LIFE SCIENCES ONTARIO

Life Sciences Ontario Sector Report 2015

Disclaimer

Contents

Foreword

People who study the life sciences enter the discipline seeking data to support and develop their theories into solutions that benefit society. This evidence-based approach, the foundation of the scientific method, is also used widely in economics to measure the economic impacts of various industrial sectors. Most sectors have well defined data sets used in statistical methodologies to measure and report their economic contributions. Yet the life sciences sector's data has significant gaps in its quantum, quality, availability and scope.

In Ontario, most data related to the life sciences sector is composed of information from industry surveys, Statistics Canada, industry databases and a variety of other sources. This data often varies in age and source, which can lead to discrepancies and multiple areas of overlap, increasing the challenges in estimating the sectors' economic contribution or tracking year-over-year trends and benchmarks against those of other jurisdictions.

Life Sciences Ontario (LSO), as the voice for Ontario's life sciences sector, published this document to address this considerable challenge. This 2015 Life Sciences Sector Report provides the data required by governments and regulators to make informed evidence-based decisions.

From the start, we recognized that this task would not be easy. The life sciences sector is defined and framed in different ways with varying scope. Without a unified definition, compiling the data involved differing layers and challenges. Thus, LSO conducted a thorough scan of various reports and methodologies. We discovered that one of the most inclusive and statistically rigorous reports was the United States' Battelle/BIO report.[1] Using this document as the basis of our approach, we adapted the U.S. methodology to Canadian statistical data sets. We believe that the resulting methodology is rigorous, transparent and balanced for Ontario's life sciences sector.

Recent global events, such as the sharp decline of the price of oil, and long-term trends like the increasing awareness of climate change have forced Canada to reassess its economic dependency on natural resources and traditional industries. The life sciences represent a huge economic growth opportunity for Canada and for Ontario in particular. Given the large public investments already made in basic scientific research and developing human capital, the case for strategically developing Ontario's life sciences sector is compelling.

This report proposes a new standard for capturing the economic impact of Ontario's life sciences sector. The sector's contributions are significant and should inform both life sciences stakeholders and policy makers about where Ontario stands and its enormous potential to build on existing strengths and position the province as a global life sciences leader.

Jason Field
President and CEO
Life Sciences Ontario

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

Executive Summary

Ontario's life sciences sector makes significant contributions to the provincial economy. Employing approximately 83,000 highly skilled workers at more than 5,600 companies, the sector ranks among North America's top clusters.[2] Conservative estimates put the industry's annual revenues at $40.5B, which directly contributes $21.6B to Ontario's Gross Domestic Product (GDP).[3] Wages in the life sciences sector are 26.5 per cent higher than the provincial average and the sector's workforce contributes approximately 10 per cent of the total personal income tax revenues Ontario annually collects (when including an expanded definition of life sciences).[4] Between 2001 and 2013, the sector's job growth outpaced the provincial average by nearly 10 per cent and demonstrated resilience during the 2008 economic downturn.

While the life sciences sector's direct contributions are significant, its overall economic impact is even higher when accounting for the economic activity it stimulates in other sectors (indirect impact) and the impact of wage and salary re-spending in the sector (induced impact). We estimate that the sector's total economic contribution to be as high as $38.5B in GDP and 167,285 jobs when accounting for its direct, indirect and induced economic impacts.[5]

Despite these impressive statistics, the life sciences are not without challenges in Ontario:

1. **Small companies** dominate the sector with 63 per cent of companies employing less than 10 employees; only four per cent of companies employ more than 100 people. [6]
2. Ontario's life sciences stakeholders consistently identify **access to capital** as a key barrier to their growth and this report's findings supports this. Ontario's share of Canadian venture capital has a worrisome trend, declining a full 20 per cent since 2001. The life sciences sector represent less than two per cent of the total equity raised on the TSX/TSXV in 2013, making it one of the least invested sectors on these exchanges.
3. At 2.18 per cent, Ontario's investment in Research and Development (R&D) Expenditures is below the OECD average (2.37 per cent) as a percentage of GDP. [7]
4. Ontario's youngest science graduates face a startling unemployment rate of 18.9 per cent.[8]

Collectively, this data points to a significant opportunity. Despite increasing global competition, Ontario's life sciences sector has grown its economic contributions to Ontario and Canada over the last 10 years. Yet, without action, the sector's momentum is at risk of stalling.

Ontario needs a coordinated economic strategy to support the life sciences sector's growth and address its key challenges. Doing so will address a significant economic opportunity for the province while also providing deep social benefits to its citizens.

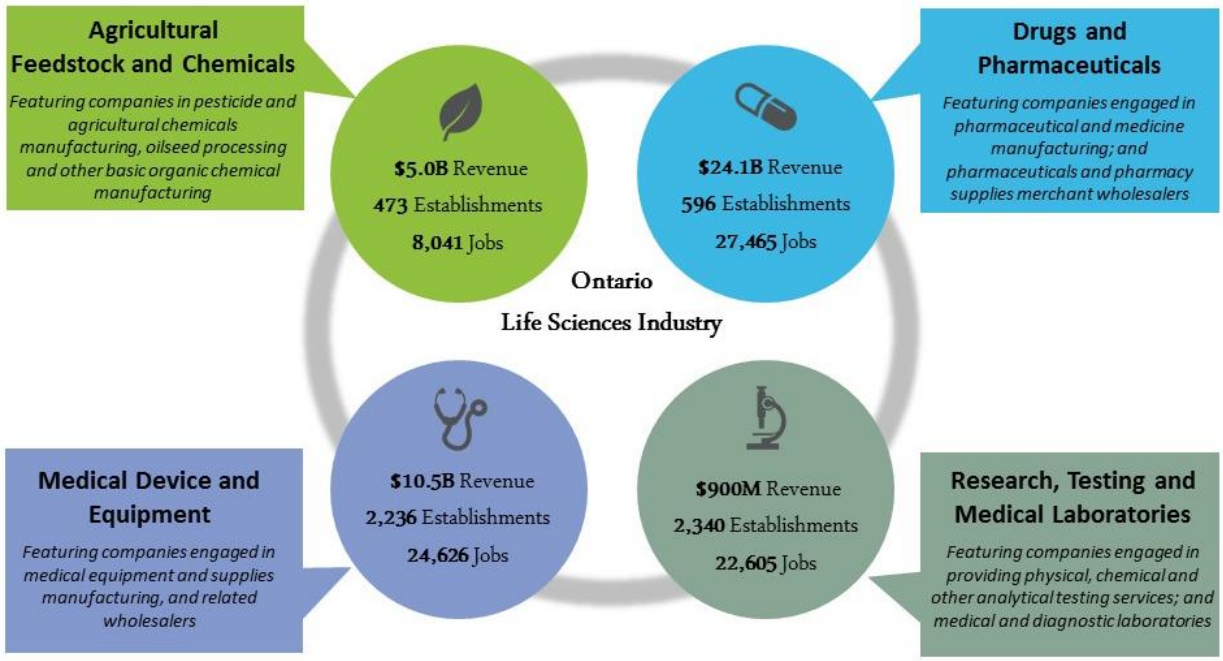
A robust life sciences sector is key to Ontario's future prosperity.

[2] Section 2.1; Appendices B,C, F
[3] Section 2.2, 2.3; Appendices D, E
[4] Section 2.1; Appendix G
[5] Section 2.4; Appendix E
[6] Section 1.3; Appendix F
[7] Section 3.1
[8] Section 3.2

1. Overview

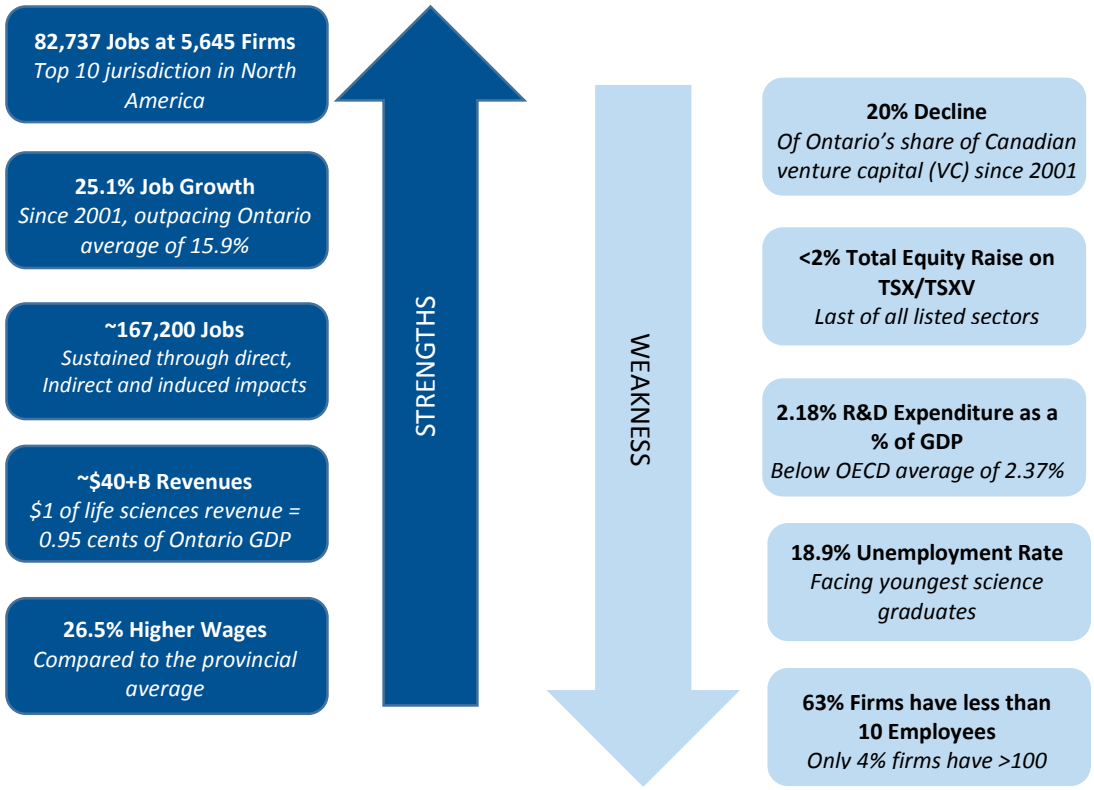
1.1 The Life Sciences Industry at a Glance

Figure 1.1.



Sources: Refer to appendices

Figure 1.2.



1.2 Industry 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, be they microbial, human, plant or animal.

Merriam-Webster[9] defines **life sciences** as:

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

It further defines **biotechnology** as:

> 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 are an economic platform or enabling technology with striking similarities to the information technology industry and fewer to traditional manufacturing or commodity-producing industries. When talking about the life sciences as an economic sector, we 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.

This definition also aligns with that of the U.S.-based Biotechnology Industry 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 A) divides the life sciences sector into four segments:

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

[9] *"life science." Merriam-Webster.com. 2015. http://www.merriam-webster.com/dictionary/life%20science (30 January 2015). "biotechnology." Merriam-Webster.com. 2015. http://www.merriam-webster.com/dictionary/biotechnology (30 January 2015).*

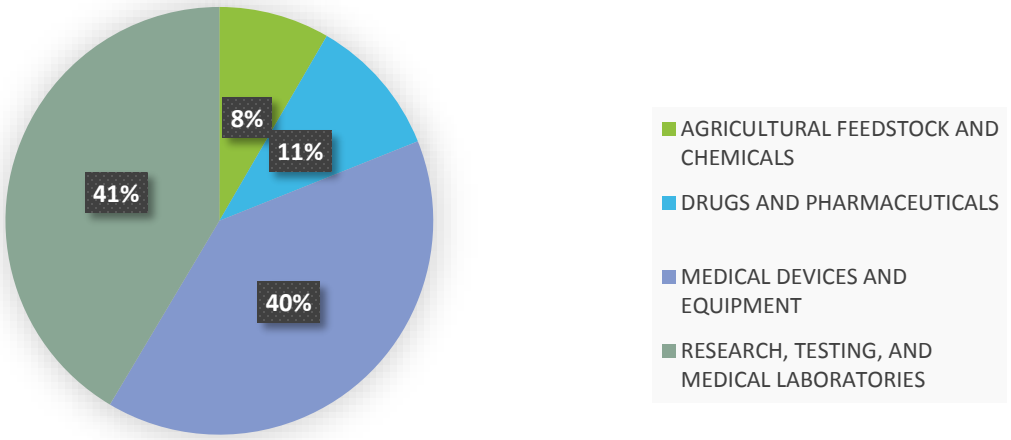
Using this methodology, we can consistently compare and benchmark Ontario's performance against individual U.S. states. However, the methodology is not entirely inclusive. For example, the definition excludes public healthcare workers and many areas of agricultural life sciences (such as wineries and 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). All data presented in the body of this report do not include this expanded definition unless explicitly noted.

1.3 Industry Structure: Overview of Establishments

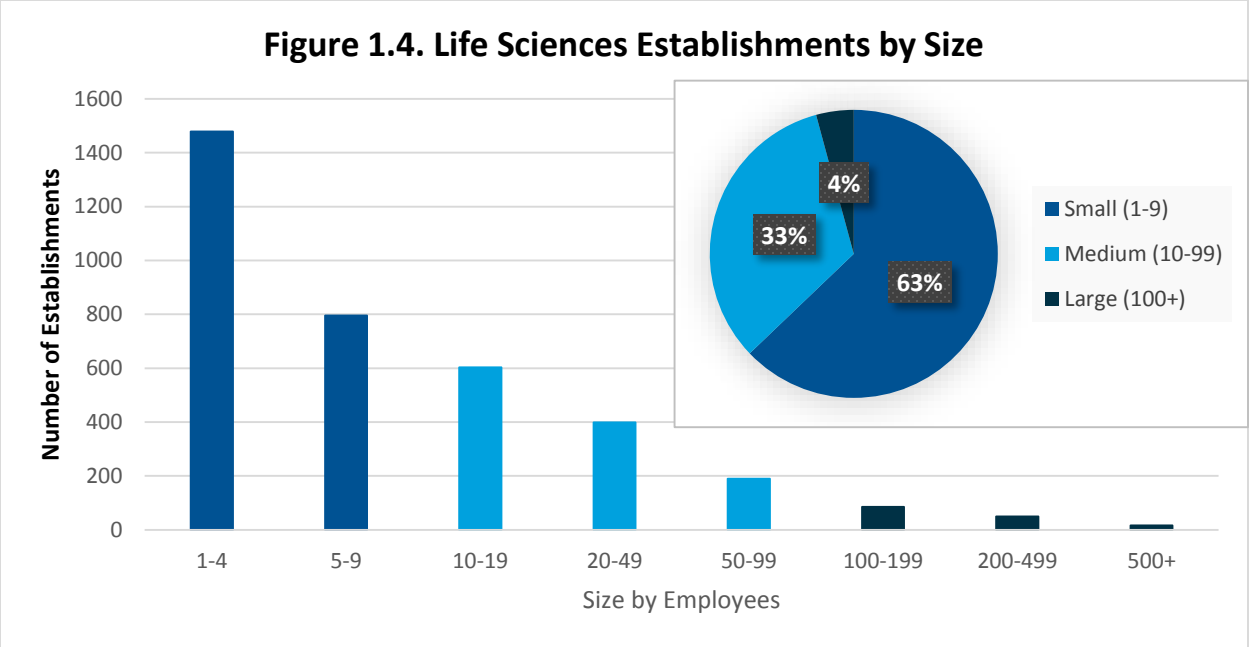
There are currently 5,645 life sciences establishments in Ontario (2013); over 80 per cent of these are in the Medical Device and Equipment or the Research, Testing and Medical Laboratories segments. The industry is highly fragmented: most life sciences companies employ less than 10 employees and only four per cent of companies employ more than 100 people. [10]

Figure 1.3. Ontario Life Sciences Segments by Establishments



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

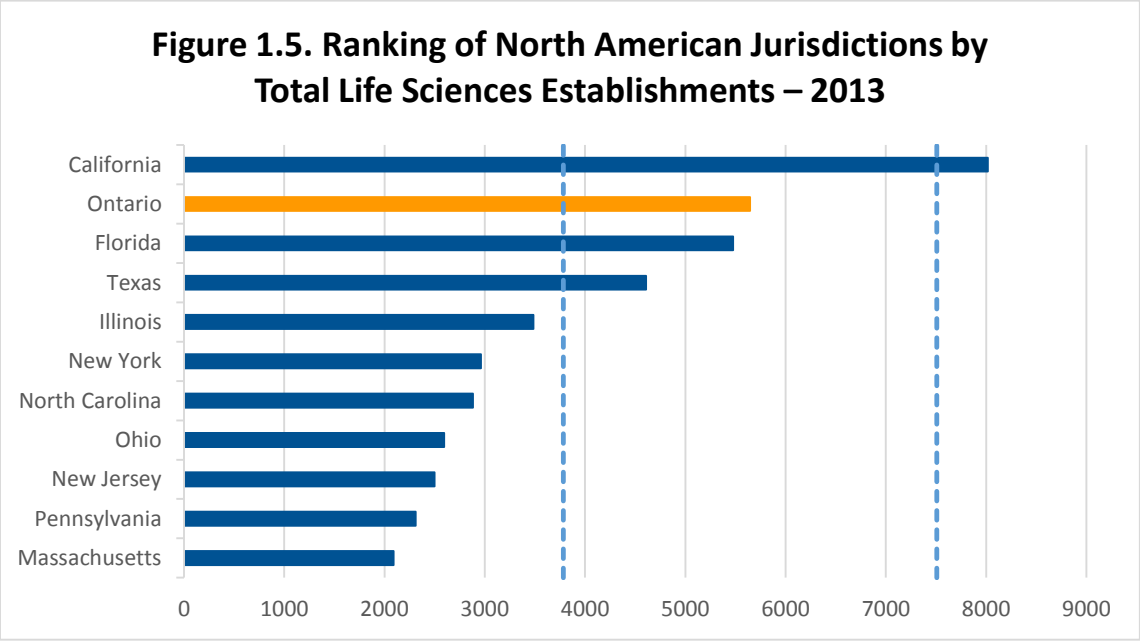
[10] *See Appendix F for detailed methodology.*



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

Although this report uses a methodology adapted from the Battelle/BIO report, significant and unavoidable data differences remain within the North American Industry Classification System (NAICS). As such, direct comparison between Ontario and individual U.S. states are difficult. Since the methodologies are similar, we can estimate to a degree how Ontario stacks up to U.S. jurisdictions.

For example, the difference between California, the leading state with 8,019 companies, and New York, the fifth largest state with 2,960 companies, is 5,059. Using our adapted methodology and assuming a large margin of variability of plus/minus a third, conservatively places Ontario among the top three U.S. jurisdictions for life sciences establishments.



