



Council on
Competitiveness

Catalyzing Cross-Border Innovation:
The Mexican Life Sciences Initiative

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About the Authors

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Global Bioeconomy Consulting (GBC) is a strategy through implementation consulting firm dedicated to developing the innovative life sciences sector and related converging sectors in regions throughout the globe. GBC works directly with local stakeholders to create practical solutions to enable and accelerate competitive growth and prosperity in the region. The company's international focus and experience provides them with a deep understanding of government policy and development challenges faced by the life sciences and related industries in different countries around the world. With an overall objective to build local prosperity, GBC works alongside their clients to engage local partners, including governments, academia, industry, and not-for-profit organizations in the implementation of actionable strategies that generate sustainable growth and global competitiveness. www.bioeconomies.com



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The Purpose of this Document

Context

The Mexican Life Sciences Initiative was launched by the Council on Competitiveness in the spring of 2005 to foster the development of the life sciences sector in Mexico and facilitate partnerships between US and Mexican institutions. It was initially conceived at the US-Mexico Partnership for Prosperity meeting in Guadalajara in June 2004. A steering committee of US and Mexican leaders from academia, government, industry, and the non-profit sector has been established to guide the project. The Council has partnered with Global Bioeconomy Consulting, LLC in the development of this report.

The first phase of the initiative has focused on three areas: assessing the national environment for life sciences innovation in Mexico; analyzing the regional capacity in the life sciences sector in three regions of Mexico City, Monterrey, and Guadalajara; and providing recommendations to support the growth of the industry.



What this document is

This document provides findings from the first phase of the initiative. To complete this work, the research team reviewed available public information about the life sciences sector, received guidance from the experts on the project steering committee and conducted over seventy interviews with sector leaders in Mexico and the United States.

This document focuses on identifying the challenges that exist for developing the life sciences sector at the regional, national and international level. The report recommendations offer suggestions on how to address the challenges and to create conditions that will foster the growth of the Mexican life sciences sector.



What this document is not

This document is not a final or definitive assessment of the life sciences sector in Mexico, but rather a report on current status, existing challenges and recommendations for change. The document does not predict future trends in the global or Mexican life sciences sector; however its recommendations have been developed in the context of the present global environment for life sciences.



In conclusion

This document is intended to provide a baseline perspective to policy makers, business executives, and university leaders in Mexico and the US as they work to improve health outcomes and spur the development of a North American life sciences industry. It is intended to be a call to action to Mexican leaders to consider implementation of the recommendations, and more broadly, to encourage increased cross-border partnerships in the sector.

EXECUTIVE SUMMARY

What are the Life Sciences?

For the purposes of this initiative, life sciences have been broadly defined to include all biological technologies and applications. This includes: biotechnology, pharmaceuticals, plant and animal technologies, medical devices, healthcare (e.g. translational research, clinical trials), biological related information technology (e.g. bioinformatics, telemedicine), as well as biological-related production and manufacturing.

What is Innovation?

Innovation can be defined as the intersection of invention and insight, leading to the creation of social and economic value.¹

In the business realm, innovation is the creation and application of new ideas that translate into new processes, products or services with commercial value. Innovation is more than invention – novel ideas must be commercialized or implemented to realize their full potential. The innovation endeavor is rarely a one-man show – but rather is a social, inclusive process that incorporates the activities of many individuals, institutions, and organizations. In the knowledge economy, innovation is the key driver of increased productivity and ultimately, the job and wage growth that leads to prosperity.

Why is the Life Sciences sector important for supporting Mexican innovation?

Innovation is the most important factor in determining the success of any nation in the 21st century. It drives economic growth, creates high value jobs, improves overall quality of life, and help nations to meet social challenges such as healthcare and security. The ability to innovate is a great competitive asset and is at the heart of Mexico's transformation from a manufacturing-based economy to a knowledge economy.

The life sciences sector offers a particularly fertile ground for innovation-based growth because of its application to many different industries. With increasing costs for human health care globally, many jurisdictions such as the United States, Japan and the European Union have recognized that the life sciences sector is a key developmental priority. In order to streamline the product development process, these countries are working together to harmonize policies for patent protection, drug approval and regulatory guidelines. In addition, economic opportunities for innovative life science technologies also exist for agricultural and environmental applications. Life sciences have become a vital element in new multidisciplinary technologies like nanotechnology and bio-materials.

In Mexico, a number of global trends and local market needs have created a significant interest in supporting the life sciences. They include:

- The Mexican local demand for improved health technologies and access to health services is increasing.
- The growth of international competitors in low cost manufacturing and service provision has pushed the Mexican economy toward producing more value-added (or innovation-based) products.

- Advances in life sciences globally have opened new market opportunities and attracted new competitors (including Mexican firms).
- The nature of life science research and development has become ever more global. Successful firms and institutions, regardless of their home base, collaborate with partners throughout the world.

In summary, investment in the life sciences offers an opportunity for Mexico to directly improve the quality of life for its citizens, develop capacity in advanced sciences, and support the development of new firms and high-paying jobs.

How does a successful innovation-based economy function?

The innovation life cycle (see figure) outlines a model that continuously brings forward innovation in response to market demand.

The Innovation Life Cycle



The four inter-related stages that make up the life cycle and are defined by different levels of development and activity. They are defined as follows:

- **Knowledge Creation / Conception Stage** – Involves significant activity in idea generation, research & development, patent creation. Internal federal, “angel” and/or entrepreneurial capital crucial to advancing to next stage
- **Technology Transfer / Formation Stage** – Typified by business planning, clinical trials, regulatory filings. Stage at which a product / process proves its worth. Entrepreneurial services and support structures, investment capital, and partnering are needed to advance to the next stage
- **Commercialization / Growth Stage** – Where a product / process enters into a commercial market. Companies hire additional personnel, file for IPO and begin early stage manufacturing and production.
- **Industrialization / Maturity Stage** – Companies begin to perform in a more traditional fashion; analyzing internal business processes for improved efficiency, developing long-

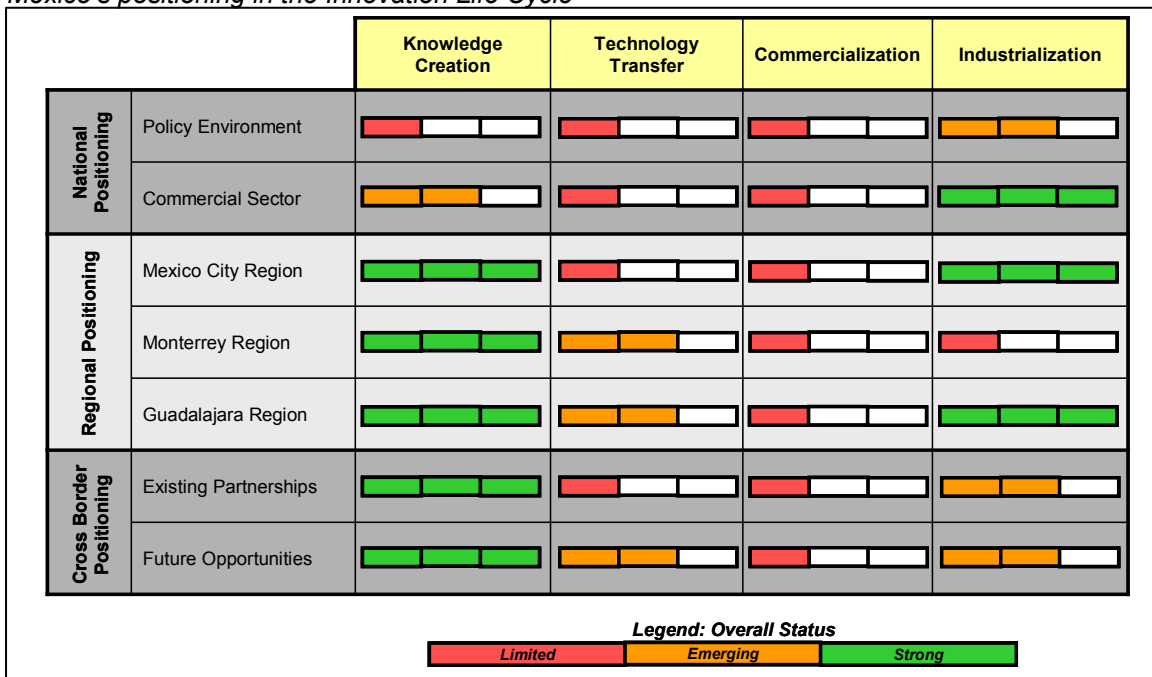
term marketing objectives, and most importantly, delivering the product or service to the public.

It is possible for a region to have strengths in some stages of the life cycle and limited assets in other stages. However, the most successful regions will develop strengths in all stages and ensure that there is a dynamic interaction between actors at all levels of the innovation system. Regions can grow by continually upgrading the knowledge and resources at each individual stage; however the full benefits of the life cycle are realized when the knowledge at one stage can be transferred to each stage. Innovation is not a linear process, but a networked one. Rapid transfers of knowledge will support the entire system.

How is Mexico progressing in the Life Sciences?

This report assesses Mexico’s strengths and weaknesses from a national, regional and cross-border perspective. The assessment is designed to indicate priority areas for action by national, regional and international actors. (See figure below)

Mexico’s positioning in the Innovation Life Cycle



Note: Status is based on a qualitative assessment of assets, resources and overall commitment that is found at each stage relative to global standards.

National Assessment

Overall the national **policy environment** in Mexico is limited in its ability to enable and promote innovation in the country. At each stage of the life cycle, there are few policies that offer significant help to facilitate the advancement of new innovations. There are some policies that address the entry of new innovative products into Mexico; however these have arisen primarily in response to foreign imports and have not been aligned with policies for Mexican companies (e.g. regulatory approval for pharmaceuticals).

