| Mixed fertilizer manufacturing [325314] | | 56 |
| Pesticide and other agricultural chemical manufacturing [325320] | | 18 |
| Seed merchant wholesalers [418320] | | 110 |
| Agricultural chemical and other farm supplies merchant wholesalers [418390] | | 225 |
| | **SUB-TOTAL** | **526** |
| **Drugs and Pharmaceuticals** | | |
| Pharmaceutical and medicine manufacturing [325410] | | 248 |
| Pharmaceuticals and pharmacy supplies merchant wholesalers [414510] | | 436 |
| | **SUB-TOTAL** | **684** |
| Medical Devices and Equipment | | |
| Medical equipment and supplies manufacturing [339110] | | 989 |
| Professional machinery, equipment and supplies merchant wholesalers [417930] | | 1,349 |
| | **SUB-TOTAL** | **2,338** |
| **Research, Testing, and Medical Laboratories** | | |
| Testing laboratories [541380] | | 711 |
| Research and development in the physical, engineering and life sciences [541710] | | 253* |
| Medical and diagnostic laboratories [621510] | | 1,628 |
| | **SUB-TOTAL** | **2,592** |
| **Total Life Sciences Establishments** | | **6,140** |

*Source: Statistics Canada Tables 33-10-0037-01 & 33-10-0038-01, December 2017.*
**Adjusted using employment weighting factor.*

### *B.2.8 Salary and Payroll Analysis, Data Sources and Methodology*

The average weekly salary data is available, mostly at the three-digit NAICS level, from Statistics Canada Table 14-10-0204-01. In some cases, four-digit NAICS level data was available and used. From this, annual average salary was estimated by multiplying by 50 weeks.

Total annual payroll was then estimated by multiplying the annual average salary by the total number of employees. The table below summarizes the data collected.

Table 29: Summary of Life Sciences Employment, and Payroll

| North American Industry Classification System (NAICS) (4) | Average Weekly Salary[1] | Average Annual Salary[3] | Adjusted Employ-ment (2017) | Estima-ted Payroll |
|---|---|---|---|---|
| **Agricultural Feedstock and Chemicals** | | | | |
| Wet corn milling [311221] | $917 | 45,851 | 435 | $20M |
| Oilseed processing [311224] | | | 444 | $20.3M |
| Other basic organic chemical manufacturing [325190] | $1,288 | 64,401 | 1,909 | $122.9M |
| Artificial and synthetic fibres and filaments manufacturing [325220] | | | 966 | $62.2M |
| Chemical fertilizer (except potash) manufacturing [325313] | | | 369 | $23.8M |
| Mixed fertilizer manufacturing [325314] | | | 741 | $47.7M |
| Pesticide and other agricultural chemical manufacturing [325320] | | | 66 | $4.3M |
| Seed merchant wholesalers [418320] | $1,080 | $54,015 | 791 | $42.7M |
| Agricultural chemical and other farm supplies merchant wholesalers [418390] | | | 2,533 | $136..8M |
| SUB-TOTAL | | | 8,255 | $480.8M |
| **Drugs and Pharmaceuticals** | | | | |
| Pharmaceutical and medicine manufacturing [325410] | $1,288 | $64,401 | 15,859 | $1,021.3M |
| Pharmaceuticals and pharmacy supplies merchant wholesalers [414510] | $1,225 | $61,240 | 14,512 | $888.7M |
| SUB-TOTAL | | | 30,371 | $1,910M |
| **Medical Devices and Equipment** | | | | |
| Medical equipment and supplies manufacturing [339110][2] | $975 | $48,752 | 8,950 | $436.3M |
| Professional machinery, equipment and supplies merchant wholesalers [417930][2] | $1,365 | $68,260 | 17,422 | $1,189.2M |
| SUB-TOTAL | | | 26,372 | $1,625.5M |

| North American Industry Classification System (NAICS) (4) | Average Weekly Salary[1] | Average Annual Salary[3] | Adjusted Employ-ment (2017) | Estima-ted Payroll |
|---|---|---|---|---|
| **Research, Testing, and Medical Laboratories** | | | | |
| Testing laboratories [541380] | $1,412 | $70,595 | 8,903 | $628.5M |
| Research and development in the physical, engineering and Life Sciences [541710] | $1,643 | $82,144 | 2,764 | $227M |
| Medical and diagnostic laboratories [621510] | $906 | $45,314 | 13,178 | $597.1M |
| SUB-TOTAL | | | $597.1M | $ 1,452.7 |
| **Ontario Life Sciences Total** | | | 89,842 | $5,469M |

[1] *Source: Statistics Canada Table 14-10-0204-01.*
[2] *Last available data used from 2016.*
[3] *Annual Salary calculated based on 50 working weeks.*

## Appendix C: Consulted Stakeholders

| | |
|---|---|
| **Ashley Challinor** | **Dina Iezzi** |
| Vice President, Policy | Director, Marketing and Special Projects |
| Ontario Chamber of Commerce | Therapure Biopharma Inc. |
| **Ed Dybka** | **David Jaffray** |
| General Manager | Executive Vice President, Technology and Innovation |
| Ipsen | University Health Network |
| **Neil Fraser** | **Sandy Marshall** |
| President | Executive Director |
| Medtronic | Bioindustrial Innovation Centre (BIC) |
| **Anthony Giovinazzo** | **Ronnie Miller** |
| President and CEO | President and CEO |
| Cynapsus | Roche Pharmaceuticals |
| **Har Grover** | **Andrea Palmer** |
| Chairman and CEO | CEO and Founder |
| Scientus Pharma | Awake Labs |
| **Brian Hilberdink** | **Peter van der Velden** |
| President | Managing General Partner |
| Novo Nordisk Canada | Lumira Ventures |
| **Rafi Hofstein** | **John Wilkinson** |
| President and CEO | Senior Vice President, Sustainability |
| MaRS Innovation | Greenfield |

There are other stakeholders consulted that are not listed here.

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