Source: Battelle/BIO State Bioscience Jobs, Investments and Innovation 2014 & Statics Canada CANSIM Table 551-0005 – See Appendix F for detailed methodology.

2. Industry Output Analysis

2.1 Employment, Wages and Taxes

Ontario is home to a large and vibrant life sciences sector. With 5,645 companies employing 82,737 people, Ontario is comparable to some of the top U.S. jurisdictions (see below). Jobs in the life sciences sector are high quality with wages that are 26.5 per cent higher than those of the provincial average.[11] These jobs also provide an estimated $447 million in personal income tax revenue to the province.

Table 2.1.

	Life Sciences	Expanded Definition*	Total
Establishments	5,645	59,555	65,200
Employment	82,737	495,596	578,333
Avg. Annual Wage	$58,193	$47,406	$48,949
Estimated Payroll	$4.81 B	$23.49 B	$28.31 B
Estimated ON Tax**	$448 M	$2.15 B	$2.60 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.

** Personal income tax on salaries only; does not include business tax generated.

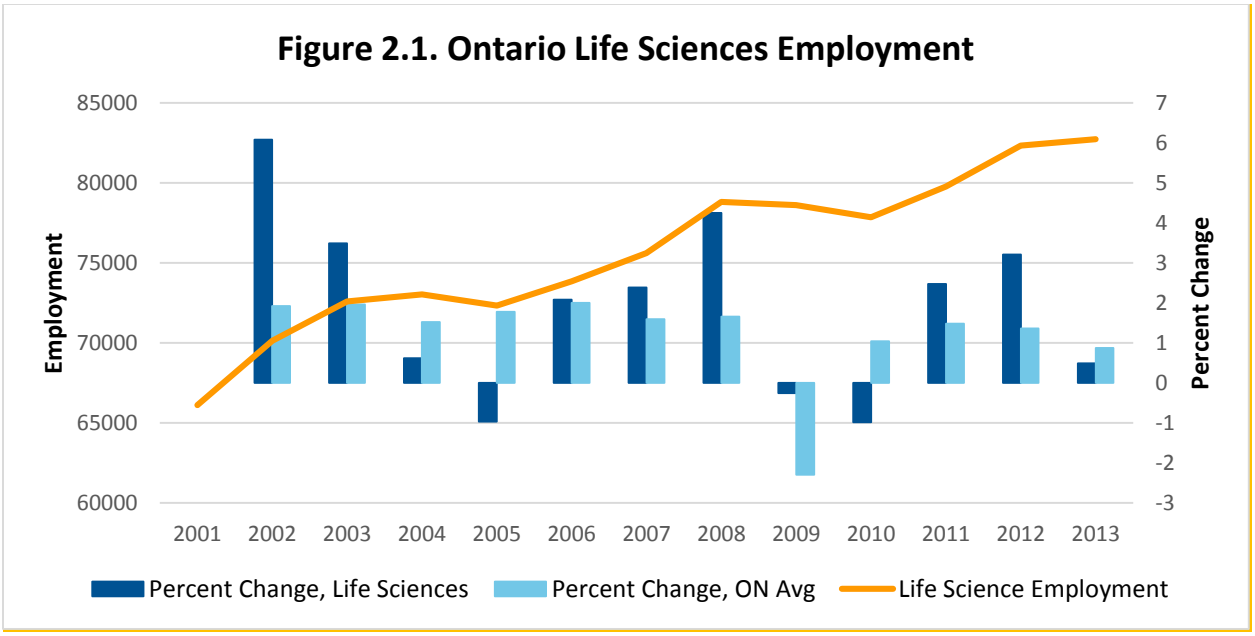
Using the expanded definition of life sciences,[12] the sector's economic impact becomes even more significant: approximately 578,300 workers are employed at approximately 65,200 companies, which means one in 12 Ontarians currently employed in the labor force works in a job connected to the life sciences sector.[13] These jobs generated an estimated $2.6 billion in personal income tax revenue, which is just over 10 per cent of the total personal income tax revenue collected by Ontario in fiscal 2012-13.[14]

[11] *In 2013, the average Ontario weekly salary was $920.12. Source: Statistics Canada, CANSIM 281-0027 (x50 weeks = $46,006).*

[12] *See Appendix B.*

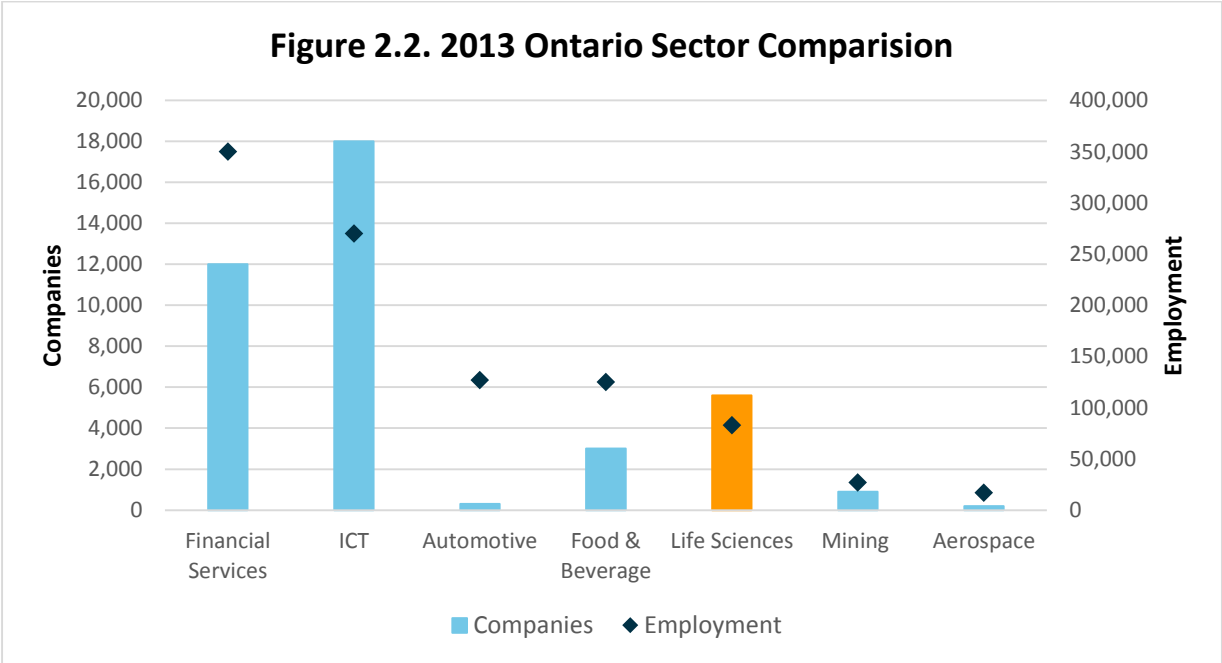
[13] *Based on Ontario Employed Labor Force of 6,879,400. Source: Statistics Canada, CANSIM 282-0002.*

[14] *Chapter 2, Section F of the 2014 Ontario Budget reports actual 2012-13 personal income tax revenue as $25,574 million.*



Source: Statistics Canada, CANSIM Table 281-0024 – See Appendix C for detailed methodology.

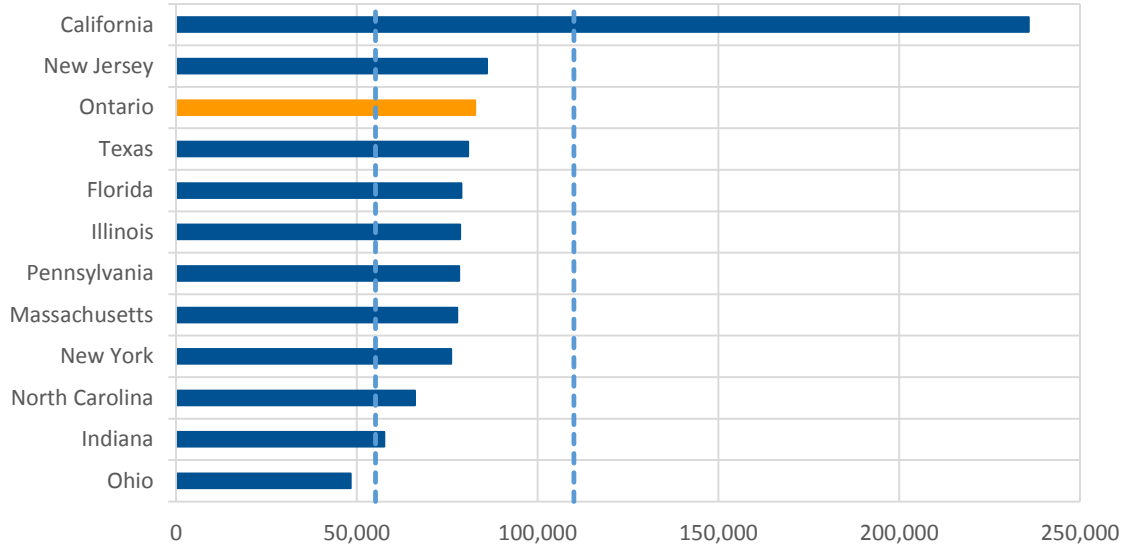
The life sciences are also a growing industry for Ontario. Employment in the life sciences sector grew by 25.1 per cent from 2001-13; significantly outpacing the provincial average employment growth of 15.9 per cent during same time period. Further, the sector showed relatively good resilience during the economic downturn that began in late 2008.



Sources: www.investinontario.com, www.ontariotechcorridor.ca, www.oma.on.ca, www.ontarioautoalliance.com, www.aofp.ca.

Employment data from the 2014 Battelle/BIO report shows a narrow difference of less than 5,000 between Texas, the third largest jurisdiction with 80,792 people working in the life sciences, and New York, the eighth-largest jurisdiction with 76,070. Using our adapted methodology, we estimate Ontario life sciences employment at 82,737. 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. However, conservatively estimating any variability in methodology to within plus/minus a third securely places Ontario within the top 10 U.S. states by employment.

Figure 2.3. Ranking of North American Jurisdictions by Total Life Sciences Employment



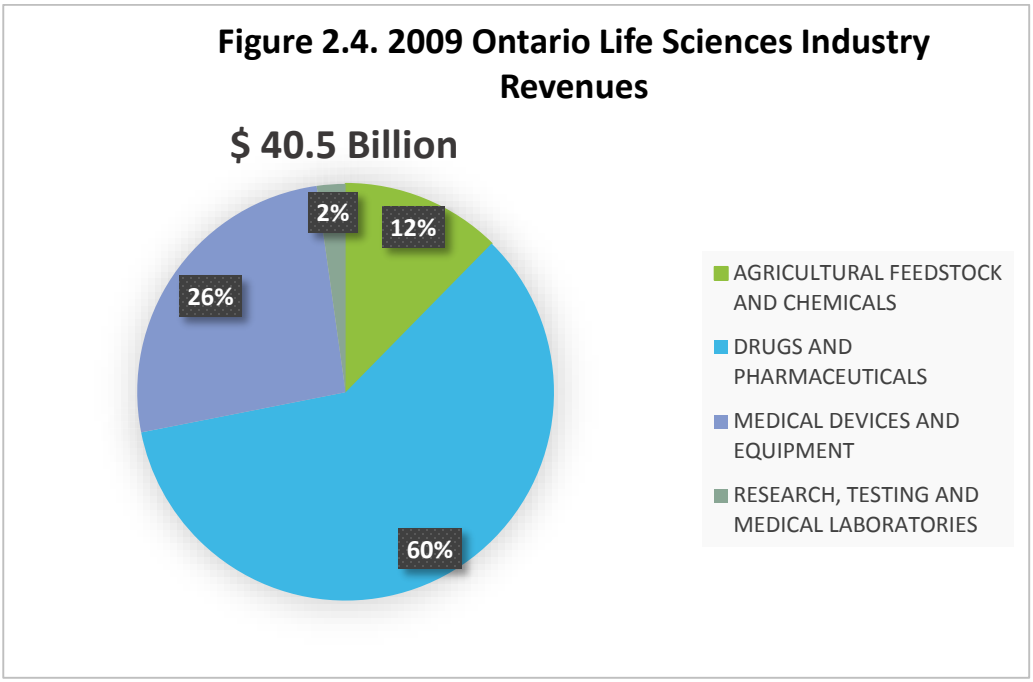
Source: Battelle/BIO State Bioscience Jobs, Investments and Innovation 2014.

2.2 Revenue

Ontario's life sciences industry generates at least $40.5 billion in revenue,[15] making it a significant economic sector in the province. The Drugs and Pharmaceuticals sector is the largest sub-sector within Life Sciences, generating approximately 60 per cent of the industry's revenue. The remaining revenue is split between the Medical Devices and Equipment Sector for approximately 26 per cent, the Agricultural Feedstock and Chemicals sector for approximately 12 per cent[16] and the Research, Testing and Medical Laboratories Sector for approximately two per cent.

[15] *2009 Data. See Appendix D for detailed methodology.*

[16] *Due to limitations in available data, this excludes certain industries within the defined Agricultural Feedstock and Chemicals segment.*



Source: Statistics Canada, CANSIM Table 301-0006, Table 081-0014; (see Appendix D for detailed methodology).

2.3 Gross Domestic Product

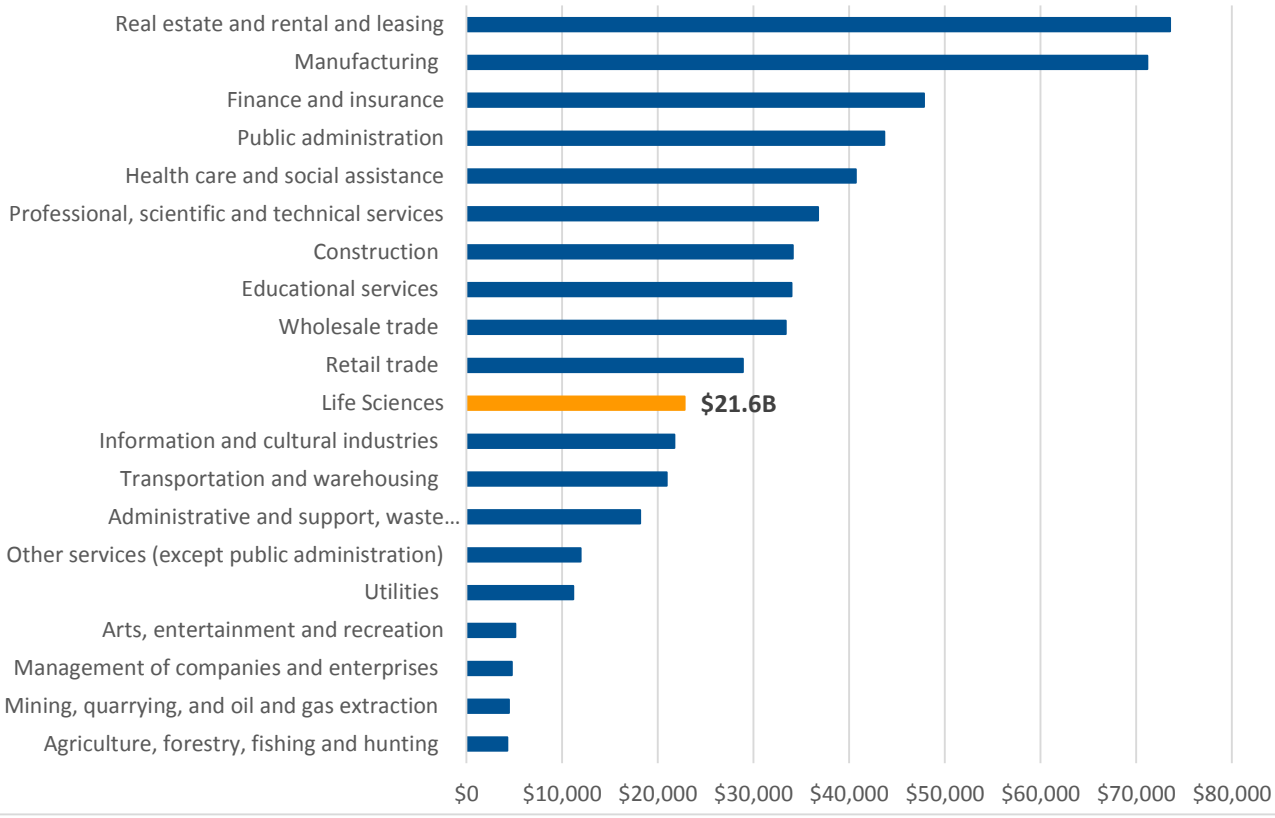
While industry revenue are commonly used to define an industry's size, economists often measure of the value an industry adds to the local economy is its Gross Domestic Product (GDP). The GDP calculation eliminates double counting revenue across companies within the sector (e.g., when one company sells products or services as an intermediary input to another company) as well as the value of imports from other jurisdictions that the sector consumes.

In 2009 — the most recent year with available data — Ontario's life sciences industry is estimated to have contributed $21.6 billion in direct provincial GDP,[17] placing it among the top 11 highest contributors to Ontario's GDP.[18]

[17] *Provincial GDP data by detailed six-digit NAICS codes was not available through CANSIM. Economic input-output multipliers were therefore used to approximate the GDP contribution. See Appendix E for details.*

[18] *The life sciences industry is not a standard NAICS industry 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*.

Figure 2.5. Ontario GDP - Current Prices, 2009



Source: Statistics Canada CANSIM Table 379-0030 for standard NAICS industry GDP figures; Life Sciences GDP figure – See Appendix E for detailed methodology.

2.4 Economic Impact

The Life Sciences industry brings Ontario a wide range of economic benefits. In addition to industry 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 others. This section of the report quantifies and describes these economic benefits.

The industry's direct impact on the economy is further multiplied by two effects called the indirect and induced impacts.