The **commercial sector** in Mexico has been advancing faster than the public policy environment. For example, although there is not a national framework for industry partnerships with academic centers, the institutions have begun to develop standardized frameworks to secure and develop these partnerships. Although there are few small-to-medium sized life sciences companies, the larger pharmaceutical firms have worked together through CANIFARMA to ensure an environment that is favorable to innovative growth.

Regional Assessment

The **Mexico City Region** (including the states of Mexico and Morelos) has a strong base at both the knowledge creation and industrialization stages of the life cycle. The strength in research at the knowledge creation stage is demonstrated primarily by the disproportionately high allocation of funding, patents, and other resources to the region. The Biotechnology Institute at UNAM in the State of Morelos, for example, has made significant contributions to basic research. Mature companies in the region, both national and multinational companies, anchor a strong sales and distribution network for pharmaceutical products. However, there is limited evidence for innovation at the technology transfer and commercialization stages in the middle of the life cycle. There are only a few examples of smaller companies operating in the region. The capital and human resource talent required to support the development of companies through the technology transfer and commercialization stages of development are not readily available.

With its leading research institutions and affiliated research hospitals, the **Monterrey Region** also has strengths in research and discovery at the knowledge creation stage of the life cycle. In addition, there is evidence of innovation emerging at the technology transfer stage due to considerable recent investments in these activities by local institutions. Both public and private sector leaders have embraced the life sciences sector as a regional industry development target. The region is still challenged with limited assets at the commercialization and industrialization stages of development, as there are still very few life sciences companies based in the region.

The **Guadalajara Region** is best known for its strength at the industrialization stage of the innovation life cycle. With the manufacturing and operations of many national and multinational pharmaceutical companies, the region has well-established physical resources and human capital to support pharmaceutical production. At the commercialization stage of development however there is little evidence of new companies or products in development. But, with the emergence of the Biocluster organization, regional interest seems to be evolving towards embracing more firms at earlier stages of the life cycle. Research and discoveries are also strong at the knowledge creation stage with an excellent base of academic research centers and institutions. There is also evidence of emerging activity at the technology transfer stage of the life cycle with an increased focus on building academic and industry partnerships.

Cross-border Assessment

Collaboration among US and Mexican stakeholders is seen both at the border state level as well as the broader national level. The border states share strong similarities in the population base and health issues, often arising from common genetic traits and environmental factors. These similarities have spurred a significant number of cross-border research partnerships and public policy efforts. At a national level, priority health issues are similar for populations in both countries, establishing a rationale for collaboration.

Existing partnerships are very strong at the knowledge creation stage of the innovation life cycle due to several informal collaborative projects and student exchanges as well as formal collaboration with US academic institutions through CONACyT (the National Science and Technology Council for Mexico). At the technology transfer and commercialization stages however, there is only a limited capacity for collaboration. This is due to a limited framework, on

both the US and Mexico side of the border, for establishing partnerships and sharing intellectual property. At the industrialization stage of the life cycle, there is a policy framework for US companies working with Mexico for manufacturing; however there are still too few examples of Mexican companies sourcing innovations or market opportunities from the US.

The most immediate **future opportunities** for cross-border innovation are linked to strengthening existing partnerships focused on research. In the short to medium term, there are cross-border opportunities for joint health care delivery and training through the use of communications technology that enables both telemedicine and distance learning. In addition, there is emerging capacity at the technology transfer stage of development, with growing opportunities for clinical trials and additional health services, supported by significant interest on both sides of the border. The industrialization stage offers an emerging capacity with established companies on both sides of the border interested in research collaborations to develop and distribute new products.

Challenges for Advancing Life Sciences in Mexico

Our assessment identified a number of challenges that stakeholders in Mexico face throughout the innovation life cycle. The challenges highlighted below are further described in detail in the report.

Life Cycle	Challenges Identified
Knowledge Creation	<ul style="list-style-type: none"> ▪ Investments in research & development are too low for competitive growth ▪ Timely access to funding and required equipment is a challenge for most institutions ▪ Little alignment of the priorities and objectives of the federal and state governments
Technology Transfer	<ul style="list-style-type: none"> ▪ The research and commercial objectives of industry and academia are not well aligned ▪ Interaction among academic and industry partners is incipient in Mexico ▪ There is no standardized legal framework to facilitate interaction among research and commercial partners ▪ Risk capital for early stage ventures is not readily accessible and difficult to source
Commercialization	<ul style="list-style-type: none"> ▪ Patenting does not adequately protect companies from having others infringe on their intellectual property ▪ National pharmaceutical companies are struggling to compete with multinational companies ▪ Despite graduate level training, students are often not able to find work opportunities with industry
Industrialization	<ul style="list-style-type: none"> ▪ Regions are struggling to make linkages locally, nationally, and internationally ▪ International partners do not fully understand Mexico's role in the global life sciences marketplace ▪ Mexican companies face some external perceptions of substandard quality

Recommendations

To address the identified challenges, the report offers a series of recommendations.

Recommendations	
Regional Capacity	Each region should establish local network organizations that facilitate interactions with local stakeholders from government, academia, industry, labor and the not-for-profit sector. Regional network organizations within Mexico should interact to fully leverage national assets.
	Each region should prioritize specific life science areas of focus for their local networks of innovation.
National Policy	Align federal funding for life science research with the health challenges faced by the Mexican population. Prioritize key areas of medical need for greater research expenditure.
	Establish a policy framework and process that increases the commercialization of academic research and the transfer of technologies to the private sector.
	Establish national policies and regulations to accelerate innovation that are aligned with best-in-class international policies.
Cross-border Partnerships	Build strategic cross-border partnerships to develop and deploy products and services that improve health care outcomes.

For each recommendation, the report offers implementation tactics, time frames, and suggested leaders.

A Call to Action

The analysis undertaken through this initiative unambiguously shows that Mexico has the assets and institutions necessary to develop and implement a vibrant national life sciences sector strategy. The top level talent, research institutions, financial capital, government policy tools and private sector interest exist. The country is on the right track. However, Mexican life science assets have not been organized nor integrated in a way that optimizes the national capacity for development. For the full potential of Mexican life sciences to be realized, leaders from the academic, business, and public sectors must come together in a coordinated effort to create a system that will support innovation and commercialization.

This initiative is a call to action to those leaders.

The report lays out a roadmap of policy and process recommendations that we believe will foster a fertile environment for life sciences innovation within Mexico. It suggests that partnerships at the regional, national, and cross-border levels will be critical in improving both the health and wealth of the Mexican people. We believe that building strong ties across the US and Mexican sector will help both countries.

Implementing these recommendations and realizing the vision outlined in this report may be difficult, but with the appropriate leadership commitment and coordination, we are confident it can be accomplished.

Suggested Projects for Short-Term Implementation

To build on the momentum generated from this report, some projects that lend themselves to short-term implementation and impact have been selected from the list of recommendations. They are highlighted below.

- ***Initiate the development of a National Life Sciences Agenda:*** The federal government should guide the development of a national strategy with significant input from state governments, academic institutions and most importantly the private sector. As an initial priority study for 2006, the private sector should be consulted to gain a better understand as to why there is not greater investment and participation in research. The study should address why there is a culture of risk aversion in regards to investing in new technologies, and how this culture can be altered to encourage risk investment and entrepreneurial activity.
- ***Identify priority areas for cross-border partnership:*** In consultation with prospective partner institutions from the US and Mexico, define three priority medical areas for investment that have implications for both countries. This process should be driven by the appropriate federal government departments (or programs) from each country. Applicants (comprised of a consortium of partners from both countries) should propose specific projects in these priority areas. The proposals should outline the specific needs and research objectives, and propose a budget to finance a large-scale initiative over the course of 3-4 years. Proposals should also identify expected discoveries or innovations and how they will create commercial opportunities and societal benefits for communities on both sides of the border. This process should bring leaders from government, academia, industry and not-for-profit organizations together at an annual cross-border life science and health care summit to continually reassess priorities and to monitor the progress of funded projects.
- ***Host academic/industry forums in priority disease and technology areas:*** On important disease and technology areas, Mexico should host forums designed to bring together the academic and business leaders addressing them. These forums should focus on a specific shared priority area for Mexico and the US and they should include participation from academic and industry partners from both countries. An explicit goal of these forums should be to foster stronger relationships between business and academic participants.
- ***Revise national researcher assessment process to include innovation metrics:*** The National System of Investigators assessment process should be revised to incorporate commercial innovation in the evaluation of researchers. Researchers should be rewarded for patenting novel discoveries and developing innovative technologies with commercial applications along with their success in peer-reviewed publishing. Mexican universities and partners should inaugurate an annual awards ceremony to recognize researchers whose efforts have led to commercial applications as a way to offer additional recognition and to attract greater private sector involvement in the university-based innovation endeavor.
- ***Build an online “Community of Innovation” to track assets and resources in each region:*** An online inventory of researchers, infrastructure, projects, and new technologies should be established for each region. This database should be publicly accessible and will require ongoing monitoring and updates. This resource will require participation from federal government departments and agencies (to source up to date information on grant funding, patents, etc.) as well as the regional organizations (to provide up to date information on research projects, collaborations, and spin-off companies in the region). The database will allow local and external partners to quickly identify opportunities for collaboration with local companies and institutions.

AN INTRODUCTION TO LIFE SCIENCES INNOVATION IN MEXICO

Context for this Initiative

What are the goals for this Initiative?

The Mexican Life Sciences Initiative was established by the US Council on Competitiveness in the spring of 2005 to understand the life sciences sector in Mexico and build partnerships between US and Mexican institutions. It was initially conceived at the US-Mexico Partnership for Prosperity meeting in Guadalajara in June 2004. A steering committee of stakeholders, with US and Mexican representation from government organizations, academia, industry, and the non-profit sector, was established for this purpose.

The first phase of the initiative has focused on three areas: assessing the national environment for life sciences innovation in Mexico; analyzing the regional capacity in the life sciences sector in the regions of Mexico City (including the states of Mexico and Morelos), Monterrey, and Guadalajara; and providing recommendations to support the growth of the industry.

The near-term project goals are to:

- Foster the development of dynamic Mexican firms and institutions that become successful international competitors in the life sciences.
- Strengthen the linkages between Mexican and US life sciences institutions by launching new partnerships that improve competitiveness on both sides of the border.

The long-term project goals are to:

- Improved health outcomes for Mexican and US residents
- Institutionalize laws, policies, and practices that support innovation in the Mexican and US economies
- Create new and higher-paying knowledge sector jobs in Mexico and the US.

By better linking US and Mexican life sciences sectors, this initiative endeavors to foster partnerships that will improve hemispheric competitiveness in the face of global competition. The ultimate goal of this effort is to increase the prosperity of Mexican and US citizens.

What are the Life Sciences?

For the purposes of this initiative, life sciences have been broadly defined to include all biological technologies and applications. This includes: biotechnology, pharmaceuticals, plant and animal technologies, medical devices, healthcare (e.g. translational research, clinical trials), biological related information technology (e.g. bioinformatics, telemedicine), as well as biological-related production and manufacturing.

Building an Innovation-based Economy

Innovation Defined

Innovation can be defined as the intersection of invention and insight, leading to the creation of social and economic value.ⁱⁱ

In the business realm, innovation is the creation and application of new ideas that translates into new processes, products or services with commercial value. Innovation is more than invention – novel ideas must be commercialized or implemented to realize their full potential. The innovation endeavor is rarely a one-man show – but rather is a social, inclusive process that incorporates the activities of many individuals, institutions, and organizations. In the knowledge economy, innovation is the key driver of increased productivity and ultimately, the job and wage growth that leads to prosperity.

Why is Innovation Important?

Innovation, according to Peter Drucker, is a purposeful response to change. In a period of constant flux, science and technology require purposeful decision-making and strategies by states and regions seeking to build clusters of economic and technological growth. No longer can haphazard approaches or episodic events drive the necessary collaboration to meet the challenges of a competitive scientific and business marketplace. Development of new business models is now a critical objective of any industry, particularly in the technological arena.

Innovation and the effective management of technology have become a top priority for nations as well as companies. Over the past ten years, a new innovation system has evolved in the U.S., with support from government and industry for basic research in universities, nurtured by rapid growth in venture capital and implemented by industrial firms through strong investments in R&D, capital equipment, and information technology. This highly complex system of innovation is also based on closer collaborations and increasing alliances among industry, universities and government labs.

The innovation life cycle (see figure on next page) outlines a model that continuously brings forward innovation in response to market demand.

Figure 1: Innovation Life Cycle: Bringing Economics and Science Together



The four inter-related stages that make up the life cycle and are defined by different levels of development and activity. They are defined as follows:

- **Knowledge Creation/Conception Stage** – Involves significant activity in idea generation, research & development, patent creation. Internal federal, “angel” and/or entrepreneurial capital crucial to advancing to next stage
- **Technology Transfer/Formation Stage** – Typified by business planning, clinical trials, regulatory filings. Stage at which a product / process proves its worth. Entrepreneurial services and support structures, investment capital, and partnering are needed to advance to the next stage
- **Commercialization/Growth Stage** – Where a product / process enters into a commercial market. Companies hire additional personnel, file for IPO and begin early stage manufacturing and production.
- **Industrialization/Maturity Stage** – Companies begin to perform in a more traditional fashion; analyzing internal business processes for improved efficiency, developing long-term marketing objectives, and most importantly, delivering the product or service to the public.

It is possible for a region to have strengths in some stages of the life cycle and limited assets in other stages. However, the most successful regions will develop strengths in all stages and ensure that there is a dynamic interaction between actors at all levels of the innovation system. Regions can grow by continually upgrading the knowledge and resources at each individual stage; however the full benefits of the life cycle are realized when the knowledge at one stage can be transferred to each stage. Innovation is not a linear process, but a networked one. Rapid transfers of knowledge will support the entire system.

Defining Principles and Universal Challenges

Critical to generating the scientific, technological, entrepreneurial and economic fraternity that exists in a region permeated by innovation is the presence of certain key ingredients – intellectual capital, human capital, financial capital, social capital and proximity. By looking at key ingredients at each stage of the innovation life cycle, it becomes possible to see how a region is performing in terms of overall growth and how it is moving innovation through to the next stage of development.

Based on benchmarking of best practices in regions across the United States, there are a number of defining principles and universal challenges that various stakeholders must address if an innovative environment is to be fostered and sustained. The following table highlights some of these defining principles and universal challenges.

Table 1: Defining Principles and Common Challenges Throughout the Innovation Life Cycle

Stage of Life Cycle	Defining Principles	Common Challenges
Knowledge Creation / Conception Stage	<ul style="list-style-type: none"> ▪ Involves significant activity in idea generation, research & development, patent creation ▪ Internal federal, “angel” and/or entrepreneurial capital crucial to advancing to next stage 	<ul style="list-style-type: none"> ▪ Critical mass of research dollars, principle investigators, and facilities for basic science work ▪ Expanding pool of knowledge in basic sciences through increased attention on K - 12 learning ▪ Environments on and off campuses that encourage applied and translational science for the purpose of advancing discoveries
Technology Transfer / Formation Stage	<ul style="list-style-type: none"> ▪ Typified by business planning, clinical trials, regulatory filings ▪ Stage at which a product / process proves its worth ▪ Entrepreneurial services and support structures, investment capital, and partnering are needed to advance to the next stage 	<ul style="list-style-type: none"> ▪ Technology transfer offices and supportive university and institutional leadership with a strong inclination for mutual rewards and economic success ▪ A broader constituency of interests that is both interdisciplinary and collaborative to meet the challenge of convergent technology development ▪ Pre-seed, early stage, and proof-of-concept monies that leverage patents and licensing of institutional research with regional entrepreneurial expertise and management ▪ Available workforce to meet the requirements of formative enterprises where initial development, clinical and laboratory, regulatory and other vital skills accelerate the time to market
Commercialization / Growth Stage	<ul style="list-style-type: none"> ▪ Where a product / process enters into commercial market ▪ Companies hire additional personnel, file for IPO and begin early stage manufacturing and production 	<ul style="list-style-type: none"> ▪ Appropriate manufacturing resources – especially financial and facilities – to sustain on-going growth ▪ Experienced managers and a broader pool of skill sets ▪ Cutting edge research that adds value to initial discoveries and/or builds upon the science within existing products and services ▪ Access to global customers and relationships to attract
Industrialization / Maturity Stage	<ul style="list-style-type: none"> ▪ Companies begins to perform in a more traditional fashion: analyzing internal business processes for improved efficiency, developing long-term marketing objectives, and most important, delivering the product or process to the public 	<ul style="list-style-type: none"> ▪ New opportunities in regions for individuals to take their existing competencies and start new companies – simply an environment to foster scientific and economic churn by constantly forming new companies and products ▪ Senior level expertise in finance and operations on which to leverage growth into global competitive status ▪ A cluster of vendors-suppliers – the depth of a value chain – that builds the long-term economic proposition

Source: *New Economy Strategies, compiled by GBC, 2005*

In order for innovation-based economies to reach their full potential, each individual component of the regional innovation system requires ongoing development and the links between the institutions that operate at each stage must be strong and continually renewed.

Demand for Life Sciences Innovation in Mexico

Innovation is the most important factor in determining the success of any nation in the 21st century. It drives economic growth, creates high value jobs, improves overall quality of life, and help nations to meet social challenges such as healthcare and security. The ability to innovate is a great competitive asset and is at the heart of Mexico's transformation from a manufacturing-based economy to a knowledge economy.

The life sciences sector offers a particularly fertile ground for innovation-based growth because of its application to many different industries. With increasing costs for human health care globally, many jurisdictions such as the United States, Japan and the European Union have recognized that the life sciences sector is a key developmental priority. In order to streamline the product development process, these countries are working together to harmonize policies for patent protection, drug approval and regulatory guidelines. In addition, economic opportunities for innovative life science technologies also exist for agricultural and environmental applications. Life sciences have become a vital element in new multidisciplinary technologies like nanotechnology and bio-materials.

In Mexico, a number of global trends and local market needs have created a significant interest in supporting the life sciences. They include:

- ***The Mexican local demand for improved health technologies and access to health services is increasing.*** There are a number of health issues in Mexico that are not being sufficiently addressed including: diabetes (currently the #1 killer in Mexico), immunization and infectious disease, several types of cancer (for which some of the new therapeutics have varied efficacy due to genomic variances in the Mexican population), a shifting disease profile from infectious to chronic degenerative diseases, and environmental health hazards such as water treatment and air pollution. Stakeholders in the life sciences sector are concerned that these health issues have not been prioritized by the national research community in Mexico, and the work of the international community has not been centered specifically on the Mexican population. With a large number of rural marginalized indigenous communities, only 50% of the population (comprised of working individuals and their families) is currently covered by the Mexican national social security system. With national policies favoring the use of generic medicines, new innovative technologies have only been accessible to ~10% of the population who can afford private medical care.
- ***The growth of international competitors in low cost manufacturing and service provision has pushed the Mexican economy toward producing more value-added (or innovation-based) products.*** The Mexican economy has historically concentrated on models of industrialization focused internally to Mexico. The country built internal capacity for manufacturing and established strengths in several industries including steel, mining, oil, cars, household appliances, construction, chemicals, and food processing. With the signing of the General Agreement on Tariffs and Trade in 1986, and then the establishment of free trade agreements with North America and Europe, the focus of industries in Mexico have become increasingly more global. With the rise of other less developed regions, such as India and China, Mexico is finding it harder to compete for lower manufacturing and labor costs in the traditional industries. As a result, there is an imperative to move away from traditional industries toward the development of more innovative technologies in order to build a more globally competitive Mexican economy.