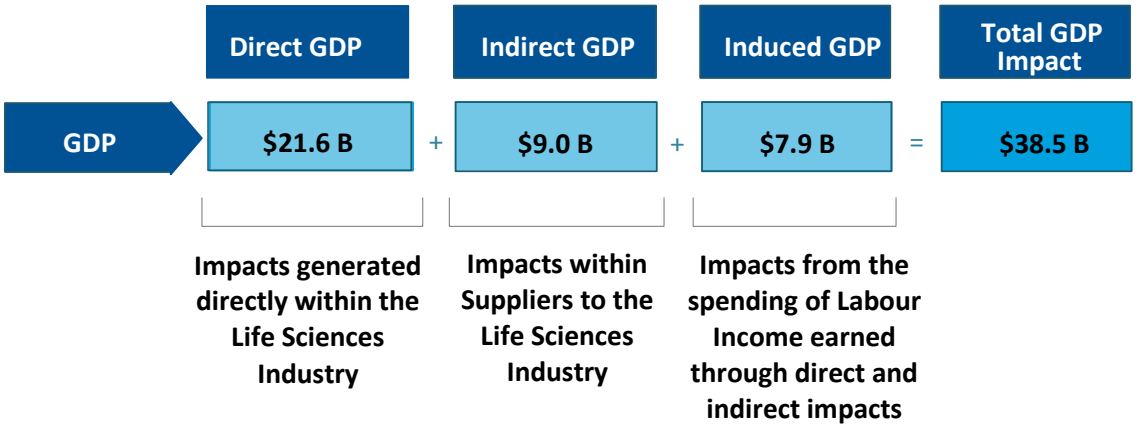
1. **Direct Impact** is the economic value created directly by companies in the life sciences sector.
2. **Indirect Impact** is the economic value created as a result of demand from life sciences companies for products and services delivered by firms in other industry sectors.
3. **Induced Impact** is the economic value created by re-spending labour income earned in the life sciences and supplier industries in the economy.

A limiting factor in our analysis: Canada has no standard industry code that comprehensively captures the multitude of sectors within the life sciences industry. For this reason, we have aggregated the impact of individual subsectors using their share of life sciences industry revenue as a relative weighting or contribution.[19]

Total Gross Domestic Product Impact

Our analysis finds, that assuming industry revenues of $40.5 billion, as in 2009, the life sciences sector contributes $21.6B directly to Ontario's economy, another $9.0B indirectly (via its impact on supplier sectors) and an additional $7.9B through induced impacts (via the re-spending of wages and salaries earned in the sector). This makes the total GDP impact of the sector as high as $38.5 billion, which is nearly equivalent to the total value of industry revenues.[20]

Figure 2.6. Life Sciences Industry Revenues of $40.5 Billion Generates:



Source: Statistics Canada Input-Output Multipliers, 2010.

Total Employment Impact

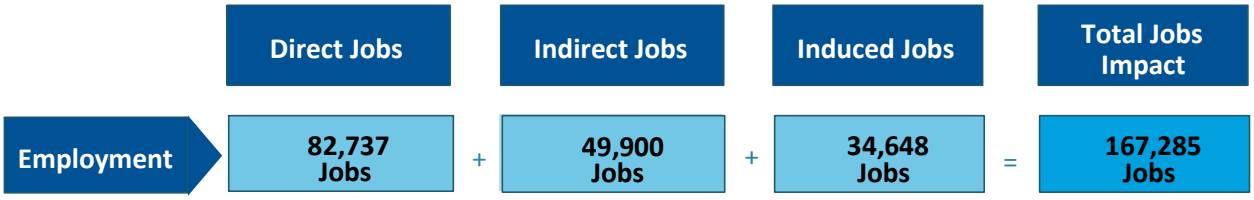
In addition to the 82,737 jobs that the life sciences sector supports directly, it supports approximately 49,900 jobs indirectly via its impact on supplier sectors and 34,648 jobs through induced impacts via the re-spending of wages and salaries earned in the sector. This indirect and induce job impacts bring the sector's total employment impact to 167,285 jobs for Ontarians.[21]

[19] *For a more detailed description of our economic impact methodology, see Appendix E.*

[20] *This report uses estimated GDP figures for 2009, the most recent year for which revenue data is available.*

[21] *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.*

Figure 2.7. Life Sciences Industry Direct Employment of 82,737 Jobs Generates:



Source: Statistics Canada Input-Output Multipliers.

Labour Income
The life sciences industry employs highly skilled workers to whom it pays relatively high wages that are 26.5 per cent higher than the provincial average. These jobs benefit not only the people so employed but also their local economies and communities at large.

Government Revenue
In 2009, the life sciences industry produced high-value goods and services generating total revenues of $40.5 billion. This activity brings significant government revenues through corporate taxes, income taxes, export taxes, and goods and services taxes. LSO's estimate of personal income tax alone is $448 million.

Talent Pooling
The life sciences sector's robust presence creates a deep talent pool in Ontario, which increases Ontario's competitiveness on the global market, and in turn helps to attract Life Sciences companies to locate here. Ontario is considered among the global leaders in research and development talent in the life sciences sector.

Innovation
Ontario has a strong history of life sciences innovation, including the development of insulin by Sir Frederick Banting and the discovery of stem cells by McCulloch and Till. Ontario continues to play a leading role in life sciences innovation and is home to world-class academic institutions and has enormous strength in life sciences research.

Quality of Life and Standard of Living
By its very nature, the life sciences industry is poised to make technological advances that improve quality of life. For example, advances in medical science often improve health outcomes, prolong life span, and improve the quality of life of individuals affected by illnesses. Additional benefits are realized through the government revenue and employment income that Ontario's life sciences industry generates. Through its contribution to government revenues, the industry indirectly funds public programs and social investments that create socio-economic benefits to the community at large. The Life Sciences industry generates high-paying jobs in the province, which not only impact the standard of living for people working within Life Sciences, but also creates further economic wealth as those employees spend their income on consumer goods and services.

3. Industry Input Analysis

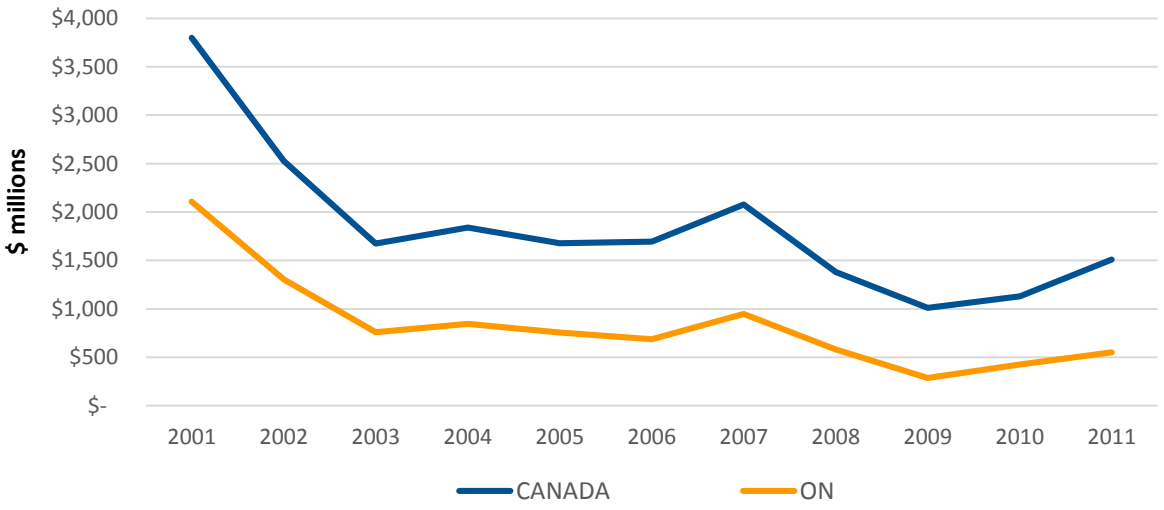
3.1 Access to Capital

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

3.1.1 Comparison of Venture Capital (VC) Investment by Jurisdiction

Overall, total Canadian venture capital investment significantly declined from 2001-09, and Ontario's venture capital resources have followed this trend. In recent years, however, venture capital investment has increased, particularly following the creation of a number of support programs designed to improve access to venture capital, such as the Federal Venture Capital Action Plan (VCAP) and the Ontario Capital Growth Corporation (OCGC). However, these investments' impact on the life sciences sector is still unclear; the data indicates that the sector's overall access to capital remains a key challenge.

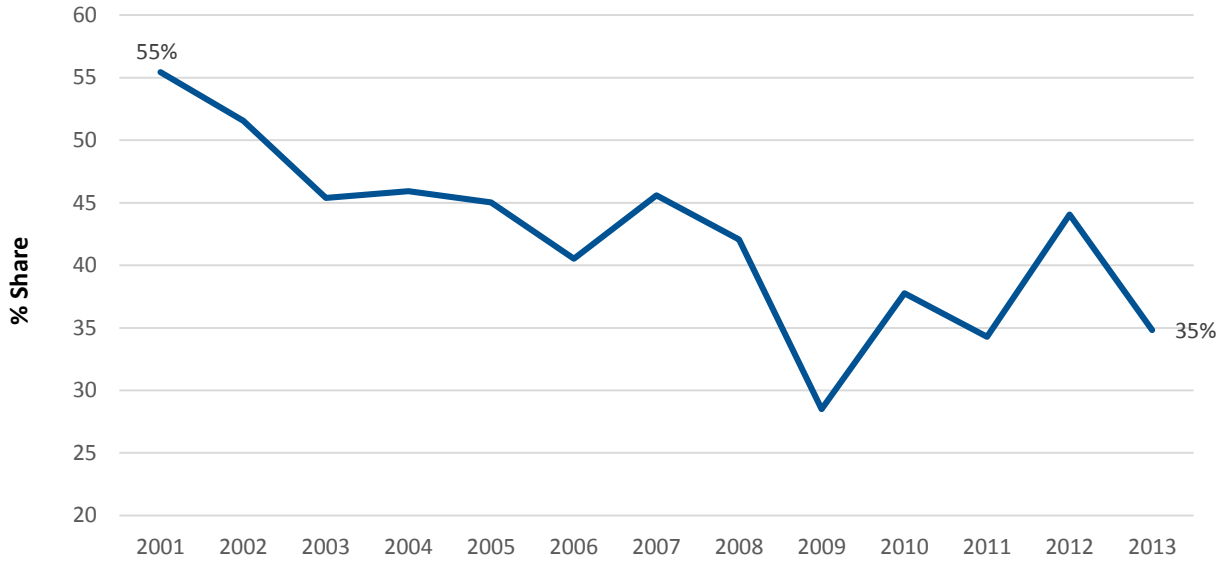
Figure 3.1. Canadian Total Venture Capital Investment



Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

Although Ontario fairs well in terms of its overall share of the total available Canadian venture capital compared to other provinces, Ontario's share of that funding dropped from 55 per cent in 2001 to 35 per cent in 2013.

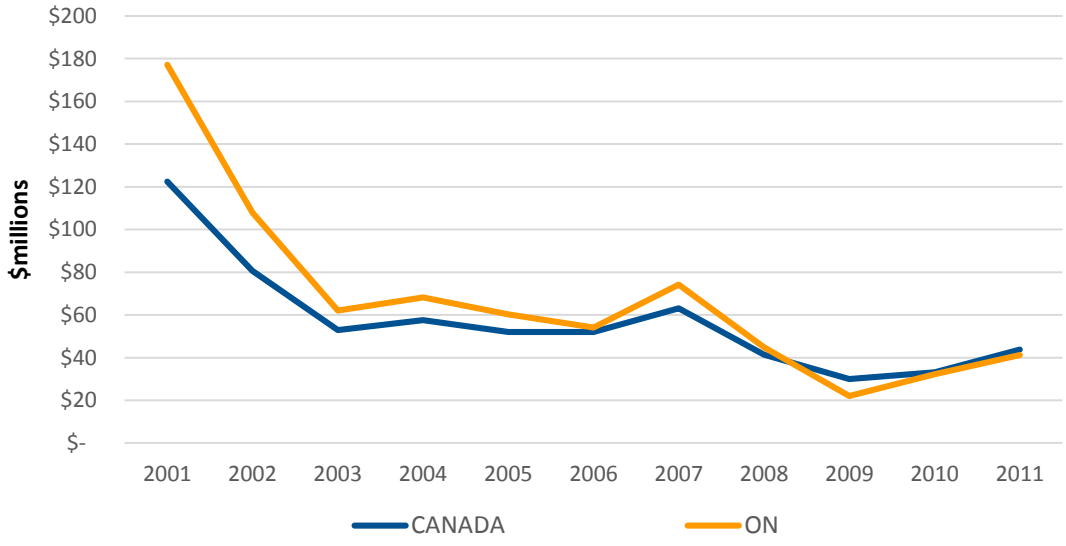
Figure 3.2. Ontario's Share of Canadian Total VC Investment



Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats and Industry Canada, Venture Capital Monitor, Q4 2013, www.ic.gc.ca/vcmonitor.

Ontario's declining share of the overall Canadian venture capital investment means that, on a per capita basis, venture capital investment in Ontario dropped below the Canadian average during the recession and remains below that average.

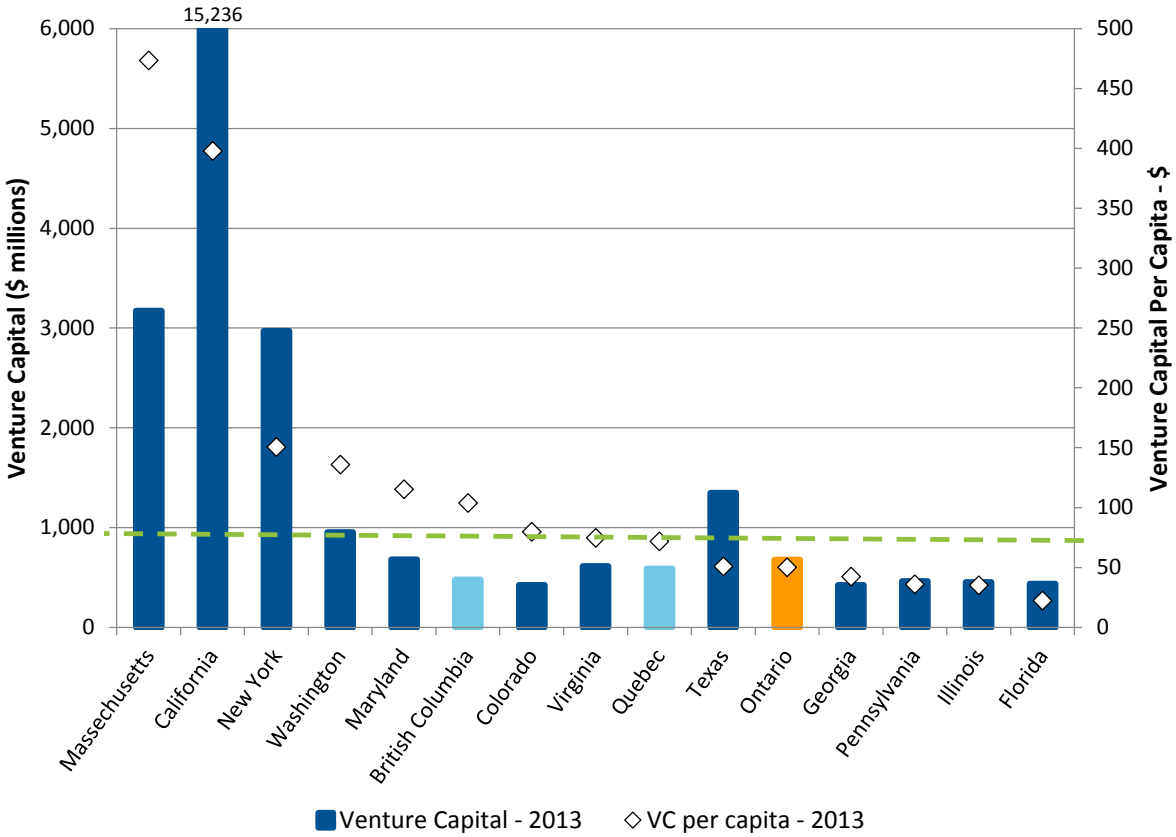
Figure 3.3. Venture Capital Investment Per Capita



Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

In 2013, Ontario's performance amongst comparative North American jurisdictions we examined was mediocre at best in terms of venture capital invested per capita.

Figure 3.4. Venture Capital Investment in North America (2013)

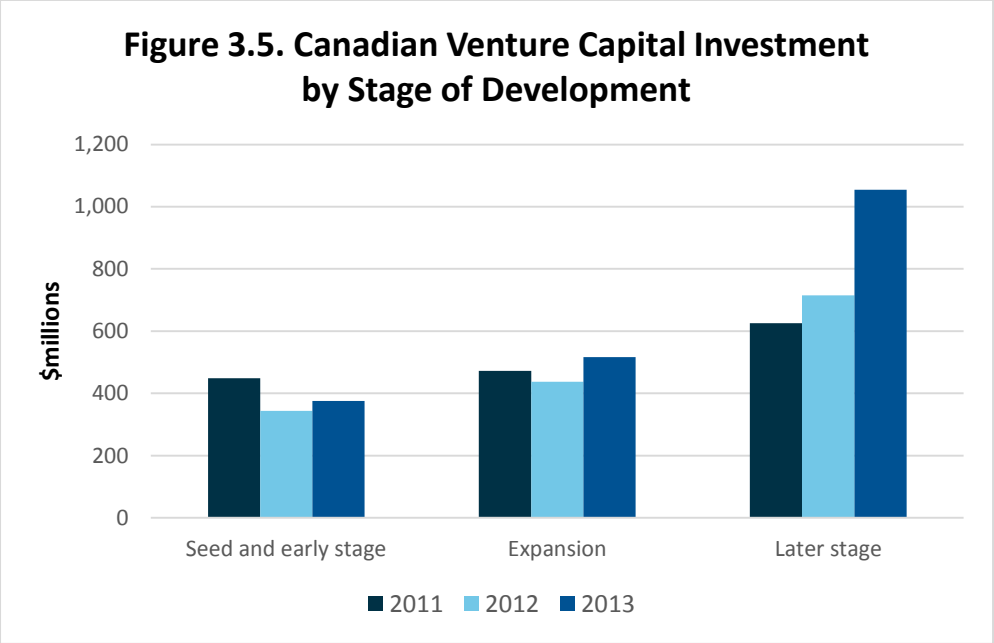


Source: Canada's Venture Capital Market in 2013, Thompson Reuters for Canada's Venture Capital and Private Equity Association.

3.1.2 Venture Capital Investment by Stage of Growth

In LSO's 2012 survey of its stakeholders, 81 per cent of respondents indicated they had less than one year of operating capital; 56 per cent had less than six months of capital.

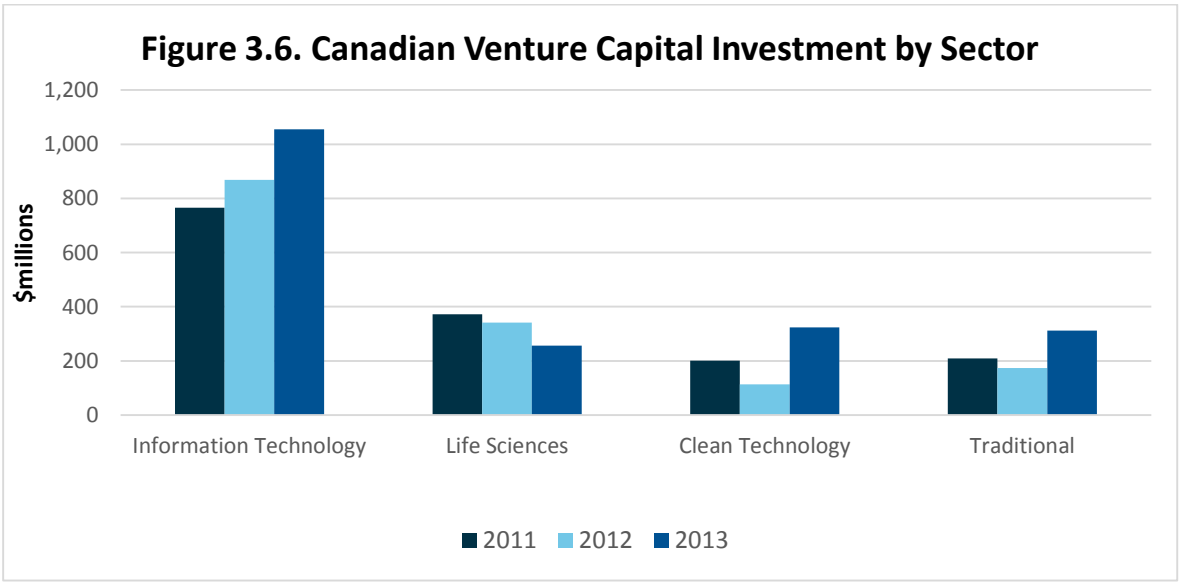
Our stakeholders have repeatedly been identified access to capital as the top issue. Of the $1.95 billion in venture capital invested in Canada in 2013, more than half was directed at companies in later-stage development. This figure is an increase from 2011, in which approximately 40 per cent of total venture capital was directed to later-stage companies. This shift to later-stage investments represents a widening of the gap in financing for early- and expansion-stage companies.



Source: Industry Canada, Venture Capital Monitor, Q4 2013, www.ic.gc.ca/vcmonitor.

3.1.3 Venture Capital Investment by Industry

Venture capital investments in life sciences have declined from $372 million in 2011 to only $256 million in 2013; life sciences are now surpassed by both clean tech and traditional sectors.[22] This trend also affects the U.S., with overall venture capital funding for the life sciences declining significantly during the same timeframe.[23]

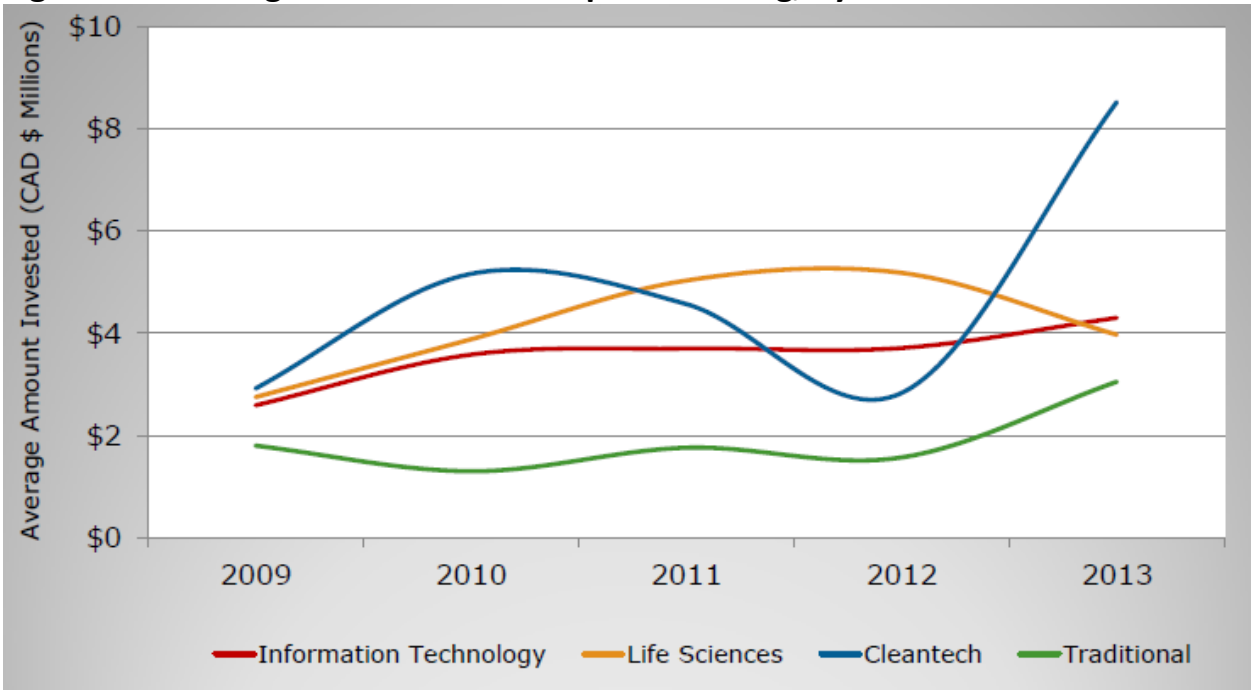


Source: Industry Canada, Venture Capital Monitor, Q4 2013, www.ic.gc.ca/vcmonitor.

[22] *Traditional refers to companies that are not included in IT, life sciences or clean technology sectors.*
[23] *PwC Report "Falling Behind," December 2013.*

Another concern is the declining amount of venture capital invested per financing or the size of the average venture capital investment. While the IT, cleantech and traditional sectors command increasing average amounts of investment per financing since 2012, the life sciences are steadily declining.

Figure 3.7. Average Amount Invested per Financing, By Sector



Source: Thomson Reuters report prepared for Canada's Venture Capital & Private Equity Association, 2013.
**Traditional refers to companies that are not included in IT, Life Sciences or Clean Technology sectors.*

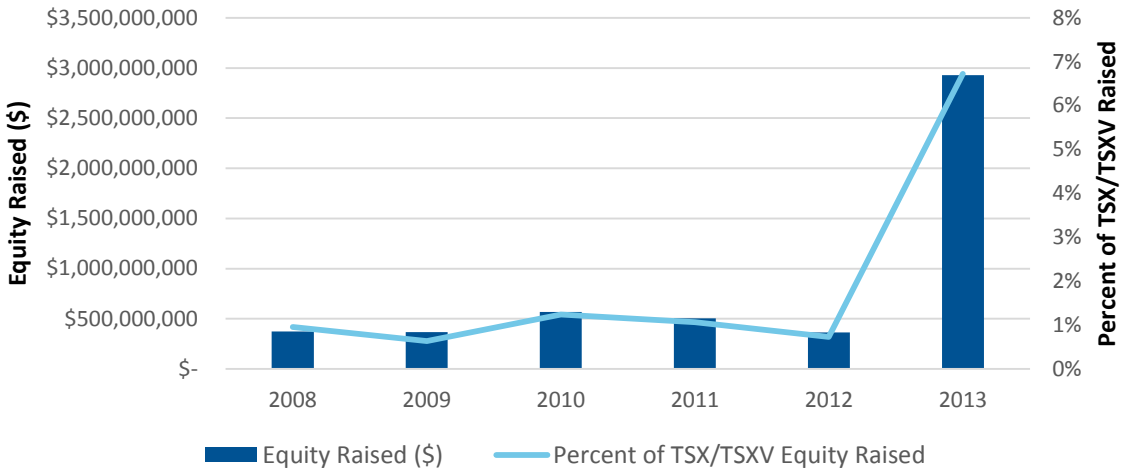
3.1.4 Life Sciences in the Public Equity Market

In a 2012 survey of 100 life sciences stakeholders by LSO, the public equity market was identified as the least utilized source of risk capital, representing only 3.3 per cent of the over $52 million raised by respondents. On the TSX and TSXV exchanges from 2008 to 2013, the life sciences segment typically represented less than 1.5 per cent of the total equity raised. This figure jumped to nearly seven per cent due to Valeant Pharmaceuticals International Inc.'s $2.4 billion secondary offering in June 2013. Excluding this single investment, the total for the life sciences sector would be 1.2 per cent. [24]

For additional context about the enormity of this missed opportunity, two US Life Sciences companies, Gilead and Amgen have a combined market cap of $275.9 billion (USD)[25] that is more than the approximately 1,500 companies combined that make up the entire mining sector (market cap of $221.7 billion CND)[26] listed on the TSX/TSXV.

[24] The MiG Report, 2008-2013, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group.
[25] *Source: www.Bloomberg.com; Nov. 2014: Gilead Sciences Inc. $152.5B market cap and Amgen Inc. $123.4B market cap.*
[26] *Source: The MiG Report, October 2014, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group.*

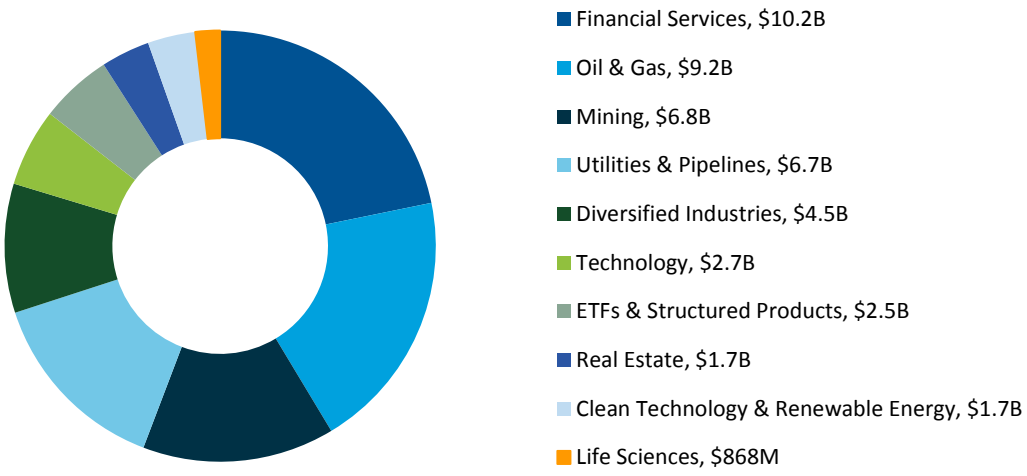
Figure 3.8. Life Sciences Equity Raised on TSX/TSXV



Source: The MiG Report, 2008-2013, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group.

An analysis of the TSX/TSXV up to Q3 2014 shows that life sciences investments continue to show improvement with $868 million raised to date and representing 1.9 per cent of the total equity raised during the same time period.[27] Although this is a slight improvement over typical past performance, the life sciences sector is being surpassed by other segments and now represents the smallest industrial sector by equity raised on the TSX/TSXV. However, Life Sciences as a sector represents three per cent of the combined TSX/TSXV total market cap in 2013, putting it ahead of clean technology and forestry products and on par with technology and real estate, although it still lags far behind financial services- and natural resource-related sectors.

Figure 3.9. Equity Capital Raised by Sector YTD Sept 2014 (TSX/TSXV)



[27] The MiG Report, September 2014, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group

Source: The MiG Report, September 2014, Toronto Stock Exchange and TSX Venture Exchange Market Intelligence Group.

3.2 Talent Availability

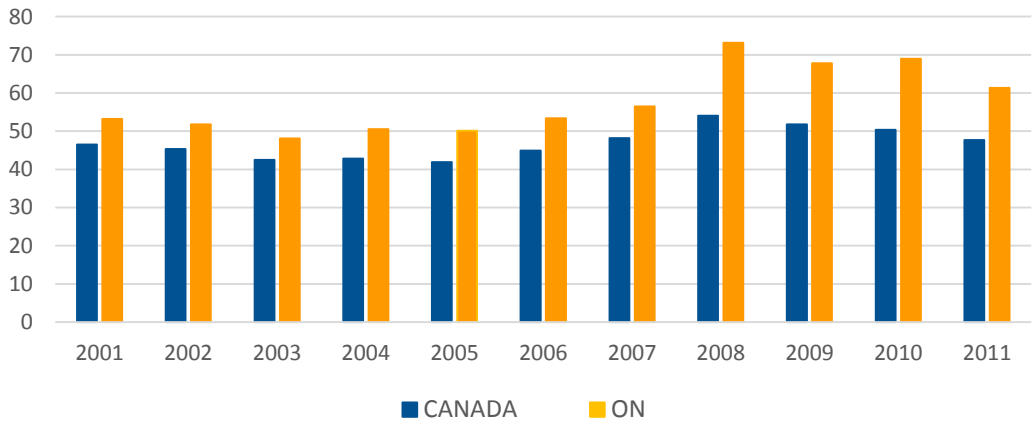
Talent is a critical resource for the life sciences industry, providing the minds to feed the innovation that drives its growth. The technical skills the industry requires are primarily developed at higher education institutions and then nurtured within the industry. The number of degrees a province awards is therefore a useful measure of the available technical talent available for companies to draw upon. It should be noted that the focus on university science degrees is one of practicality in terms of available data. The talent pool required to sustain the Life Sciences sector requires a diverse range of skillsets and education including universities, colleges and other specialized training.

More difficult to measure, yet often cited as a talent gap in Ontario's life sciences sector, is the lack of experienced senior management and entrepreneurs with deep knowledge of product commercialization. In a recent survey by BioTalent Canada, companies were asked to rate nine different employee skills in terms of anticipated importance for the next three years. Management or leadership skills topped the responses with 93.5 per cent of companies identifying these skills as critical.[28]

3.2.1 Enrollment in Life Sciences Disciplines

Over the last decade, Ontario has performed relatively well compared to the Canadian average in terms of per capita enrollment in the physical and life sciences at the undergraduate level.

Figure 3.10. Physical and Life Sciences Undergraduate Degrees per 100,000 persons

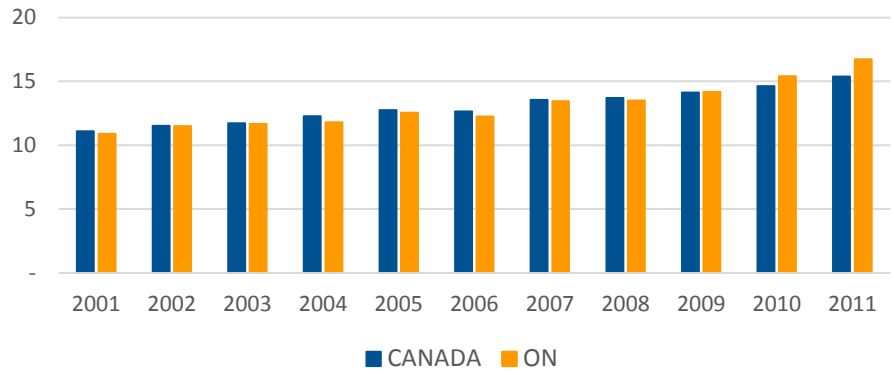


Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

At the graduate level, Ontario has been comparable to the Canadian average, having surpassed it only two years ago in its per capita enrollment of physical and life sciences graduate students. Canada has also been ranked as having the second most PhD graduates in life sciences per capita, second only to New Zealand.[29]

[28] *Source: BioTalent Canada 2013, Sequencing the Data, http://www.biotalent.ca/en/sequencing.*
[29] *Scientific America Worldview – A Global Biotechnology Perspective, 2013 Worldview Scorecard.*

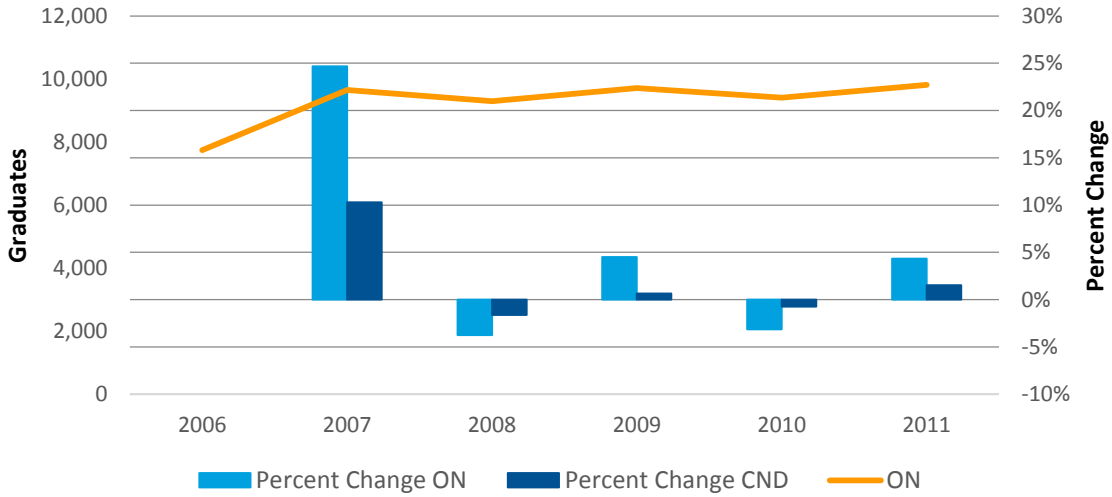
Figure 3.11. Physical and Life Sciences Graduate Degrees per 100,000 persons



Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

Ontario produced 9,813 postsecondary graduates from physical, life sciences, and technologies[30] programs in 2011, accounting for 49 per cent of the national total. Of these graduates, 93 per cent were from universities and seven per cent from colleges. From 2006-11, the rate of graduation increased 27 per cent in Ontario as compared to only 10 per cent for all of Canada during same period.

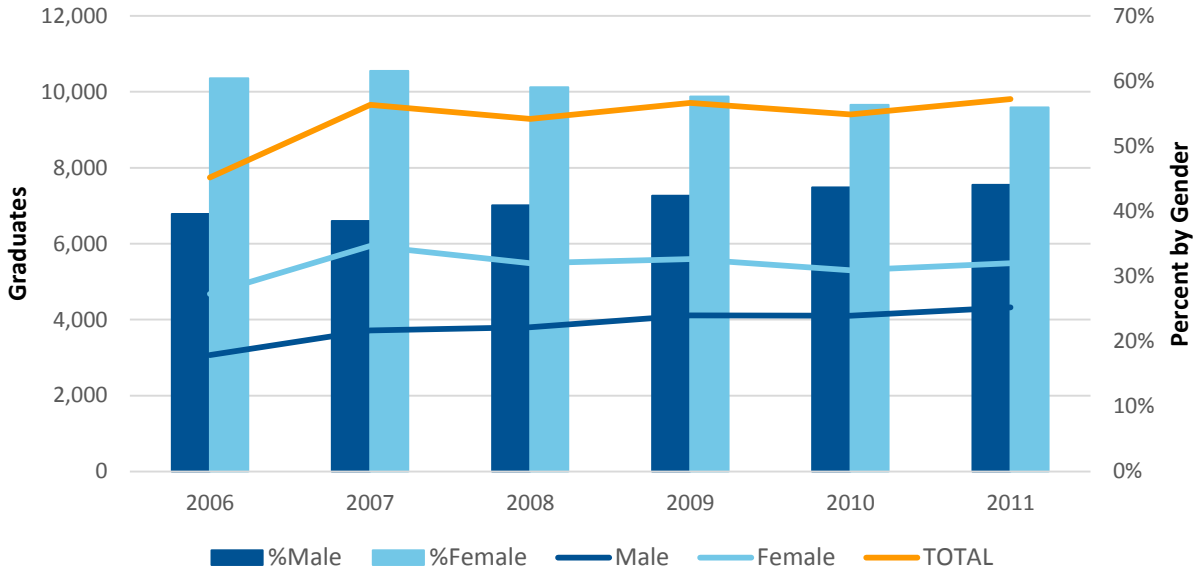
Figure 3.12. Ontario Life Sciences Graduates



Source: Statistics Canada, CANSIM Table 477-0030.