- **Advances in life sciences globally have opened new market opportunities and attracted new competitors (including Mexican firms).** The Mexican community has just begun to align its need for building an innovation-based economy with the demand for improved health technologies and access to health services. Innovation in Mexico has not been used effectively to respond to local market needs and this alignment requires strengthening to be successful. There is no national framework or “road map” to guide the research and business community to address the priorities facing the Mexican population. Although Mexico has established, and continues to develop, life sciences capacity at both the academic and industrial level, there is no framework to facilitate collaboration among stakeholders and no clear mandate to align outcomes with national health priorities. Basically, there is no national plan for the development of life sciences in Mexico. Admittedly, this could be said of other developed nations, but it serves to emphasize the value of sharing experiences for mutual benefit.
- **The nature of life science research and development has become ever more global. Successful firms and institutions, regardless of their home base, collaborate with partners throughout the world.** Competing pressures in manufacturing and the demand for better jobs and wealth creation are examples of the many competitive factors that Mexico will need to address. The development of an indigenous life sciences sector in Mexico is no longer solely dependent on the performance of national stakeholders, but also the ability to link with the international community to further drive economic development through the innovation life cycle. Increased interaction and collaboration with global players therefore will be essential to accelerating the development of the life sciences sector in Mexico.

In summary, investment in the life sciences offers an opportunity for Mexico to directly improve the quality of life for its citizens, develop capacity in advanced sciences, and support the development of new firms and high-paying jobs.

MEXICAN NATIONAL LIFE SCIENCES ENVIRONMENT

Background on Mexico's Competitiveness

The Mexican economy has achieved significant progress since the 1994 devaluation and recession, with GDP growth in 2004 at over 4%.ⁱⁱⁱ However, Mexico's ability to create dynamic, sustainable growth continues to be impeded by political and structural constraints.

With 106 million inhabitants, Mexico is now considered the world's tenth largest economy with a GDP/PPP surpassing one trillion dollars in 2004.^{iv} Since the inception of NAFTA, Mexican trade with the US and Canada has tripled and 90% of its exports are currently under free-trade agreements.^v The US alone purchases over 80% of Mexican exports.^{vi} There is a general misconception that Mexico's economy is agrarian, however, only 4% of GDP is attributed to agriculture, with manufacturing contributing less than 30%. Services make up the lion's share of the Mexican economy, contributing to over 68% of GDP.^{vii} Services include transport, trade, hotels, restaurants, banks, insurance, real estate, business services, government, health, education and other personal services.

Employment continues to be an issue in Mexico, with an estimated 25% of the population underemployed.^{viii} The services sector employs roughly 58% of the working population, while agriculture accounts for 18%.^{ix} Although unemployment has been relatively low (3.2%)^x in recent years, 2005 saw this rise to 5%, putting the government under significant pressure from labor organizations. Today, the government estimates that 40% of the Mexican population lives below the poverty line.^{xi} Mass migration of low-skilled workers to the US continues to strain border relations between the two countries.

While the Mexican economy has sustained positive growth since the 1994 devaluation, Mexico's competitiveness, in terms of its ability to innovate and create growth, continues to be challenged by several factors, including: intense international competition, limited R&D investment, the under-performing education system, access to capital, and risk-adverse cultural norms. Examples of these are outlined below:

- Mexico's race to achieve an impressive number of free trade agreements with most trading blocks in the world has attracted almost universal admiration, but within the country there has been a marked absence of government supported plans to strengthen embryonic industry. Private businesses have therefore had to channel profits into survival and upgrading, leaving the system lacking of venture capital for expansion into new high tech areas.
- Although the Fox administration has advocated increased expenditure in R&D, Mexican investment in R&D in 2002 was only 0.4% of GDP, compared to 2.7% in the US and 2.2% in the EU.^{xii} A national program was introduced in 2001 to stimulate private investment in R&D, allowing companies to receive a tax credit equal to 30% of their investment in R&D, regardless of the companies' size.^{xiii} However, despite the incentive to stimulate private R&D investment, the overall R&D investment in Mexico still remains at a level significantly lower than other OECD countries.
- Researchers are also underrepresented in the Mexican workforce compared to other OECD countries. For example, in Mexico there are approximately 259 researchers per million people compared to 4,526 and 3,487 in the US and Canada respectively.^{xiv} Because of the low funding levels, many top Mexican researchers seek job opportunities abroad, particularly at better funded institutions in the US, Canada and Europe.

- In spite of a large young population in Mexico, Mexico's spending on primary and secondary education as a percent of GDP is among the lowest in the OECD.^{xv} Like most Latin American countries, large programs were developed in the past 20-40 years to support post-graduate and university level education, sacrificing crucial spending on mass improvements in primary and secondary schools. This difficulty is compounded by the intransigency of a highly unionized teaching workforce. Poverty pressures on top of that force secondary school children to earn income and has led to an unusually high drop out rate (27.9%)^{xvi} - a level akin to that of more under-developed countries.
- Limited access to capital is a challenge for Mexican entrepreneurs and innovators. Foreign investors provide most equity investment into Mexico, although large untapped resources exist within Mexico, especially in the form of large private sector corporate groups and other institutional investors. Furthermore, a risk-adverse cultural attitude stemming from "family-based business norms" hinders the development of venture financing in Mexico.^{xvii}

Entrepreneurship, in the form of dynamic, innovative start-up companies, has not grown significantly in Mexico in part due to a mindset of driving the larger traditional industries (e.g. steel, glass, beer, ceramics, etc.). This mindset has been difficult to change in Mexico, despite growing evidence that the majority of job creation in an economy comes from SME's (small-to-medium sized enterprises). SMEs account for 66% of private sector employment in Europe and 46% in the US.^{xviii} While there are a growing number of SMEs in Mexico, these are more a consequence of creative solutions to unemployment i.e. the buying and reselling of consumer goods, than the true venture capital required to manufacture.

There are some 374,000 micro, small and medium sized companies (MIPYMES) in Mexico and the 2005 budget for supporting them was set at US\$ 121.98 million in December 2004. In January 2005 the House of Representatives voted to increase this further to US\$ 165.3 million, due to increased public pressure over unemployment (job creation). Compared with US\$ 90.34 million in 2004, this represents a massive 83% increase. A good percentage of this extra funding is being directed towards high tech sectors, including agro-biotechnology, nanotechnology, IT, medical equipment, and environmental technology. This support will reach 130,329 MIPYMES through programs such as Red Centro-Crece (regional development in Central Mexico), Marcha Hacia el Sur (regional development in South Eastern Mexico) and Compite (main competitiveness plan). Through this, the Ministry of the Economy hopes to preserve 293,707 jobs, generate 31,199 more and create around 4,000 new MIPYMES.

These programs go hand-in-hand with twin bank credit schemes. Start-up funds are granted through the National Finance System for Small and Medium Industries (SNFP), and these require no guarantee, although interest is charged at LIBOR (London Inter-Bank Offer Rate) plus 7 to 11 percent. Under this system, 15,350 credits have been granted so far in 2005. Project finance comes directly from Fondo PYME, whose budget this year is US\$ 52 million. This scheme has benefited 17,259 companies and has created 34,267 jobs.^{xix} On 30 September Lic. Sergio Alejandro Garcia de Alba Zepeda, previously the Undersecretary for Small and Medium Enterprise, assumed the role of Minister of the Economy, in order to give even more impetus to this program.

While Mexico continues to face growth constraints, a substantial framework exists within the country that can be leveraged by entrepreneurs and businessmen to foster growth opportunities. The challenge is aligning interests of investors, innovators, researchers, manufacturers and consumers within the Mexican framework.