[30] *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.*

Figure 3.13. Ontario Life Sciences Graduates by Gender



Source: Statistics Canada, CANSIM Table 477-0030.

Women comprise the majority of life sciences graduates (60 per cent in 2006) but the gap is closing (56 per cent in 2011). However, this dominance of female science graduates is not reflected in either employment or wages. In fact, female university graduates aged 25 to 34 from science programs had a higher rate of unemployment compared to their male counterparts.[31] There was also an 18.9 per cent skills mismatch for women compared to only 16.8 per cent for men, and men were paid 13 per cent more than women within this same demographic.[32]

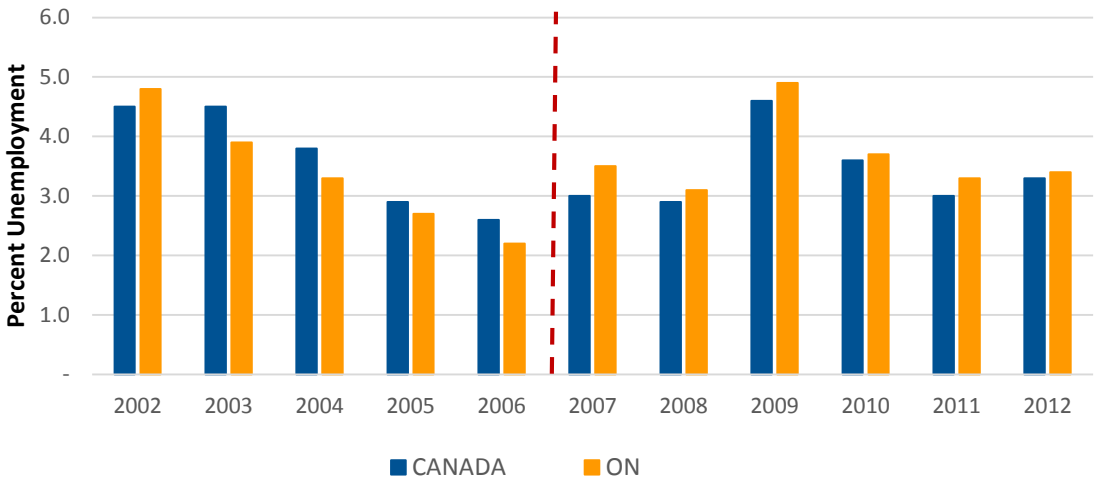
3.2.2 Unemployment in Life Sciences Occupations

Prior to the economic slowdown period, Ontario had a lower rate of unemployment in the natural and applied sciences occupations than the Canadian average. That has changed in the last five years. While unemployment rates in these occupations rose Canada-wide, it has continued at a higher rate in Ontario.

[31] *There was a 6.6 per cent unemployment rate for women versus 5.8 per cent for men. Source: Insights on Canadian Society: Gender differences in science, technology, engineering, mathematics and computer science (STEM) programs at university, Darcy Hango, December 2013, Statistics Canada, Catalogue no. 75‑006‑X, ISSN 2291-0840.*

[32] *Source: Ibid.*

Figure 3.14. Unemployment Rate for Natural and Applied Science Occupations



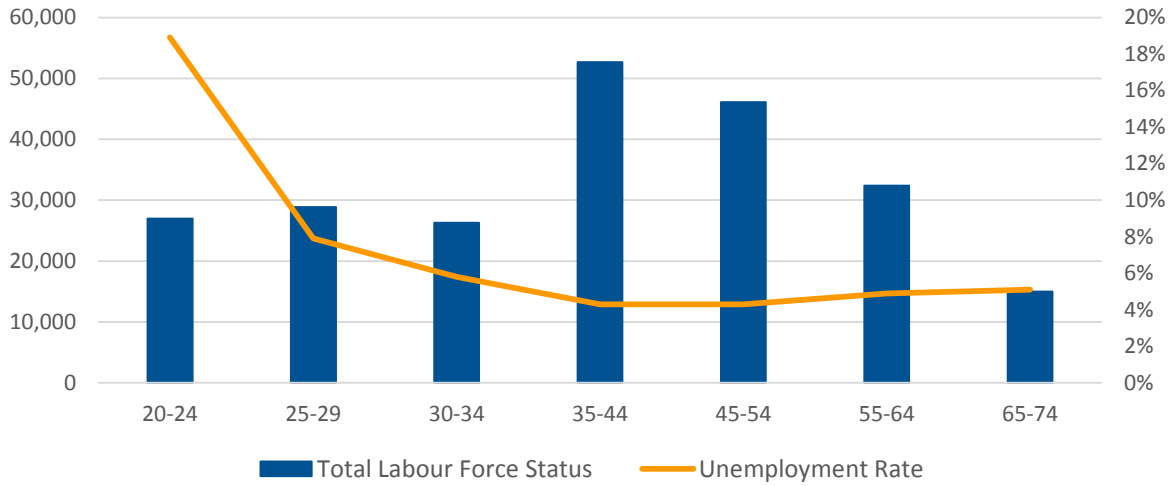
Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

While unemployment for all science graduates remains slightly higher than that of other Science, Technology, Engineering and Mathematics (STEM) disciplines, such as engineering and computer sciences, the major disparity is for young science graduates.

Of the 26,960 Ontario science graduates with a minimum university bachelor's degree in 2011 between the ages of 20 and 24, the unemployment rate was a disturbing 18.9 per cent.[33] This rate drops rapidly to 7.9 per cent for ages 25 to 29 then to 5.8 per cent for ages 30 to 34 and 4.3 per cent for ages 35 to 44. This disparity highlights the need to better transition science graduates into their first career-related position more efficiently. Wage subsidy programs, such as the federal Career Focus program, provide much needed financial incentives for companies to hire new graduates. Professional internships and apprenticeships that are integrated with higher education have also proven highly successful in jurisdictions such as Germany.[34]

[33] *2011 National Household Survey: Data tables, STEM Groupings, Major Field of Study, Catalogue no. 99-012-X2011043.*
[34] *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?".*

Figure 3.15. Unemployment Rates by Age Group in the Sciences



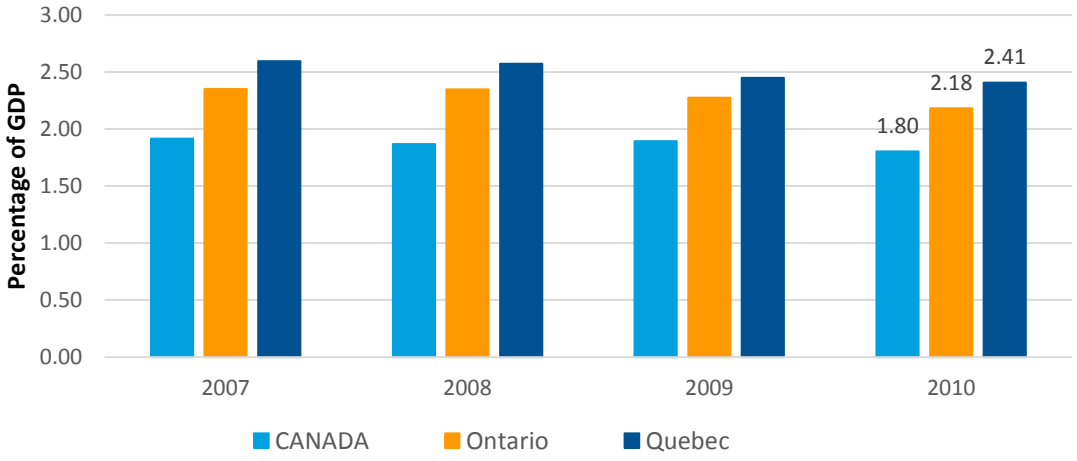
Source: 2011 National Household Survey: Data tables, STEM Groupings, Major Field of Study, Catalogue no. 99-012-X2011043. The data represents graduates with a minimum bachelors degree or higher in Science discipline.

3.3 Intellectual Capital[35]

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

Ontario spends 2.2 per cent of its GDP on R&D, outperforming the Canadian average but lagging Quebec's investment in this area.

Figure 3.16. Research and Development as a Percentage of GDP

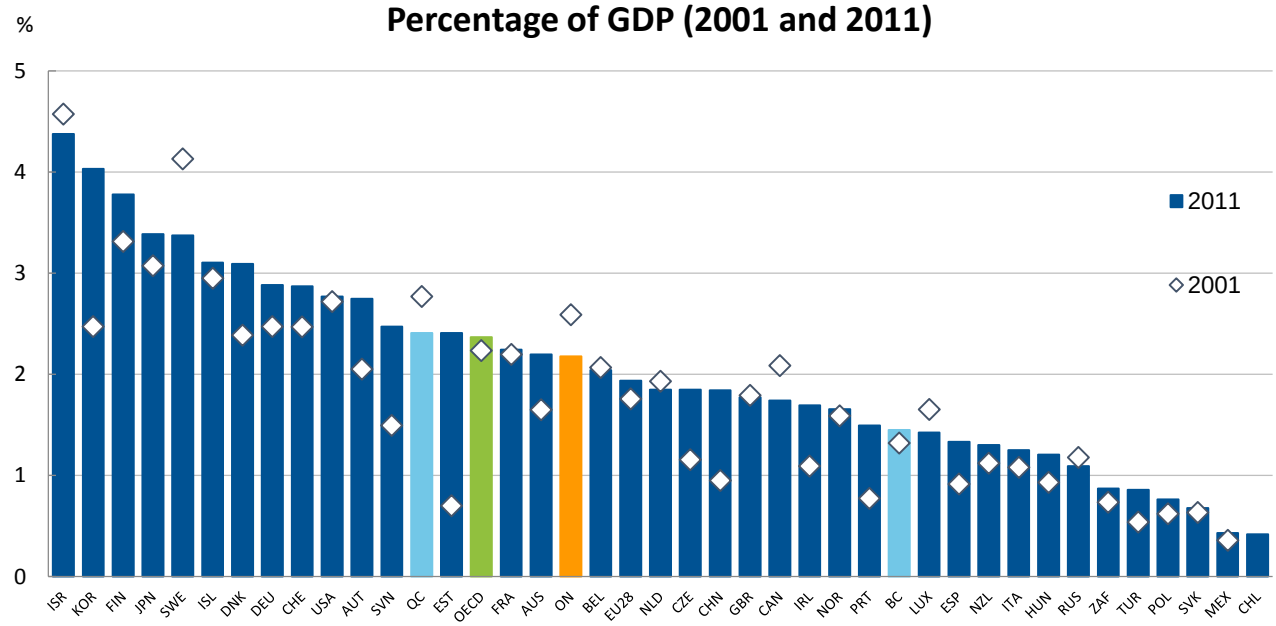


Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

[35] *Patents and R&D data in this section are not specific to life sciences unless explicitly stated.*

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. Its R&D intensity has also declined since 2001 while the leading countries have generally improved this metric.

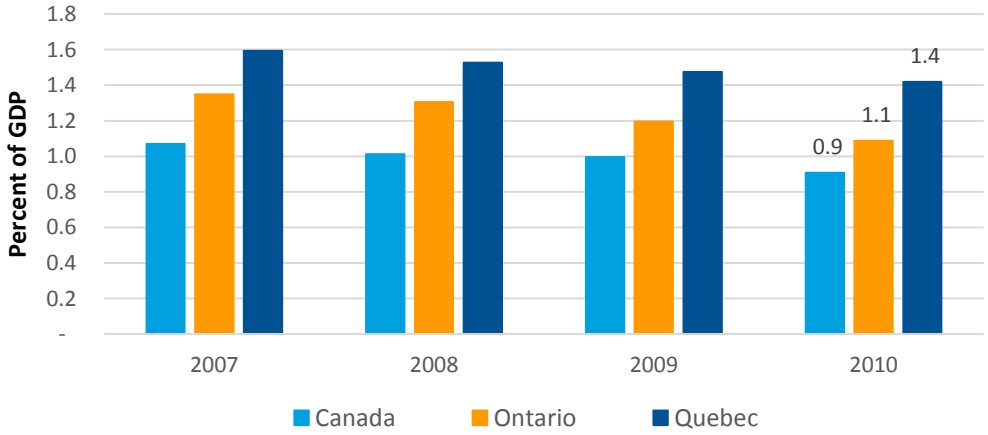
Figure 3.17. Research and Development Expenditure as a Percentage of GDP (2001 and 2011)



Source: OECD Science Technology and Industry Scorecard.

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, which recognize the value of innovative life sciences products.

Figure 3.18. Business Expenditure on Research and Development as a Percent of GDP

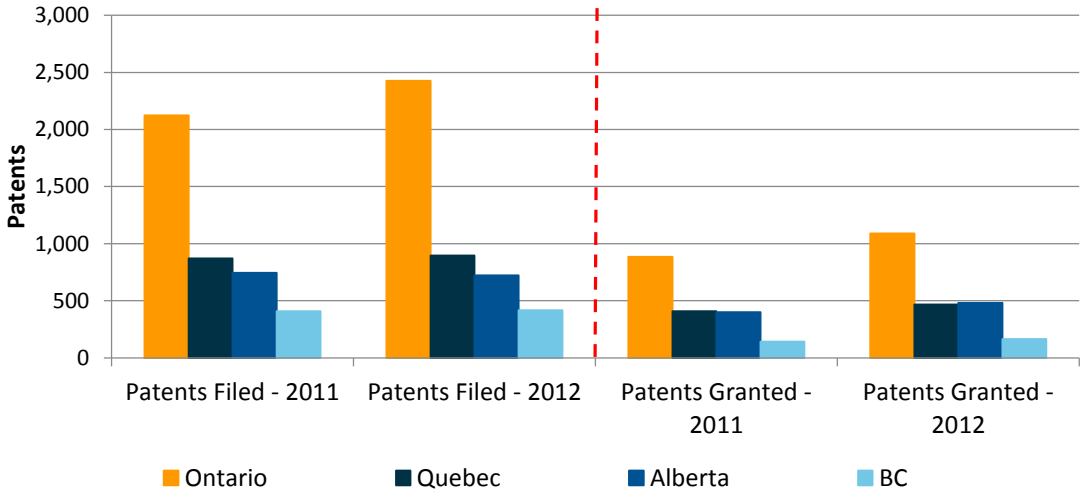


Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stat.

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 industry.

Ontario leads the country in both submitting and granting patent applications. Nationally, Ontario is at par with the Canadian average in patents granted as a percent of patent applications filed, although Alberta leads the country in this particular measure.[36]

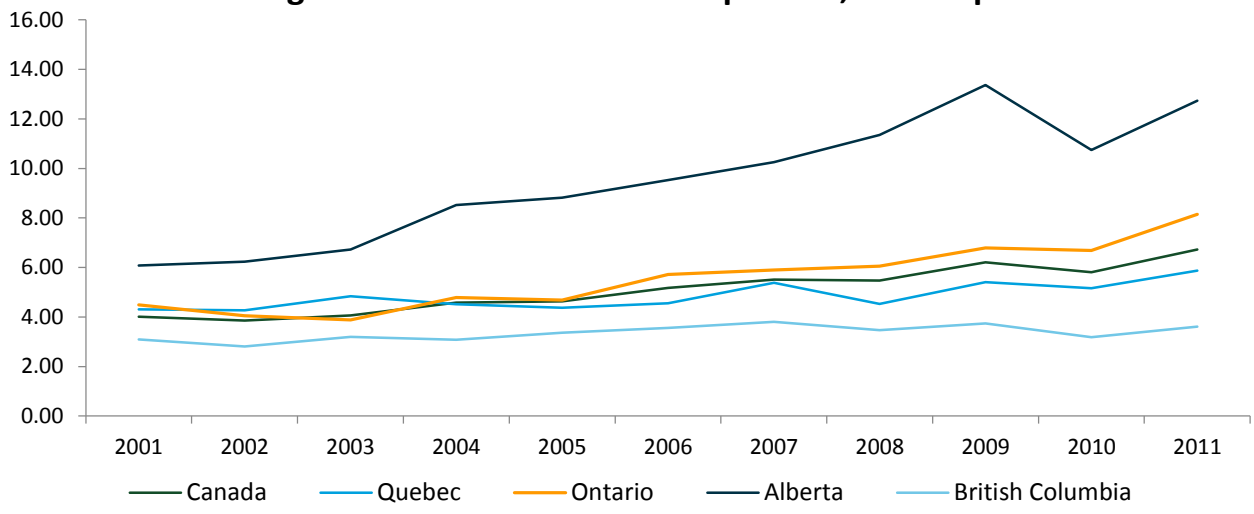
Figure 3.19. Canadian Patents Filed and Granted



Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

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

Figure 3.20. Patents Awarded per 100,000 People



Source: Input Indicators of the BC High Technology Industry 2013 Edition, BC Stats.

[36] *This data is not specific for the life sciences sector.*

4. Subsector Analysis

4.1 Agricultural Feedstock and Chemicals

Table 4.1

	Agricultural Feedstock and Chemicals	Life Sciences	Per Cent of Life Sciences
Establishments	473	5,645	8.4%
Employment	8,041	82,737	9.7%
Avg. Annual Wage	$55,378	$58,193	95.2%
Estimated Payroll	$445M	$4.8B	9.2%
Estimated ON Tax*	$40.7M	$448M	9.1%

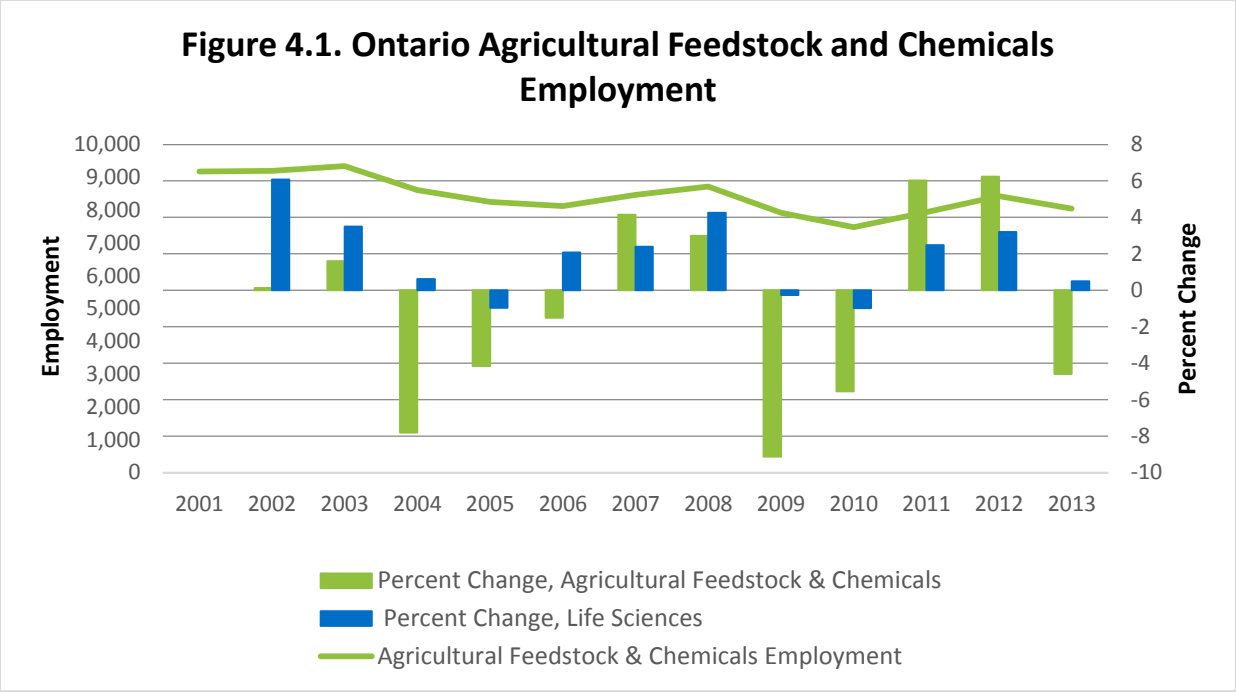
Source: Statistics Canada – See Appendices for detailed methodology.
**Personal Income tax on salaries only, does not include business tax generated.*

Ontario has tremendous strengths in agri-food and industrial biotechnology. In fact, a recent economic impact analysis report showed that the food processing industry alone now employs more people in the province than the automotive sector.[37] However, it remains extremely difficult, if not impossible, to accurately assess the part of this sector directly related to life sciences using currently available data. Thus, in our current analysis, the Agricultural Feedstock and Chemicals segment represents the smallest component of the life sciences industry but also the most underreported in the current methodology.

For example, dairy product manufacturing and wineries, breweries, and distilleries are not included in the core definition of life sciences under the current methodology,[38] but represent more than 16,000 employees that would make this segment comparable to both the drugs and pharmaceuticals and the medical devices and equipment segments. As another example of the significant underrepresentation of this segment, BIOTECanada estimates the agricultural and industrial biotechnology component to be approximately 33 per cent of the total provincial bio-economy by GDP.[39] According to the Battelle/BIO report, this segment has the largest employment multiplier effect by far of 18.1, which is nearly double that of the drugs and pharmaceutical segment at 9.9 and above the industry's reported average of 4.9.

In the absence of better quality data and a comparable methodology for benchmarking, we have provided the results of our current methodology to enable jurisdictional comparisons.

[37] *Economic Impact Analysis of Ontario's Food and Beverage Processing Sector, prepared by MNP for the Alliance of Ontario Food Processors (Now called Food and Beverage Ontario).*
[38] *These industries are included in other reports of the bioeconomy such as:* Measuring the bio-based economy: A Canadian perspective*, William Pellerin and D. Wayne Taylor, Industrial Biotechnology, Winter 2008, Vol. 4 No. 4.*
[39] *Source: BIOTECanada "Beyond Moose and Mountains," 2008 Data.*



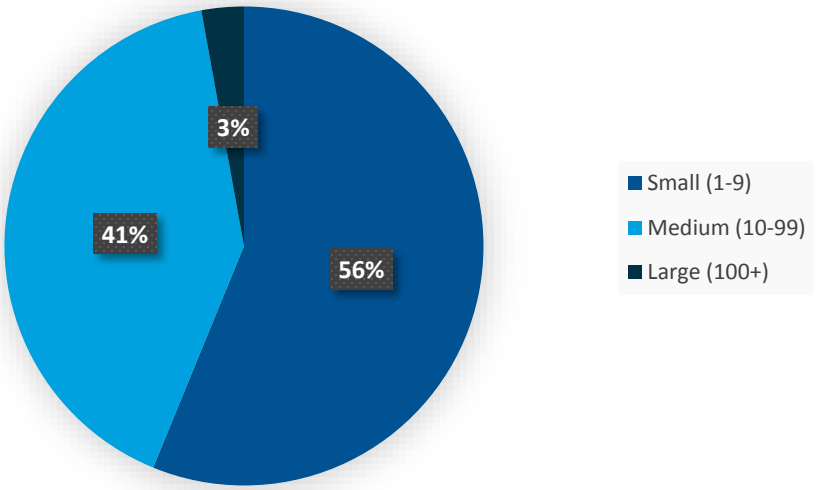
Source: Statistics Canada, CANSIM Table 281-0024 (2013) – See Appendix C for detailed methodology.

We note with concern the declining employment trend (down 12.4 per cent from 2001-13) and the high degree of year-to-year volatility. Unlike the rest of the life sciences industry, this segment appears to be particularly sensitive to external forces, which is not surprising since this segment is also inextricably linked to traditional agriculture that is highly impacted by economic forces, such as commodity prices, and increasingly the changing climate and extreme weather events. In contrast, other industries not included in this analysis, such as dairy product manufacturing and wineries, breweries, and distilleries, showed significant growth from 2009-13.

The agriculture feedstock and chemicals segment shows revenues of $5 billion or 12 per cent of the total life sciences sector, despite the exclusion of two NAICS codes due to unavailability of data.[40] Like most segments within the life sciences sector, agricultural feedstock and chemicals is 97 per cent dominated by small- and medium-sized enterprises. This segment also has the largest percentage of medium-sized enterprises.

[40] *See Appendix D for detailed methodology.*

Figure 4.2. Ontario Agricultural Feedstock and Chemicals Establishments by Size



Source: Statistics Canada, CANSIM Table 551-0005 (2013) – See Appendix F for detailed methodology.

4.2 Drugs and Pharmaceuticals

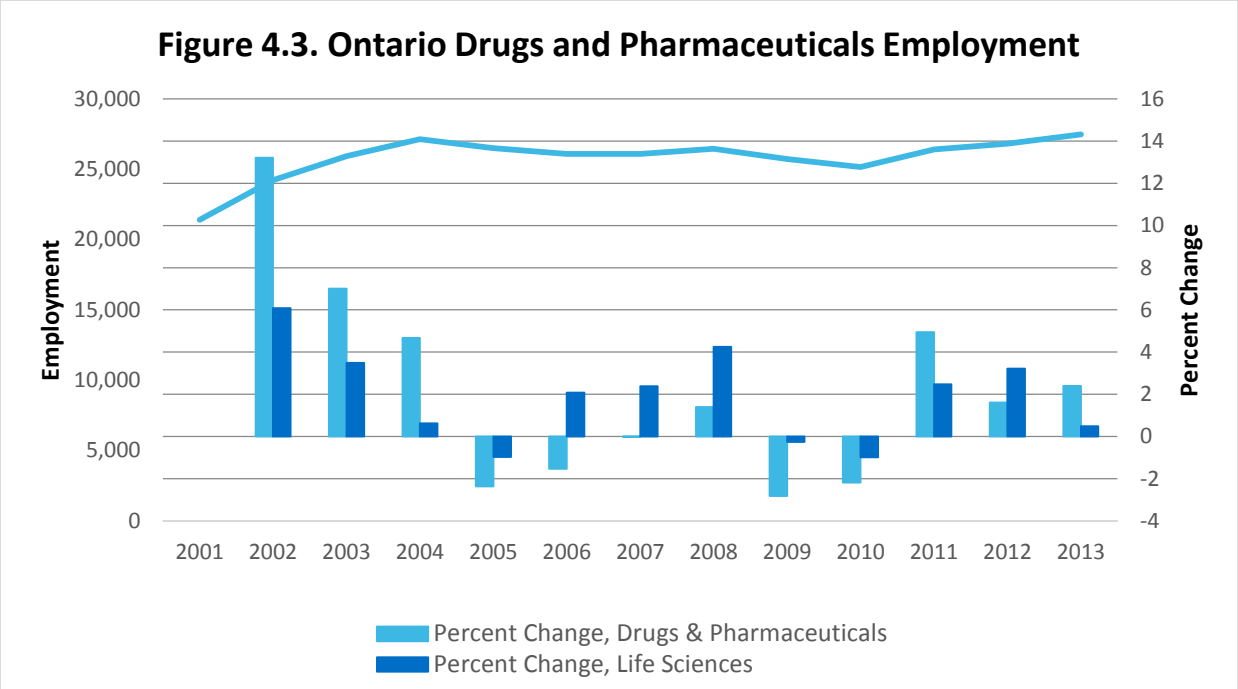
Table 4.2

	Drugs and Pharmaceuticals	Life Sciences	Per Cent of Life Sciences
Establishments	596	5,645	10.6%
Employment	27,465	82,737	33.2%
Avg. Annual Wage	$59,999.34	$58,192.91	103.1%
Estimated Payroll	$1.65B	$4.8B	34.2%
Estimated ON Tax*	$150.8M	$448M	33.7%

Source: Statistics Canada – See Appendices for detailed methodology.
**Personal Income tax on salaries only, does not include business tax generated.*

Ontario's bioPharmaceutical industry anchors the overall life sciences ecosystem, consisting of a number of large multi-national enterprises (MNEs) and emerging small and medium enterprises (SMEs). Representing a third of the total employment and more than half the total revenues[41] with only 10.6 per cent of companies, this is a highly concentrated segment. It is also the highest paying segment in life sciences, with average annual wages of $59,999, which is 30 per cent higher than Ontario's average.

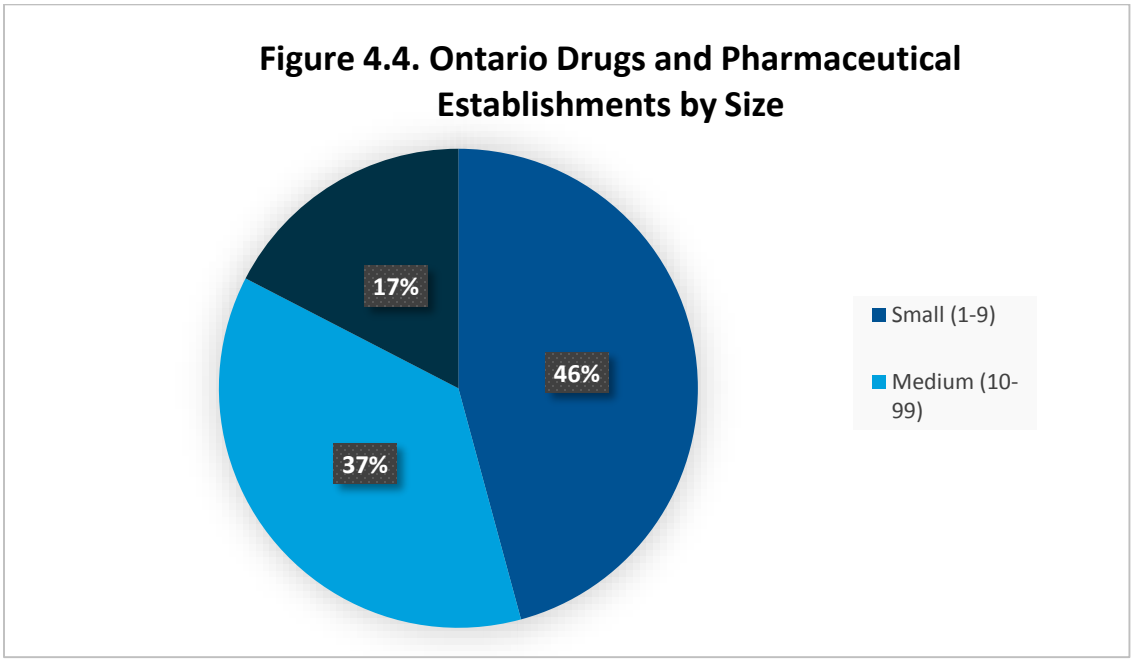
[41] *We estimate the pharmaceutical and drugs segment generates $24.1 billion in annual revenues, of which $18.4 billion is from wholesale activities.*



Source: Statistics Canada, CANSIM Table 281-0024 (2013) – See Appendix C for detailed methodology.

Drugs and pharmaceuticals employment grew by 28.3 per cent from 2001-13; the bulk of growth occurred between 2001 and 2004. Since then, employment growth has been relatively flat with the last three years showing positive signs of modest growth.

Unlike most other life sciences segments, drugs and pharmaceuticals have a significant number of large establishments (more than 100 employees). In fact, within all large establishments across the entire life sciences sector, nearly half (45 per cent) are from the drugs and pharmaceuticals segment.



Source: Statistics Canada, CANSIM Table 551-0005 (2013) – See Appendix F for detailed methodology.

4.3 Medical Devices and Equipment

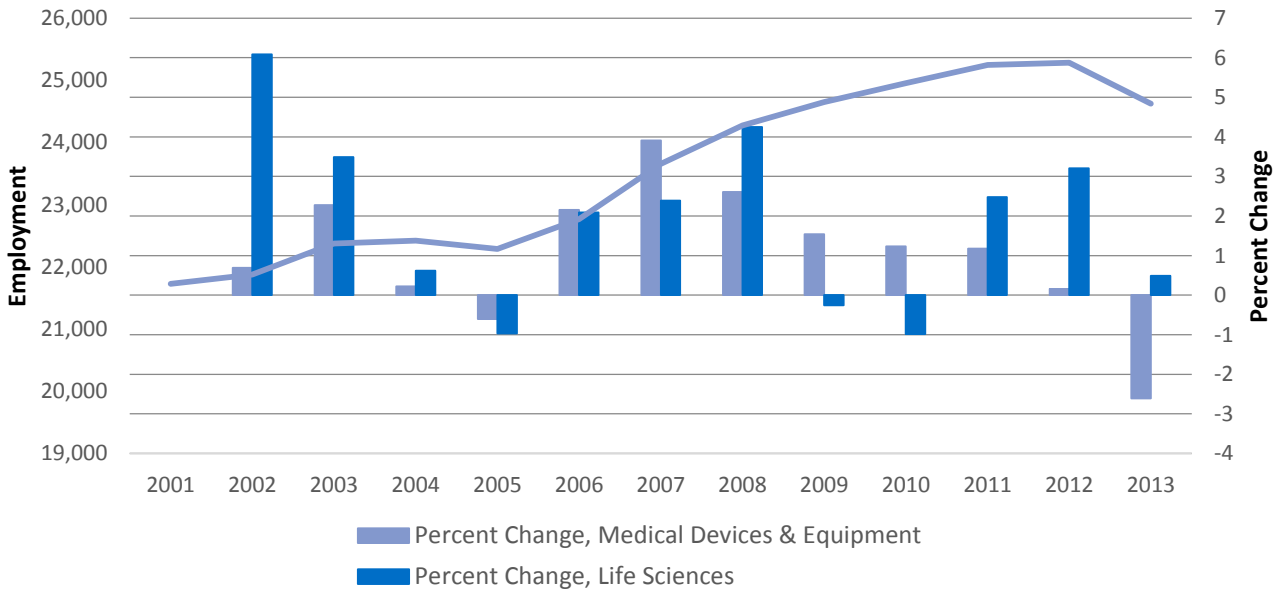
Table 4.3

	Medical Devices and Equipment	Life Sciences	Per Cent of Life Sciences
Establishments	2,236	5,645	39.6%
Employment	24,626	82,737	29.8%
Avg. Annual Wage	$56,610.61	$58,192.91	97.3%
Estimated Payroll	$1.39B	$4.8B	29.0%
Estimated ON Tax*	$127.6M	$448M	28.5%

**Personal income tax on salaries only; does not include generated business tax.*
Source: Statistics Canada – See Appendices for detailed methodology.

Medical devices and equipment is one of the largest components of Ontario's life sciences sector. Employing 24,626 people in 2,236 firms, it is also a highly diversified segment and the second largest revenue generator, with $10.5 billion or 25 per cent of the total.

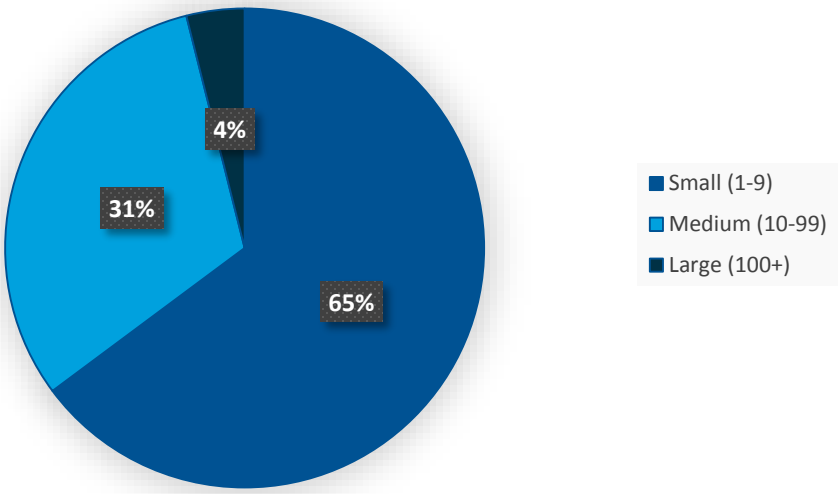
Figure 4.5. Ontario Medical Devices and Equipment Employment



Source: Statistics Canada, CANSIM Table 281-0024 (2013) – See Appendix C for detailed methodology.

From 2001-13, medical devices and equipment employment grew by 13.3 per cent with much of that growth occurring between 2006-11 despite the beginning of the economic downturn in late 2008. There was a sharp decline in employment in 2013, the largest observed in the available data. This may partly reflect increasing external pressures, such as cost containment measures within public healthcare.