Understanding Government – Stakeholders in Life Sciences Policy

The Mexican government is organized into several different, decentralized ministries. Numerous ministries are involved in the life sciences field and have specific programs related to the promotion of life sciences. The ministries involved in the development of life sciences include the following, along with descriptions of example programs:

- **Ministry of Agriculture, Cattle-raising, Rural Development, Fishing and Food (SAGARPA)** – SAGARPA enforces and works to establish laws and regulations that support the development of agriculture, cattle-raising, rural development, fishing and basic food supply within Mexico. SAGARPA, along with CONACyT (the National Science and Technology Council – described below), has a special program to fund research in agriculture, fishing, water culture, agro-biotechnology and phyto-genetic resources. This fund was created to support science and technology research projects that contribute to 1) knowledge creation, 2) address the problems and opportunities related to agriculture, rural development, cattle-raising, fishing and food, 3) strengthen the scientific and technological competitiveness of the firms related to these industries, 4) elevate the level of Mexican economic competition, and 5) promote the creation of new business based on the application of new knowledge and technological advances.^{xx} In 2001, the Ministry spun-off the National Institute of Forestry, Agriculture and Livestock Research (INIFAP) to become a public research center. The objective of the institute is to generate and support the transference of knowledge and technological breakthroughs as a support to sustainable development of the forestry, agricultural and livestock productive processes, without deteriorating the natural resources.
- **Ministry of the Environment and Natural Resources (SEMARNAT)** – SEMARNAT is a government agency whose main purpose is to create a State environmental protection policy reversing the tendencies of ecological deterioration and establishing the bases for sustainable development in the country.^{xxi} SEMARNAT also manages a research center, the National Institute of Ecology (INE), in conjunction with CONACyT and the Autonomous Metropolitan University (UAM).^{xxii} In 2002, the INE conducted over 202 environmental research projects and had access to a budget of over US\$ 28 million.^{xxiii}
- **Ministry of Health (SALUD)** – The Ministry of Health has overall responsibility for health in Mexico. In practice, it is the public healthcare provider for the uninsured (around 37 million people). Workers (around 47 million people) are covered for both healthcare and pension by a contributory scheme (IMSS – described below). Civil servants (around 10 million people) are also covered for both health and pension through ISSSTE (a separate social security program for state workers). There are a number of other smaller schemes. SALUD created its own healthcare insurance scheme last year called Seguro Popular (described below), through a reform to the General Health Law, modifying the financial and budgetary relationship between federal and state resources. SALUD's research activities are channeled through a huge network of National Institutes of Health (INSALUD – described below), organized by tertiary care specialty. INSALUD is at the forefront of a proposed reform to guide researchers towards industrial applications and production. SALUD has a close interface with ECONOMIA for the development of local health technology through a newly established organization, - the National Centre for Excellency in Health Technology (CENETEC).
- **Ministry of Education (SEP)** – SEP is in charge of the funding, support, curriculum and regulation of education at all levels in Mexico and holds the largest budget of the entire Cabinet. Its priority project this year has been ENCICLOMEDIA, which aims to computerize and bring up-to-date primary education, by installing interactive whiteboard facilities in 140,000 classrooms by 2006. As well as granting funding for all public universities and their programs, SEP collaborates with CONACyT to provide extra funding for postgraduate study projects. This program was created in order to promote research in the basic sciences.

Postgraduate students can apply for funding in three different categories, after which their proposals will be evaluated by committees and possibly chosen for additional funding.^{xxiv}

- **Ministry of Economy (ECONOMIA)** – ECONOMIA is responsible for all trade and investment related issues. The ministry is particularly sensitized to technology issues, since advanced technology can lead to increased high value exports as well as the substitution of foreign imports. In this role, ECONOMIA has developed several programs to enable the development of innovation-based businesses.

The **SPyME Innovation Model for Economic Growth** is an example of a leading program that works to position Mexican firms within the global market place. Its objectives are to create and strengthen the development of innovation-based firms and technologies, enhance regional and sector productivity, and to improve access to financing and markets. Thousands of Mexican companies have participated in ECONOMIA initiatives. The SPyME program actively engages in 3 strategies to foster growth of innovation:

- **Entrepreneurship & Innovation** – By facilitating the integration of best practices for innovation based approaches to business, organizational structure, market penetration, product development and processes, SME's can develop a more competitive profile transforming the low value industries into higher value business models.
- **Promotion of Collective Efficiency** – Linkages are established between institutional programs and firms in order to effectively leverage similar activities among the various parties. By promoting a culture of collaboration, the inhibitors of innovative growth (e.g. poor ability to identify changes in market, low interactive capacity, high transactional cost to obtain and apply new knowledge, etc.) are eliminated.
- **Application of a Systemic Model of Growth** – In order for states and municipalities to benefit from federal policies, they need to have regional structures that promote their areas of strength. These regional innovation systems are established based on economic sectors. Among the various economic sectors, there are models that are localized to a municipality; where as other economic sectors have models that span several states.

ECONOMIA's National Commission for Foreign Investment designs and financially supports investment clusters. ECONOMIA also supports life sciences through SISTEC (Information Systems for Technology Services). SISTEC contributes to technological awareness in start-up companies and small to medium-sized enterprises in Mexico. SISTEC provides businesspersons with information on the services provided by Applied Research and Technological Development Centers and Institutes. This fosters the creation of links between technological research and private enterprise, contributing to modernization and improved competitiveness.^{xxv}

State governments also play a significant role in the development of life sciences policy. Out of the 32 States in Mexico, 23 have a State Council on Science and Technology. The state councils are a permanent forum to discuss and propose programs and actions furthering local scientific and technological development. They also exchange information about the science and technology systems of the various States, and aim to further cooperation between institutions and researchers in different geographical areas on subjects of common interest.^{xxvi}

Policies & Programs – Current Landscape

Overall there are very few laws in Mexico concerning the development of life sciences. Regulations for the control of biological products for example, have in some cases compliance certified with the Mexican Official Standards (NOMs), while in other cases they have compliance certified through foreign authorities (e.g. US Food & Drug Administration) with the applicable regulations of the country of origin.^{xxvii} The government has however created the Inter-Ministerial Commission for Bio-safety and Genetically Modified Organisms (CIBIOGEM). This organization is charged with the implementation of bio-safety laws, is the officially recognized body for input on bio-regulation and gives training specific to this sector.

Most laws in Mexico relating to life sciences deal primarily with bio-safety and genetically modified organisms. Mexico is a signatory to the Cartagena Protocol^{xxviii} on Bio-safety and has been compliant since September 2003. Additionally, a law on bio-safety and transgenics was recently approved by the Senate.^{xxix}

Intellectual Property in Mexico

The ***Mexican Institute for Industrial Property (IMPI)*** was created in 1993 as a decentralized agency of the federal government. Statistics as of 2003, after 10 years in operation, show that IMPI issued 51,953 patents (with 20 years protection).^{xxx} However, less than 10% of these patents are filed within the country, indicating that most development is imported to Mexico. In terms of biotechnology related patents, only 37 were based in Mexico in the year 2000 (see table on next page).

Table 2: Biotechnology Related Patents Granted by IMPI as of 2000 by Country of Origin.

Country	Number of Patents	% Share
United States	388	50
Japan	86	11
Germany	66	9
Switzerland	55	7
Mexico	37	5
Netherlands	23	3
France	22	3
Others	99	13
Total	776	100

Source: *Industry Canada, 2003*

IMPI has been successful with registering patents, however many researchers and companies are dissatisfied with the fact that the patent laws are not adequately enforced. The course of action required in order to challenge a patent infringement is time consuming, onerous and often expensive. By the time a ruling comes through in favor of the owner, the benefit gained from patenting may be lost and there are limited recourses that can be taken. Overall, despite the existence of well-drafted patent laws, there are insufficient deterrents to prevent infringement.

Innovation-based Policies and Programs

The ***National Council of Science and Technology (CONACyT)*** was created by the Mexican government in order to coordinate funding and programs that support research and development of technology in Mexico. Through its many national and international partnerships, CONACyT

supports a broad range of science and technology advancements. CONACyT also works together with individual state and local governments to foster regional science and technology development.

Descriptions of a few of the major initiatives undertaken by CONACyT are included below:^{xxxi}

- **CONACyT Grant Funding Programs** – Researchers, academics, technologists, entrepreneurs, universities and research centers can request finance from different funds available at CONACyT by presenting proposals that contribute to the resolution of state and local problems, expand knowledge in pertinent fields of study or create new businesses that use scientific and technological knowledge. CONACyT supports, fosters and promotes both basic and applied science.

The funds available through CONACyT include: **Mixed Funds** which are made available through a partnership with CONACyT and either the state or municipal governments; **Sector Funds** which are made available through a partnership with CONACyT and the federal Government Ministries (e.g. Health, Agriculture, Education, etc.); and **Institutional Funds** which are directed toward scientific/technological research and development, especially in public universities and institutions, as well as businesses, and private institutes that are a part of RENIECyT (described below).

In the period of 2001-2004 approximately US\$ 216 million were given to basic science. CONACyT also supported 4,588 applied science projects from 2002-2004 with an average yearly expenditure of approximately US\$ 148 million.

- **The AVANCE Program** – This program was created to drive the development and growth of businesses based on the exploitation of scientific and technological developments. Its activities commenced in 2003, and by September 2005 it had distributed approximately \$19 million to 86 different projects.

AVANCE incorporates four support programs: **The Guarantee Fund for Technological Promotion CONACyT - NAFIN** which gives guarantees and preferential financing terms to companies that develop new business lines based on science and technology; **Program for Entrepreneurs CONACyT - NAFIN** which contributes capital to companies that develop high value-added businesses that leverage scientific or technological discoveries; the **Business Schools Program** which fosters the incorporation of innovation administration and technology management into the curriculum of the nation's most prestigious business schools; and the **"Last Mile" Program**, designed to finance the last stages in converting mature scientific and technological projects into investment opportunities that will create new businesses or lines of business.

- **Public Centers for Research** – CONACyT has 27 research centers and its units/host centers exist in 24 states and 42 cities in the country. They represent a fundamental part of the research and development capability in Mexico, and cover a broad range of knowledge disciplines. Seventy percent of the centers' human and physical infrastructure is located in the provinces, and approximately 75% of research activities take place outside Mexico City. Approximately 70% of the researchers at the centers are qualified through the National System for Researchers (described below). The cumulative budget of the centers in the period 2001 – 2004 was approximately \$US 1.4 billion.
- **Development Program for Scientists and Technology Specialists** – This program is responsible for scholarships (national and international), recognition of qualified national postgraduate programs, maintenance of information related to former scholarship winners, and recruitment / job search services in the science and technology sector. In 2004, 8,758 scholarships were granted and the list of qualified postgraduate programs increased by 80%.

- **The National System of Scientific and Technological Evaluation (SINECyT)** – This program of CONACyT has a fundamental purpose to guarantee that the proposals presented for CONACyT funding are assessed in a transparent and objective manner.

In addition to the core programs at CONACyT, the organization is also involved in the development and promotion of additional programs that contribute to strengthening the life sciences sector in Mexico. These programs include:

- **National System of Researchers (SNI)** – The National System of Researchers was created by Presidential decree and recognizes the work of investigators dedicated to the generation of scientific and technological knowledge. Recognition is offered after an evaluation, primarily based on the researcher's publications record, and includes the bestowal of the title of "national researcher". This distinction recognizes the quality and prestige of the individual's scientific contribution. As well as the designation of "national researcher", economic incentives are granted to the recipient through scholarships. The level assigned to the researcher determines the amount of the scholarship.

According to the National System of Information on Science and Technology, there are 239 research institutes in Mexico; 85 of which have SNI researchers involved in life sciences. There are a total of 1,364 life science researchers in Mexico.

- **Industry Specialists Placement Program** – This program, recently introduced in 2005, will place highly talented scientific and technological academics in key companies. The internships should both help companies to make their productive processes more efficient, and foster the incorporation of new scientific and technological discoveries into their operations. The first year of the project will provide support for the placement of approximately 200 postgraduate professionals.
- **The National System of Networks and Research Centers** – This program supports the formation of consortiums and/or scientific and technological research networks that incorporate links between sectors and regions. To date, two consortiums have been formed under the pilot scheme, which are operating satisfactorily and are developing nearly twenty projects. Nine more collaborative initiatives are in the pipeline.
- **RENIECyT** – RENIECyT is a registry of institutions, centers, organisms, businesses or individuals from the public, social and private sectors, who carry out scientific and technological activities, as part of the Integrated System of Information about Scientific and Technology Research (SIICyT). This program is a prerequisite for individuals or groups that wish to receive benefits or federal fiscal support for activities related to science and technology.
- **Fiscal Incentives for Research and Development** – Financed through the Federal Government, the program provides incentives to corporate taxpayers who have invested in research and technological development projects that create new products, materials or processes. This program promotes new science and technology businesses by allowing investors to recuperate 30% of expenses and investments made in approved projects. Credits can be applied to income tax (ISR) and/or asset tax (IMPAC), only in the tax year that the investment/costs took place. There has been a dramatic increase in the budget destined to this program; from US\$50 million in 2001 to \$300 million in 2005. In 2006, and the approved program budget is will be \$400 million.

On 7 September 2005, Dr. Gustavo Chapela Castañares, a former CONACyT scholarship recipient, assumed the directorship of the organization. Education Minister Reyes Tamez Guerra urged Dr. Chapela to develop further Mexico's higher education institutes and, in particular, to support young researchers.^{xxxii}

The national CONACyT works closely with allied **State Councils for Science and Technology (COECyT)**. These state public-sector organizations were legally created to act as an advisory body to state authorities for the planning, budgeting, coordination, guidance, organization, promotion and the channeling of activities related to science and technology, in the context of state and national development. Since February 1983, when the first State Council for Science and Technology created in Puebla State, 25 other states have launched these councils.

The **Mexican Health Foundation (FUNSALUD)** is a private not-for-profit institution whose mission is to contribute to the improvement of health in Mexico. It aims to mobilize resources from national and international donors and sponsors in order to independently generate information, data, and analysis and to provide an objective assessment on health problems in Mexico. FUNSALUD is recognized as a leading institution among civil society organizations devoted to health issues. The institutional activities include:^{xxxiii}

- **Support for Research** – FUNSALUD has carried out fourteen state of the art studies, which identified several opportunities along with the associated technical, economic, social and political feasibility. The studies include the consolidation of research infrastructure in Mexico and research topics affecting high-risk groups or those that cause a significant health burden for the Mexican population. In alliance with business firms and health institutions, FUNSALUD currently participates in the fields of human nutrition, health education, health technology and competitiveness & health.
- **Development of Genomic Medicine** – In 1999, FUNSALUD promoted a feasibility study in order to develop genomics medicine in Mexico. A five-year strategic planning process was carried out in alliance with the Ministry of Health (SALUD), the National Autonomous University of Mexico (UNAM), the National Science and Technology Council (CONACyT) and FUNSALUD to establish a temporary Promoting Consortium, devoted to create the National Institute of Genomic Medicine (INMEGEN) in 2004.
- **Health Education** – FUNSALUD supports several distinct efforts regarding health education and promotion. Working with corporate sponsors, the foundation has supported communications through campaigns, internet, radio, and television spots, as well as printed material including manuals, posters, brochures, and magazines.
- **Human Resources Development** – FUNSALUD supports the Incubation of Talents Program in collaboration with the National Institutes of Health (INSALUD). The purpose of the program is to select postgraduate students, residents, doctors or researchers who can successfully partake in specialized courses or spend a short time studying abroad, so that they can return to Mexico to implement new services in their institution.
- **FUNSALUD Awards and Conferences** – Since 1992, FUNSALUD has awarded Biennial Prizes to Mexican scientists in recognition of the quality of their research work in specific fields. Since 1988, the Manuel Martinez Conference addresses specific health problems in Mexico.

The Ministry of Health has established the **National Institutes of Health (INSALUD)** to focus on research and training in areas of tertiary care specialty. INSALUD consists of a network of twelve separate institutes in areas such as cardiology, cancer, neurology, nutrition, and rehabilitation among others. An overall framework is in development to facilitate the transfer of research from the institutions to industrial applications.

Two of the institutes are profiled below:

- The **Mexican National Institute of Public Health (INSP)** is a leading organization contributing to the advancement of life sciences research and development. Established by the Ministry of Health, the INSP was created as an independent academic institution for the

purpose of researching priority issues in public health prevention and control, and also to train health professionals to promote health in the population. Their mission is to promote total population health by means of knowledge generation, creating innovation within the health system, and training human resources for public health. Priority areas of research include: cervical, uterine, and breast cancer; undernourishment / obesity; diabetes mellitus and hypertension; cardiovascular risk; and the appropriate use of medication and vaccines; as well as other priority areas.

- The **National Institute of Genomic Medicine (INMEGEN)** was created in 2004 with a mission “to contribute towards improving healthcare for the Mexican population by developing scientific research and training human resources in genomic medicine, leading to medical applications based on innovation, world-class technology and strategic alliances, with strong ethical principles”. The institute was established to focus on national health problems, and also to play a role in the development of public health policies in genomic medicine. Its initial research plan is based on six areas: genomic structure of the Mexican population; diabetes mellitus, hypertension and obesity; cancer; infectious diseases; cardiovascular diseases; and pharmacogenomics. Within these areas of research INMEGEN is conducting large scale population genomics studies, developing large scale analytical and diagnostic technologies, developing clinical protocols for prevention, diagnosis, and treatment, identifying molecular mechanisms of disease, and developing new diagnostics and therapeutics. Combined, all these efforts are aimed at diminishing the cost of public health through prevention, early diagnosis and new cost-effective interventions and treatment.^{xxxiv} In 2005, INMEGEN launched the largest genotyping study ever in Latin America.^{xxxv} The race-based genome project will provide new insights into the genetic make-up of the Mexican population. The unique formula of the Mexican genome is believed to play a key role in treating chronic diseases such as asthma, diabetes, hypertension, and other priority health issues in Mexico. By understanding the genetic composition of the Mexican population, Mexico will be better equipped to develop or even adapt diagnostic and therapeutic technologies to respond to the unique needs of the population.

As INMEGEN is Mexico’s newest and most advanced National Institute, there are signs that it will be used as a testing ground for new systems models. For example, it will be the first National Institute to have an internal intellectual property office, almost from its inception.

Health Policies and Programs

Mexican Institute of Social Security (IMSS) – IMSS operates the health and pension rights of some 47 million workers through a contributory scheme. IMSS hospitals account for 37% of hospitals in the country and provide over 400,000 medical consultations each day. IMSS is also involved in research specifically to address the most salient health needs in Mexico. Through the **IMSS Foundation**, an independent not-for-profit organization, funds are provided to research priority health issues. The foundation proactively seeks collaboration with other organizations in Mexico and abroad to develop funding schemes that will support scientific research. The IMSS Foundation is interested in linking corporations with other sectors of the community and with foreign organizations and foundations interested in the development and strengthening of social security in Mexico. Currently, there are over 3,000 ongoing research projects that deal with the main health problems of the insured population.^{xxxvi}

The current Fox administration has made universal healthcare and financial protection a major priority for Mexico and established the **National Program for Health 2001-06 (NPH)** to achieve that objective. The principle goal is to bring financial protection to the Mexican population that is currently without social insurance through an adjusted scheme whose purpose is to reduce out-of-pocket payments and foster universal health coverage.

Seguro Popular, a social program currently being implemented, will help implement the objectives of the NPH by offering public health insurance to families and citizens who, due to their work conditions or socioeconomic status, are not covered by other social insurance institutions. The objective of the program is to reduce the impoverishment arising from families who cannot afford the massive private payments for healthcare, thereby overcoming inequalities and achieving universal coverage. The financial objectives are to re-engineer the budget distribution between the federal authorities and each individual State.^{xxxvii} From 1 January 2006, Seguro Popular will become enshrined in the public health structure as the Institute of Social Protection (IPS), and it will acquire the right to also operate a pension scheme.