Figure 4.6. Ontario Medical Devices and Equipment Establishments by Size



Source: Statistics Canada, CANSIM Table 551-0005 (2013) – See Appendix F for detailed methodology.

Small companies employing less than 10 people dominate the medical devices and equipment segment (65 per cent). The segment also has the second largest number of large firms, accounting for 38 per cent of the total number of large firms within the entire sector.

4.4 Research, Testing and Medical Laboratories

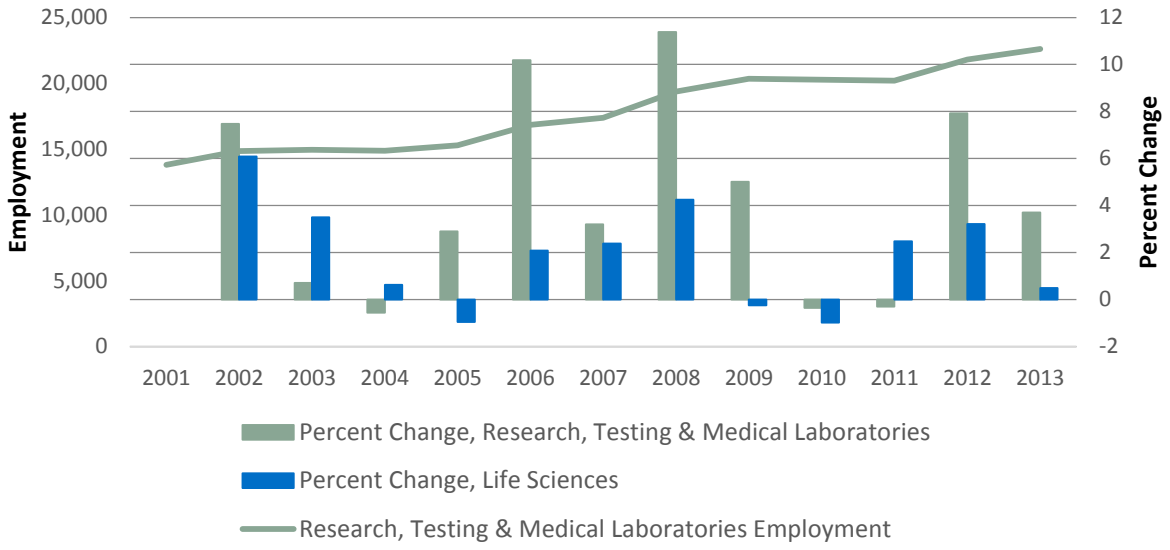
Table 4.4

	Research, Testing and Medical Labs	Life Sciences	Per Cent of Life Sciences
Establishments	2,340	5,645	41.5%
Employment	22,605	82,737	27.3%
Avg. Annual Wage	$58,723.32	$58,192.91	100.9%
Estimated Payroll	$1.33B	$4.8B	27.6%
Estimated ON Tax*	$128.9M	$448M	28.8%

**Personal income tax on salaries only; does not include generated business tax.*
Source: Statistics Canada – See Appendices for detailed methodology.

The research, testing and medical laboratories segment is the largest life sciences segment by number of establishments, accounting for 27.3 per cent of employment. Yet it generates the smallest revenues at an estimated $2.5 billion or six per cent of the total; it represents one of the higher paying segments, second only to drugs and pharmaceuticals.

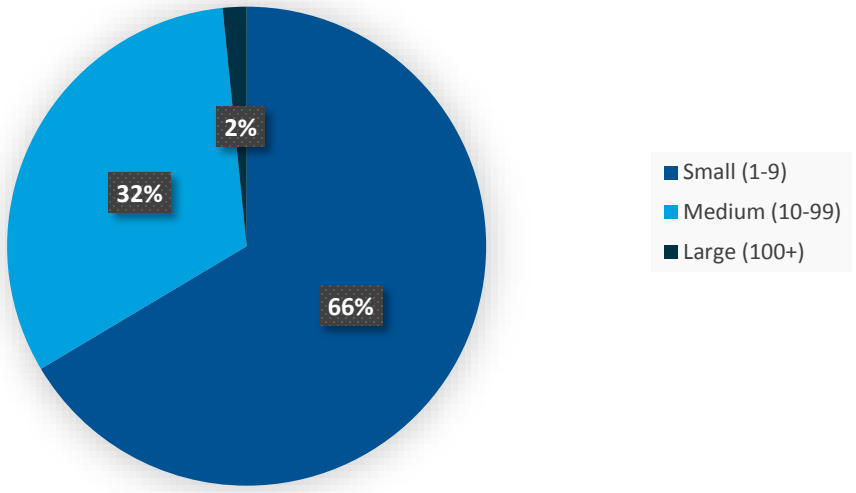
Figure 4.7. Ontario Research, Testing and Medical Laboratories Employment



Source: Statistics Canada, CANSIM Table 281-0024 (2013) – See Appendix C for detailed methodology.

The research, testing and medical laboratories segment is also the fastest growing segment within life sciences. Employment grew 63.7 per cent from 2001-13, and showed great stability during the economic downturn that began in 2008.

Figure 4.8. Ontario Research, Testing and Medical Laboratories Establishments by Size



Source: Statistics Canada, CANSIM Table 551-0005 (2013) – See Appendix F for detailed methodology.

Small and medium enterprises that employ less than 100 people dominate research, testing and medical laboratories (98 per cent). More specifically, this segment accounts for the largest number of small companies with 10 or fewer employees (66 per cent).

5. Conclusion

Collecting and analyzing economic data for Ontario's life sciences sector led us to these conclusions relating to the year 2011:

1. **The life sciences sector significantly contributes to Ontario's overall economy**. Employing nearly 83,000 highly skilled workers at more than 5,600 companies, Ontario's life sciences sector ranks among North America's top clusters. The industry is conservatively estimated to generate at least $40.5B in annual revenue that directly contribute $21.6 billion in value added to the provincial GDP. Too often, life sciences is viewed as a cost to government rather than an economic contributor, largely due to its association with publicly-funded research and the public healthcare system.

2. **Life sciences present a strategic opportunity for Ontario's future prosperity**. The Life Sciences sector has a high economic-impact multiplier due to the demand it creates in other industry sectors and the relatively high wages and salaries paid to workers in the sector. We estimate that the sector's total economic contribution could be as high as $38.5 billion in GDP and 167,285 jobs supported through direct, indirect and induced economic impacts. These are remarkable characteristics considering 63 per cent of Ontario's Life Sciences companies have less than 10 employees and only four per cent have more than 100. With the right support, such as public policies that support strong intellectual property protection, market access, talent development and access to capital; the sector has the potential to significantly grow its contributions to Ontario and Canada.

3. **Future sector growth requires focused efforts by industry, government and academia to address a number of challenges**, including:
   - **a.** *Access to Capital*: Life sciences stakeholders in Ontario consistently identify access to risk capital as their top challenge. Ontario's share of Canadian venture capital has trended downward since 2001; venture capital per capita lags that of many North American jurisdictions. Public markets are a crucial funding source to explore as the life sciences typically represents less than two per cent of all equity raised on the TSX/TSXV exchanges.
   - **b.** *R&D Investment*: Our analysis indicates that while Ontario's business expenditure on R&D, as a percentage of GDP, is higher than the national average, the province's total R&D expenditure is below the OECD average.
   - **c.** *Transition of Talent*: We face a significant gap in transitioning young life sciences graduates into the workforce. Our data shows that Ontario science graduates with a minimum bachelors degree between the ages of 20 to 24 face a staggering 18.9 per cent unemployment rate. We must address this gap in efficiently transitioning Ontario's science graduates into the workforce.

LSO calls upon industry and government to work together to create a coordinated strategic plan to grow Ontario's Life Sciences sector, focusing on the supports needed to help small and medium life sciences companies to grow in Ontario.

---

6. Acknowledgements

LSO acknowledges our members and sponsors whose support made this report possible.

Appendices

A. Industry Definitions

Robust economic data is essential to informing sound, evidence-based policy development to support the growth of various industry clusters. Sourcing data for Ontario's life sciences sector is difficult for several reasons. First, there is no consistent definition of "life sciences." In fact, there are several conflicting definitions that create confusion. Second, the major source for economic data is Statistics Canada (StatsCan) using the North American Industry Classification System (NAICS), a six-digit coding system created to assist in harmonizing economic data between Canada, the United States and Mexico. Unfortunately, NAICS is only harmonized to the two-digit level for some industries and is seldom comparable at the six-digit level, at least for life sciences-related industries. In Canada, six-digit NAICS codes related to life sciences are also often difficult to delineate from other industries. Further complicating the matter is the lack of availability of detailed economic data at the five- and six-digit NAICS levels. Yet, NAICS-based data from StatsCan remains the best source for consistent, reproducible and recurring economic data for Canadian industries.

Given these limitations, LSO set out to create a benchmarking report for the life sciences sector in Ontario with the following goals:

1. Establish a consistent definition for the life sciences sector consistent with leading jurisdictions to enable data collection using NAICS.
2. Collect economic data for Ontario's life sciences sector to:
    a. Assess its economic impacts
    b. Monitor year-over-year trends to assess its economic health
    c. Enable jurisdictional comparisons (i.e., benchmarking)
3. Inform evidence-based policy development to support Ontario's life sciences sector

Defining the Sector

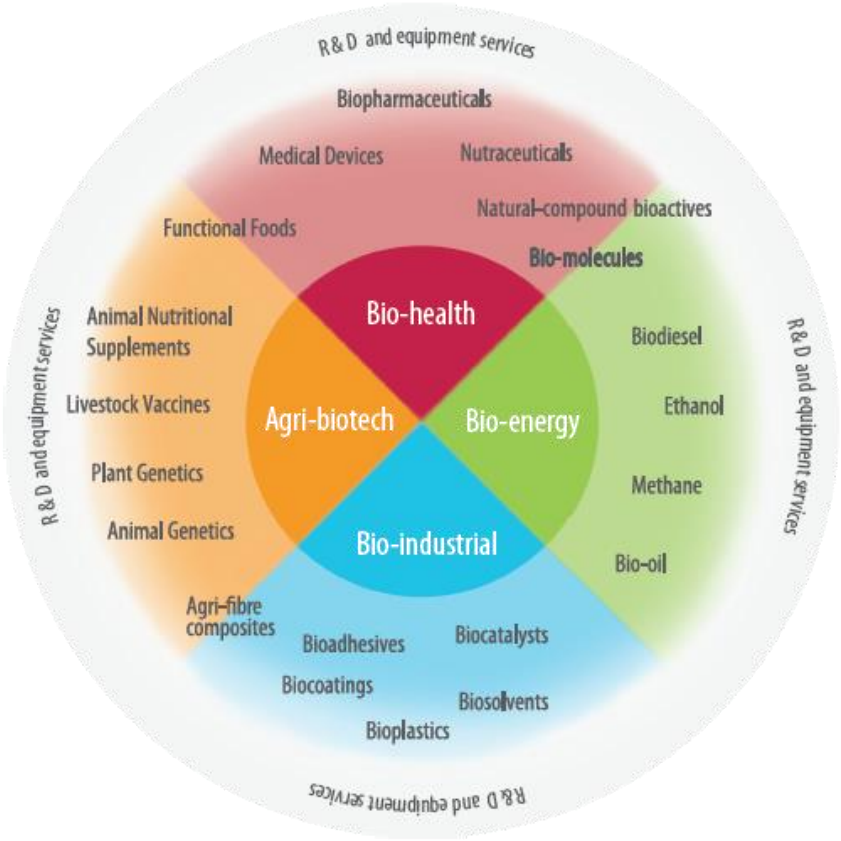
i. **Province of Ontario** — Historically, the provincial government defines Life Sciences as human health sciences only. In a recent marketing publication, the province described the industry as employing 51,000+ workers at 1,600+ firms and generating $39+B in revenue.[42]

ii. **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.[43] 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.[44] The report uses a NAICS-based definition and includes agri-food and human health biotechnology as well as their related distribution.

[42] *Life Sciences in Ontario – You Need to be Here. Stat. – 2014 Brochure by InvestinOntario.com.*
[43] *Description from www.bio.org.*
[44] *Battelle/BIO State Bioscience Jobs, Investments and Innovation 2014.*

iii. **Life Sciences Ontario**'s definition of the life sciences — LSO aligns its definition 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. In its 2013 Labour Market Information Report, BioTalent created an infographic that captures this inclusive definition.

Figure A.1: Defining life sciences



Source: BioTalent Canada 2013, "Sequencing the Data," http://www.biotalent.ca/en/sequencing.

B. Data Challenges

Unlike most other industrial sectors, industrial and economic data for the Canadian life sciences sector is particularly difficult to obtain. The main driver for this difficulty is the inconsistent definition of the sector (see Appendix A above) and the sector's diverse nature, which leads to life sciences data being spread across many industrial classifications and often aggregated with data from unrelated industries.

Many life sciences organizations collect their own data, either through targeted data segments from Statistics Canada or by collecting primary data from their direct stakeholders through membership or surveys. However, aggregating this data across multiple sources is very difficult when trying to assess the entire life sciences sector. Data from these sources can vary by its recurring availability and vintage, can include overlaps (i.e., double counting) and does not lend itself well to benchmarking because of the inherent variability in methodologies from jurisdiction to jurisdiction.

Using the Battelle/BIO report as a best-in-class example of life sciences benchmarking, LSO adapted available Canadian NAICS data to be representative of Ontario's life sciences industry (see Table 1). One major difference in the data segmentation is we have included related distribution within each sub-sector rather than as a separate sub-sector. We have also identified a segment of data for an expanded definition of life sciences that is not included in the current benchmarking methodology but is directly relevant to the life sciences in Ontario. This expanded dataset includes hospitals and other health services along with dairies, distilleries and other food processes that extensively use biotechnology.

LSO has also adopted a NAICS-based approach 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. Tables B.1 shows a comparison of this definition to that used by Battelle/BIO.

Table B.1: Comparison of NAICS-based definitions from Battelle/BIO6 and LSO

Six-digit NAICS	Battelle/BIO (2014)[45]	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	✓	
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 science activities.

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

Expanded definition of life sciences

The above definition represents the closest Canadian analogue that we could determine to that used in the Battelle/BIO report. However, although useful for tracking industry trends and benchmarking jurisdictional performance, this methodology does exclude key components of the life sciences industry. To capture some of the missing components, we developed a data section for related industries. 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. When taken together, the life sciences and related industries data may provide a more realistic view of the large economic impact of biotechnology as a platform technology. Table B.2 below shows a summary of the NAICS included in the expanded definition of related industries.

Table B.2: 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

C. Employment Analysis, Data Sources and Methodology

Raw Employment Data

Determining employment statistics by NAICS is not a straightforward process. StatsCan collects employment data in the Survey of Employment, Payroll and Hours (SEPH). SEPH data is correlated to NAICS codes to the four-digit level in CANSIM Table 281-0024. Table C.1 below summarizes the historical employment data for the relevant four-digit NAICS categories.

Table C.1: Historical Employment Data for Life Sciences Industries by Four-Digit NAICS

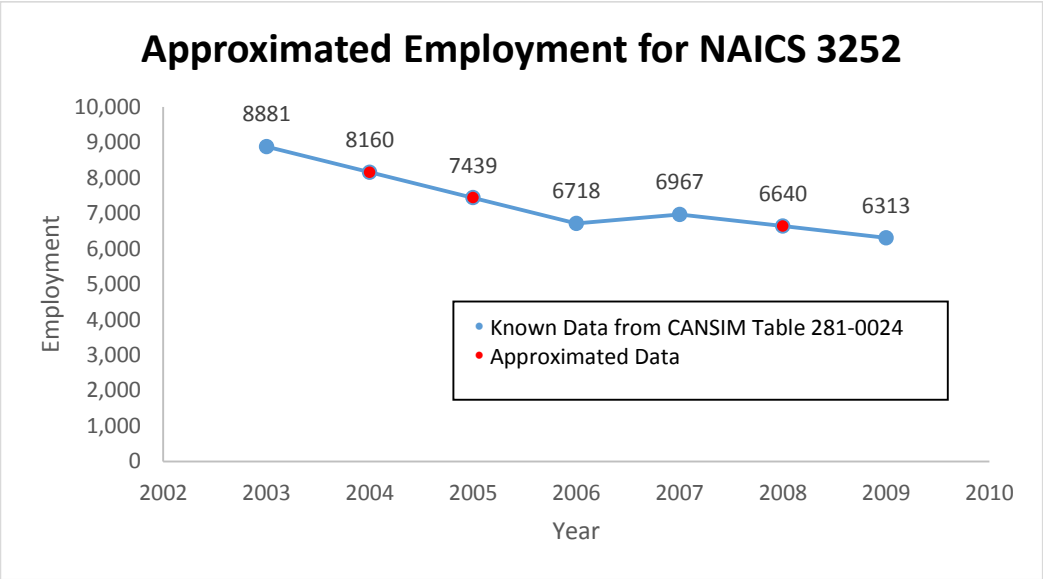
NAICS	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Grain and oilseed milling [3112]	5294	4946	4829	4329	4355	4945	4252	4525	3967	4630	4865	4815	4847
Basic chemical manufacturing [3251]	6544	6631	6403	5376	5249	5247	5661	6612	5332	5166	5341	6139	5338
Resin, synthetic rubber, and artificial and synthetic fibres and filaments manufacturing [3252]	5734	7585	8881	8160	7439	6718	6967	6640	6313	5730	5321	5824	5332
Pesticide, fertilizer and other agricultural chemical manufacturing [3253]	1677	1272	1224	1172	1120	1068	1161	1056	951	776	962	964	975
Pharmaceutical and medicine manufacturing [3254]	11650	13475	14548	15697	15375	15477	15423	15556	15323	14803	14923	14913	15690
Navigational, measuring, medical and control instruments manufacturing [3345]	13274	12753	12588	12772	13240	13357	13254	13387	12842	12987	12412	12366	11745
Medical equipment and supplies manufacturing [3391]	6707	6716	7418	7503	7377	7382	7720	8123	8376	8580	8505	8589	8341
Pharmaceuticals, toiletries, cosmetics and sundries merchant wholesalers [4145]	15010	16553	17515	17612	17122	16343	16420	16777	15987	15924	17654	18325	18116
Other machinery, equipment and supplies merchant wholesalers [4179]	29448	29724	29325	29255	29238	30169	31251	31669	31905	32101	32823	32737	31931
Agricultural supplies merchant wholesalers [4183]	4486	4518	4497	4423	4266	4221	4543	4630	4542	4191	4603	4786	4763
Architectural, engineering and related services [5413]	46080	43423	43371	43981	45485	47090	50643	55769	54530	55640	57111	61472	61212
Scientific research and development services [5417]	14744	18276	17656	15655	16984	21264	21482	20261	23043	24140	25114	27693	28862
Medical and diagnostic laboratories [6215]	6084	6857	7067	7234	7275	7956	8046	9625	10291	9912	9522	10199	10848

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 CANSIM Table 281-0024.