Commercial Perspective on National Policies & Programs

Mexico currently occupies 9th place in the world for pharmaceutical sales, with annual sales in excess of US\$ 9,600 million. Three quarters of sales within Mexico are related to patented medicines, representing 42% of the total volume. With 35 large trans-national manufacturing facilities, Mexico is the largest pharmaceutical market in Latin America and in a privileged position geographically. Mexico itself represents a market of 106 million people and the elderly population (which accounts for a third of all pharmaceuticals sold in the US and Canada) continues to grow in size. In addition, Latin America represents a market of over 500 million people, who have mostly lacked adequate medical care all their lives.^{xxxviii}

The Mexican pharmaceutical industry contributes a little over 1% to GDP and generates 45,000 jobs. For this reason, the pharmaceutical industry is one of five that have been singled out for additional support by the Mexican Foreign Trade Bank (BANCOMEXT). There are 69 companies in Coahuila, Jalisco, Nuevo Leon and Tamaulipas states, as well as Mexico City, that have qualified for this support aimed at increasing exports to Asia (China, Korea and Hong Kong), North America (Los Angeles, Miami and Vancouver), Latin America (Argentina, Brazil, Colombia and Costa Rica) and Europe (Germany, Spain, Holland, Italy and the UK). BANCOMEXT aims to generate US\$ 29.9 million in export earnings through the program. Key segments of the pharmaceutical industry chosen for this assistance are anti-bacterial medicines (monthly sales US\$ 69 million), dermatological applications (US\$ 235 million), and anti-parasite treatments (US\$ 7.6 million). At the same time, some large trans-nationals have announced an expansion in their investments in Mexico, such as Astra Zeneca, Bristol Myers Squibb, Solvay Pharmaceuticals, Debiopharm, Biotech Holdings, Perrigo and AlphaRx.^{xxxix}

At the 2005 National Conference for Pharmaceutical Training, Antonio Pascual Feria, President of the National Pharmacy Association, said that the final implementation of Seguro Popular in Mexico City would boost pharmaceutical sales by 10 – 15%. Of 20,000 pharmacies operating in Mexico, 6,900 are located in the capital. The increased income would allow for better training of the 100,000 employees in the sector. At present only 0.5% of dispensing chemists are fully trained.^{xi}

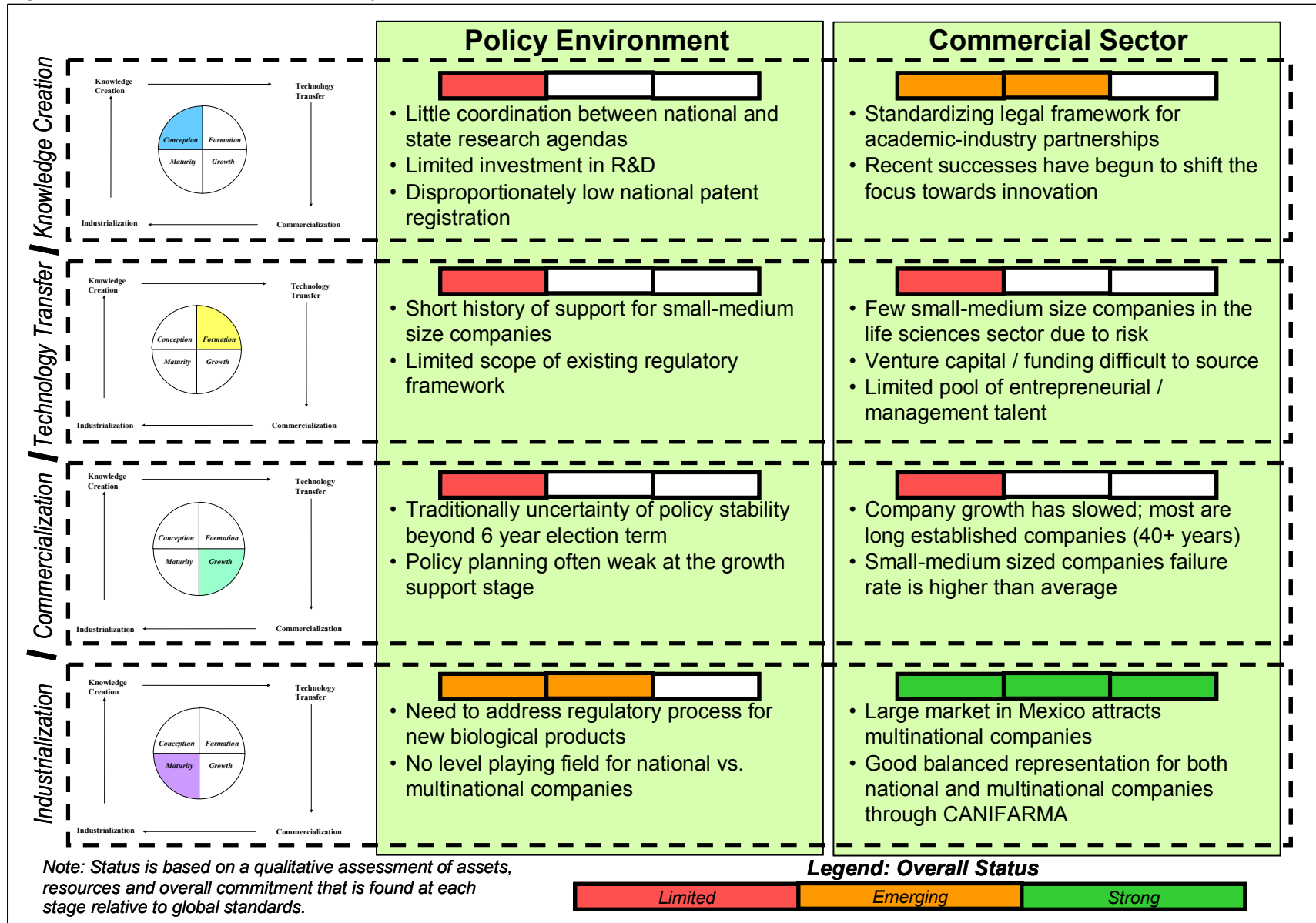
National Assessment Summary

Overall the national ***policy environment*** in Mexico is limited in its ability to enable and support innovation in the country. At each stage of the life cycle there is little evidence of policies that help to facilitate the advancement of new innovations. There are some policies that address the entry of new innovative products into Mexico; however these have arisen primarily in response to foreign imports and have not been aligned with policies for Mexican companies (e.g. regulatory approval for pharmaceuticals).

The ***commercial sector*** in Mexico has been advancing faster than the public policy environment. For example, although there is no national framework for industry partnerships with academic centers, the institutions have begun to develop standardized frameworks to secure and develop these partnerships. Although there are few small-to-medium sized life sciences companies, the larger pharmaceutical firms have worked together through CANIFARMA to ensure an environment that is favorable to innovative growth.

See the national assessment in Figure 2.

Figure 2: National Assessment Summary



REGIONAL CAPACITY OF LIFE SCIENCES INNOVATION

Overview of Regional Capacity in Mexico

Three regions in Mexico were selected to assess the regional capacity for life sciences innovation-based on a preliminary review of the top states in terms of funding, research institutions, and patent activity. The three regions that were selected were the Mexico City region (which for the purposes of this initiative is defined as the Federal District as well as the states of Mexico and Morelos), the Monterrey region, and the Guadalajara region. Although this assessment focuses on the three regions defined above, additional regional capacity exists in other areas throughout Mexico.

The following figures highlight that the majority of life sciences activity that supports innovation capacity in Mexico is located in the Mexico City region. At the same time, complementary and equally relevant strengths in life sciences innovation are also seen in the Monterrey region (located in the state of Nuevo Leon) and the Guadalajara region (located in the state of Jalisco).

Science & Technology Investment

The Mexico City Region, including the Federal District and the States of Mexico and Morelos, is by far the largest recipient of federal funding for health research. With an investment of 78.5% of the total investment for the country this region is significantly higher than in other regions. By comparison, both Jalisco and Nuevo Leon are among the top 5 regions in Mexico, but only receive approximately 3% of the total budget.

Figure 3: Top 5 Regions in Mexico for Health Sciences Funding from CONACyT (2000 – 2004)

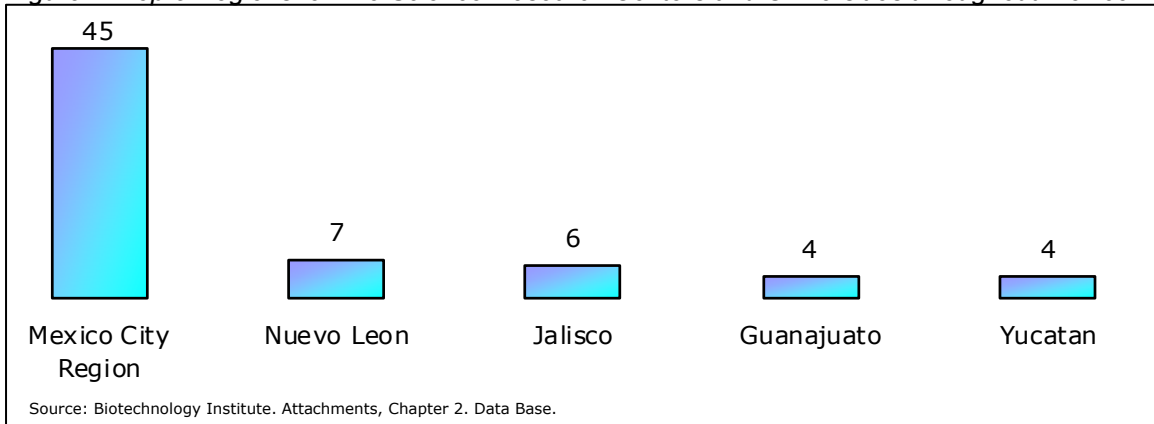
Region (State)	Number of Projects	Approximate Funding (USD)	Percentage of Total Funding
Mexico City Region	345	\$35,829,000	78.5%
Queretaro	12	\$1,790,000	3.9%
San Luis Potosi	13	\$1,714,000	3.8%
Jalisco	16	\$1,429,000	3.1%
Nuevo Leon	9	\$1,210,000	2.7%
Total Funding All Regions	455	\$45,563,000	100%

Source: CONACYT: Science and Technology National Council
*Amount converted to US dollars

Life Sciences Research Institutions

Echoing the centralization of most commerce and government offices, the life sciences sector is highly concentrated in and around the Federal District. Of a total 99 life sciences designated institutions in the country, the Mexico City region has by far the largest number with almost 50%. As Figure 4 shows, this region has more than four times the number of institutes than any state in Mexico. Jalisco and Nuevo Leon are also significant players in the national life sciences sector with the next greatest proportion of life sciences research institutions in the country.