Approximating Missing Employment Data

In Table C.1, there are two industry categories missing employment data for three annual entries. To form a complete historical data set, these missing entries were estimated by assuming 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. Figure C.1 below provides an illustrative example using the employment data from NAICS 3252 between the years 2003 and 2009.

Figure C.1: Illustrative Example of Estimating Missing Employment Data



Source: Statistics Canada CANSIM Table 281-0024

Weighting Factors for Estimating Six-Digit NAICS Employment

To extract the relevant life sciences portion from existing four-digit NAICS employment data, it is necessary to estimate employment to the six-digit level. To do so, we derived a weighting factor from available establishment and by employment size data in CANSIM table 551-0005. 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 C.2 provides an example of how this weighting factor was derived for NAICS 311211 [Flour milling] and NAICS 311224 [Oilseed processing].

Table C.2: 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	4	3	6	2	0	0	0	427.5	0.12
Rice milling and malt manufacturing [311214]	1	0	0	2	1	0	0	0	146	0.04
Wet corn milling [311221]	0	2	0	0	2	0	1	0	512.5	0.14
Oilseed processing [311224]	5	2	2	1	1	1	0	0	314	0.08
Fat and oil refining and blending [311225]	1	0	0	4	1	1	0	0	364.5	0.1
Breakfast cereal manufacturing [311230]	1	1	0	0	1	1	2	2	1932.5	0.52
SUB-TOTAL Employment for NAICS [3112]									3697	

Source: Statistics Canada CANSIM Table 551-0005.

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, we estimate that 90 per cent of the employment was contained in NAICS category 54171. Unfortunately, this broad category includes many industries unrelated to Life Sciences. To more accurately estimate the employment weighting for NAICS 5417, a customized report 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 C.3: Calculating Employment Weighting Factor for NAICS 5417 Using NOC Data

5417 Scientific research and development services	Employment (Ontario)
All occupations	21,530
031 Managers in health care	85
082 Managers in agriculture, horticulture and aquaculture	15
2112 Chemists	1,015
212 Life science professionals	600
2211 Chemical technologists and technicians	645
222 Technical occupations in Life Sciences	385
311 Physicians, dentists and veterinarians	95
313 Pharmacists, dietitians and nutritionists	55
321 Medical technologists and technicians (except dental health)	570
Life Sciences Sub-Total	3,465
Employment Weighting Factor	0.161

Source: Statistics Canada – Customized Report from 2011 National Household Survey.

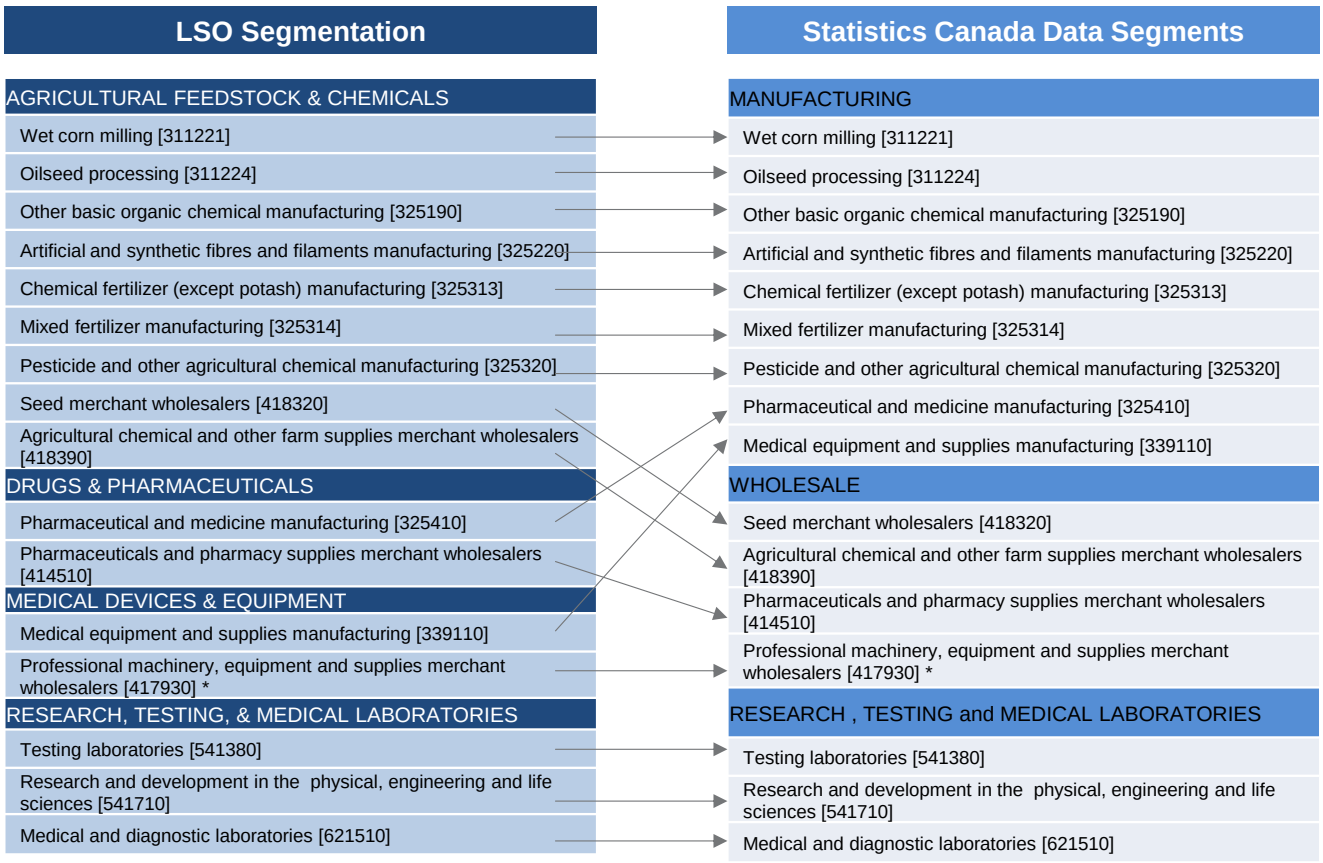
D. Revenues Analysis, Data Sources and Methodology

The Life Sciences Industry, as defined in this report, consists of 16 NAICS codes organized into four sub-sectors:

- 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 the buckets manufacturing, wholesale and research, testing and medical laboratories, based on the nature of the final product or service.

Figure D.1: Segmentation differences between LSO and Statistics Canada Data Segments



Segmented this way, data was gathered as follows:

1. Data for the manufacturing codes was sourced from CANSIM Table 301-0006. Given that it provides revenue information at the detailed six-digit NAICS code level, the data is relatively incomplete and dated. Specifically, revenue information for two sectors (Wet Corn Milling and Oilseed Processing) is suppressed for confidentiality, making the dataset incomplete. As such, the total revenue figure of $40.5 billion is an underestimate of the actual revenues. As well, the latest year for which data is available for all other NAICS codes is 2009. The more recent data is deemed to be too unreliable to be published for the majority of sectors.

2. Data for the wholesale sectors was estimated using aggregated NAICS Revenue data sourced from CANSIM Table 081-0014. Of the four wholesale NAICS codes, revenue data at the detailed five-digit level was available for one sector: pharmaceuticals and pharmacy supplies merchant wholesalers (41451). Data for the other three codes was imputed using available data at the four-digit level.

Table D.2: Estimating Revenues for Wholesale Sectors

WHOLESALE	Revenues (2009) CANSIM 081-0014	Employment Weight	Estimated Revenues
Agricultural supplies wholesaler-distributors [4183]	$3,674,772,000		
Seed merchant wholesalers [418320]		0.15	$551,215,800
Agricultural chemical and other farm supplies merchant wholesalers [418390]		0.46	$1,690,395,120
Pharmaceuticals and pharmacy supplies merchant wholesalers [414510]	$18,389,052,000		
Other machinery, equipment and supplies wholesaler-distributors [4179]	$17,654,718,000		
Professional machinery, equipment and supplies merchant wholesalers [417930] *		0.51	$9,003,906,180

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 industry definition. We assume that revenue is proportional to the employment level, and that revenue per employee is constant within the four-digit NAICS bucket.

Revenue information for the research, testing and medical laboratories industry codes was not available through CANSIM. Based on primary research, including all major private medical laboratories in Ontario, the market size of the research, testing and medical laboratories subsector is estimated to be at least $2.5 billion in Canada. To derive the Ontario number, we have used as a factor the Ontario's share of national healthcare spend (36 per cent). Our estimate for Ontario's revenues from research, testing and medical laboratories is $900 million.

E. Economic Impact Analysis, Data Sources and Methodology

Economic impact analysis uses industry impact multipliers developed from previous runs of a statistical input-output economic model. The input-output model maps the demand and supply relationships between the economy's various sectors, and between each industry's different labour requirements.

Using this model, the direct, indirect and induced impacts of an industry can be estimated by simulating an output shock of that industry and estimating the value of the additional goods, services and labour that would be needed to meet the demand.

For the life sciences industry, there is no single industry classification within the North American Industry Classification System (NAICS) that comprehensively captures all relevant sub-sectors. For this reason, there is no single set of economic impact multipliers that perfectly reflect the life sciences industry's impact either provincially or nationally. Due to this limitation, impact multipliers for the NAICS codes were sourced using the life sciences sector definition adapted for this report, and aggregated them to a single life sciences industry code based on the revenue share of individual NAICS industries.

As is standard industry practice, the multipliers were adjusted using direct employment and GDP figures where they were known. We calculated the direct impact of the revenue generated by the life sciences industry using actual data on revenues, employment and GDP. Since the multipliers are not available at the six-digit NAICS level, adjusting direct impacts using observed employment levels allows for a more accurate estimation of indirect and induced impacts.

F. Establishment Analysis, Data Sources and Methodology

We determined the total number of Life Sciences establishments using Statistics Canada CANSIM Table 551-0005 (see A.7 below). 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 F.1: Number of Life Sciences Establishments

North American Industry Classification System (NAICS)	Establishments Total, all sizes
Agricultural Feedstock and Chemicals	
Wet corn milling [311221]	5
Oilseed processing [311224]	18
Other basic organic chemical manufacturing [325190]	53
Artificial and synthetic fibres and filaments manufacturing [325220]	12
Chemical fertilizer (except potash) manufacturing [325313]	21
Mixed fertilizer manufacturing [325314]	46
Pesticide and other agricultural chemical manufacturing [325320]	18
Seed merchant wholesalers [418320]	93
Agricultural chemical and other farm supplies merchant wholesalers [418390]	207
SUB-TOTAL	473
Drugs and Pharmaceuticals	
Pharmaceutical and medicine manufacturing [325410]	212
Pharmaceuticals and pharmacy supplies merchant wholesalers [414510]	384
SUB-TOTAL	596
Medical Devices and Equipment	
Medical equipment and supplies manufacturing [339110]	870
Professional machinery, equipment and supplies merchant wholesalers [417930]	1366
SUB-TOTAL	2236
Research, Testing, and Medical Laboratories	
Testing laboratories [541380]	710
Research and development in the physical, engineering and life sciences [541710]	250*
Medical and diagnostic laboratories [621510]	1380
SUB-TOTAL	2340
Total Life Sciences Establishments	5645

Source: Statistics Canada CANSIM Table 551-0005, December 2013.
**Adjusting using employment weighting factor.*

G. 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 CANSIM Table 281-0027. 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.

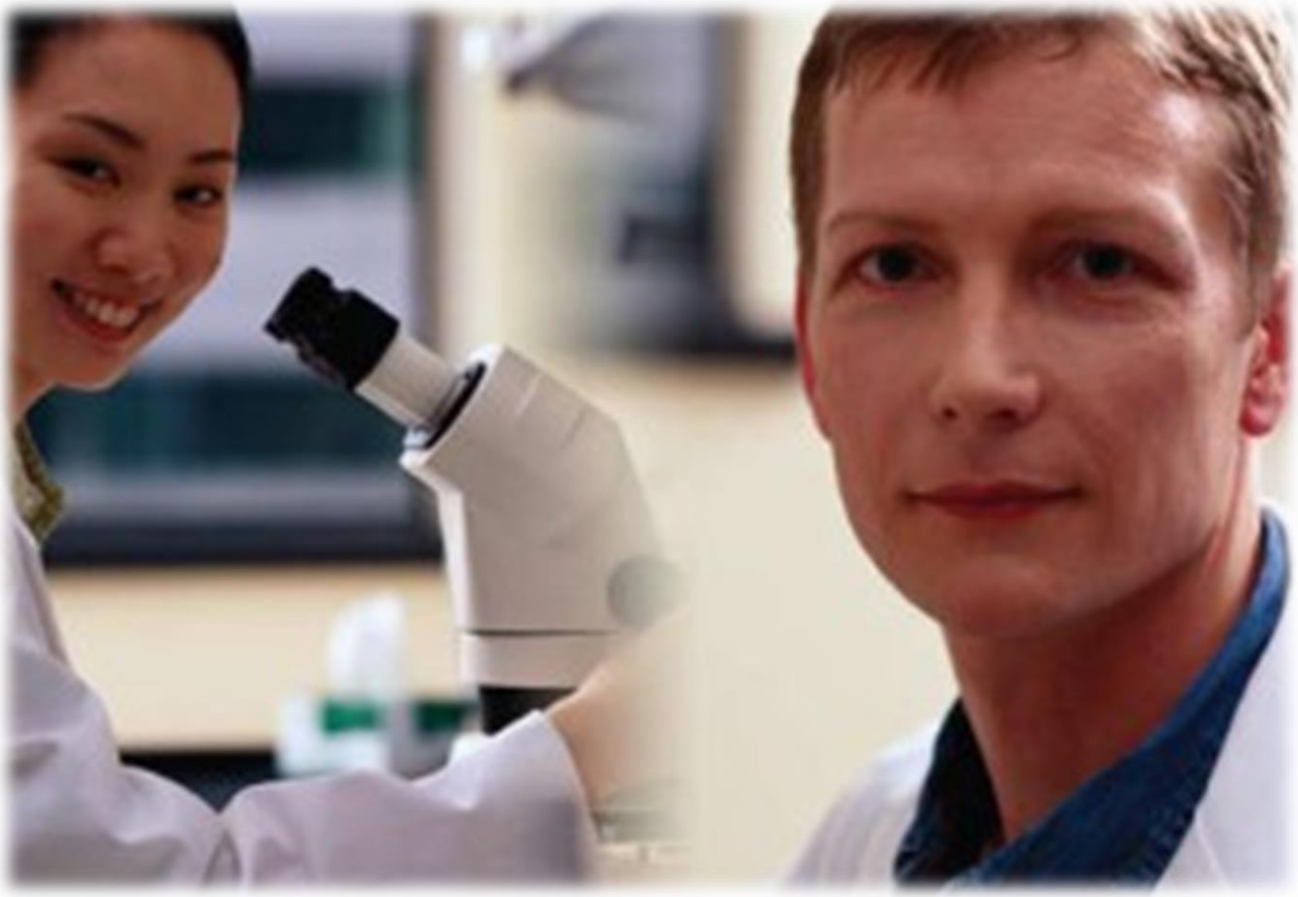
Summary of Life Sciences Employment, Payroll and Taxation (individual income tax only)

Table G.1: Summary of Life Sciences Employment, Payroll and Taxation (individual income tax only)

North American Industry Classification System (NAICS) (4)	Average Weekly Salary[1]	Average Annual Salary[4]	Adjusted Employment (2013)	Estimated Payroll	Estimated Ontario Tax[3]
Agricultural Feedstock and Chemicals					
Wet corn milling [311221]	$855.4	$42,769	678.58	$29,021,848.73	$2,655,499.16
Oilseed processing [311224]			387.76	$16,583,913.56	$1,517,428.09
Other basic organic chemical manufacturing [325190]	$1,294	$64,700	1814.92	$117,425,324.00	$10,744,417.15
Artificial and synthetic fibres and filaments manufacturing [325220]			1279.68	$82,795,296.00	$7,575,769.58
Chemical fertilizer (except potash) manufacturing [325313]			975.00	$63,082,500.00	$5,772,048.75
Mixed fertilizer manufacturing [325314]					
Pesticide and other agricultural chemical manufacturing [325320]					
Seed merchant wholesalers [418320]	$939.0	$46,948	714.45	$33,541,641.38	$3,069,060.19
Agricultural chemical and other farm supplies merchant wholesalers [418390]			2190.98	$102,861,033.55	$9,411,784.57
SUB-TOTAL			8,041	$445,311,557.22	$40,746,007.49
Drugs and Pharmaceuticals					
Pharmaceutical and medicine manufacturing [325410]	$1,294	$67,288	15690.00	$1,015,143,000.00	$92,885,584.50
Pharmaceuticals and pharmacy supplies merchant wholesalers [414510]	$1,075	$55,885	11775.40	$632,762,894.40	$57,897,804.84
SUB-TOTAL			27,465	$1,647,905,894.40	$150,783,389.34
Medical Devices and Equipment					
Medical equipment and supplies manufacturing [339110]	$910.7	$47,355	8341.00	$379,799,094.00	$34,751,617.10
Professional machinery, equipment and supplies merchant wholesalers [417930]	$1,246	$64,775	16284.81	$1,014,283,106.04	$92,806,904.20
SUB-TOTAL			24,626	$1,394,082,200.04	$127,558,521.30

Research, Testing, and Medical Laboratories					
Testing laboratories [541380]	$1,385	$72,023	7111.85	$492,513,661.93	$45,065,000.07
Research and development in the physical, engineering and Life Sciences [541710][2]	$1,583	$82,338	4645.00	$367,749,221.46	$41,040,813.11
Medical and diagnostic laboratories [621510]	$861.3	$44,788	10848.00	$467,169,120.00	$42,745,974.48
SUB-TOTAL			22,605	$1,327,432,003.39	$128,851,787.66
Ontario Life Sciences Total			82,737	$4,814,731,655.04	$447,939,705.79

[1] Source: Statistics Canada CANSIM Table 281-0027.
[2] Last available data used from 2011.
[3] The 9.15 per cent Ontario Taxation rate used, except for NAICS 541710 where 11.16 per cent applied, as per the CRA 2013 individual tax return for Ontario resident.
[4]Annual Salary calculated based on 50 working weeks.



LSO Office
109-1 Concorde Gate,
Toronto, ON
M3C 3N6
P: 416-426-7293
F: 416-426-7280
admin@lifesciencesontario.ca

@LifeSciencesON
www.lifesciencesontario.ca