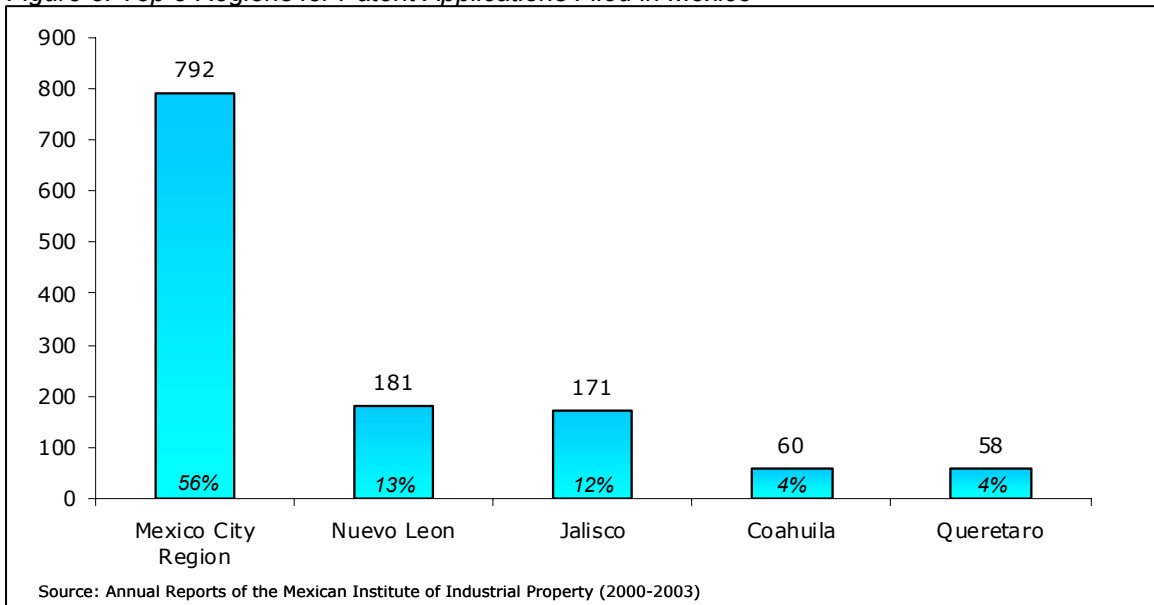
Figure 4: Top 5 Regions for Life Science Research Centers and Universities throughout Mexico



Patent Applications

Correspondingly, the Mexico City region has the highest patent activity in the country. Of a total 1423 patent applications filed between 2000 – 2003, the region has filled almost 56%. Nuevo Leon and Jalisco are both leading regions for patent activity in Mexico, well ahead of other states (excluding those in the Mexico City region). In terms of life sciences and health, the Mexico City region also has the highest patent activity in the country. All other regions in Mexico are at an embryonic stage of development in the life sciences and health.

Figure 5: Top 5 Regions for Patent Applications Filed in Mexico



The Mexico City region represents the vast majority of research activity in Mexico. This capacity includes a large number of federal research institutions and centralized research programs. In addition, the high population base (about a quarter of the national population lives in the capital) also contributes to the high proportion of activity in the Mexico City region. The Monterrey region and Guadalajara regions (represented by the states of Nuevo Leon and Jalisco respectively) have significantly lower capacity for research innovation than the Mexico City region, however in comparison to other regions in the country; these two regions are comparatively higher in their level of innovation capacity, albeit at an early stage of development.

The Mexico City Region

Mexico City is thought to be one of the largest cities in the world with a sprawling metropolis of over 25 million people, just less than one quarter of the country's population base. As the nation's capital, Mexico City is home to the federal government and all affiliated departments. Mexico City has many industries including commerce, textiles, metal products, food production, and chemicals with significant manufacturing capacity in the surrounding regions, such as Naucalpan and Tlalneantla.

For the purposes of examining the life sciences sector in Mexico City, the Mexico City region has been defined as the Federal District and the states of Mexico and Morelos. The region's strengths in the life sciences are primarily found in both basic research and medium to large enterprises. A challenge (and opportunity) remains in bridging the gap between academia and the private sector.

Local Infrastructure

Infrastructure in the region is consistent with that required to support a core national strength in basic life sciences research. There are many university facilities and research institutions with growing programs in life sciences research; however there do not seem to be any immediate plans to expand the existing infrastructure base through large-scale development projects.

Mexico City is home to the majority of federal research institutions and funding bodies.

The vast majority of federal funding agencies, government departments, and other non-governmental organizations are all located in the Mexico City region. Although there are efforts underway to decentralize some of these resources, Mexico City has benefited from the ability to secure a significantly higher proportion of resources than other regions in the country. For example, the National Institutes of Health, focused on improving healthcare through research, training, and public education, are concentrated in the Mexico City region. As a result, the region attracts significant federal funding for health research. Another example is CINVESTAV, which is based at the National Polytechnic Institute (IPN), an independent academic research and post-graduate training institute. CINVESTAV is headquartered in Mexico City with two of its research centers. Although it continues to expand throughout the country, it still attracts significant federal funding to the Mexico City region.

Strong research universities are located in the Mexico City region. There are five major universities in the Mexico City region, three of which have strong research programs in the life sciences. In addition to the IPN mentioned above, there is also the Metropolitan Autonomous University (UAM), and the National Autonomous University of Mexico (UNAM). Of these three, UNAM represents the largest proportion of research activity in the life sciences. The following table helps to demonstrate how UNAM accounts for more than 5 times the amount of life sciences activity than the two other institutes combined.^{xli}

Table 3: Researchers and Investment (in million pesos) for Biotechnology and Genomics projects at Major Universities in the Mexico City region

University	1999		2000		2001		2002	
	Researchers	Investment	Researchers	Investment	Researchers	Investment	Researchers	Investment
National Polytechnic Institute	43	3.2	64	4.8	66	5.9	63	6
Metropolitan Autonomous University	31	2.2	38	2.9	42	3.6	43	4.1
National Autonomous University of Mexico	407	35	407	37.4	425	45.5	405	47.6

Source: SIICYT, 2005

UNAM has two major institutes for life sciences research. The first is the Biotechnology Institute located in Cuernavaca, in the State of Morelos (about 30 miles from Mexico City). The Biotechnology Institute performs research in cellular engineering, biological development, biological structure, physiology, microbiology and molecular medicine. The second is the Biomedical Research Institute located at the UNAM campus in Mexico City. This facility houses research in cellular biology & physiology, molecular biology & biotechnology, immunology, genomic medicine and environmental toxicology.

Education and Training Base

Training programs and enrollment in the life sciences has been growing in recent years. Academic institutions continue to turnout highly skilled researchers in many areas of the basic life sciences.

The UNAM is by far the largest academic institution for life sciences training in Mexico. With an enrollment of over 260,000 students, the university focuses on three areas of scientific research: chemical, biological and health sciences; physics and mathematical sciences; and land and engineering sciences. All scientific research and development is coordinated through a central office. As previously described, UNAM has two major research institutes in life sciences. The Biotechnology Institute in Morelos is the largest life sciences research institute in the country and houses over 700 researchers.

The UAM hosts a broad spectrum of life sciences training programs. The university has an enrollment of 44,000 students with four campuses in the Mexico City region. A variety of programs in life sciences are offered to students at two of the four campuses. The programs include health sciences, engineering, agricultural sciences, and environmental sciences, all of which focus on biotechnology applications. Although the health sciences are among the main programs at the school, UAM has a distinct strength in the areas of environmental sciences and engineering that is not as predominant at other schools.

Case Study: UAM hosts Mexico's first program in biomedical engineering.

Created in 1974, the biomedical engineering program has graduated ~700 students, well above other schools in Mexico that have graduated ~200 students.

The IPN is a polytechnic institute with smaller bioscience and bioengineering programs. It has an enrollment of 27,000 students with three campuses in Mexico City. The majority of life sciences research and training is done in partnership with CINVESTAV, whose main office is located on the main IPN campus in Mexico City. CINVESTAV graduates ~125 PhD's and Masters students each year in the life sciences in the areas of medical science, bioengineering, agriculture and environmental science.

Exchange programs are common and provide students with additional training. Each of the universities researchers has informal relationships with researchers at international academic institutes, primarily in the North America and in Europe. Graduate students are almost always trained in an international laboratory setting for a term using this informal exchange program. This provides the students an opportunity to work with other researchers in their field of study.

Commercial / Industry Base

There is a growing pharmaceutical industry base in Mexico City, which is comprised primarily of sales and distribution capacity with some commercial development in niche areas.

Interactions between the commercial and public sector have been limited in the past, but are slowly increasing due to an evolution in the traditionally academic focused mindset.

Academic institutions have a long tradition of scientific discovery, which increases our understanding of the world around us. The application of this knowledge for commercial gain however has not always been accepted as a role for the academic community. The prevailing mindset at academic and research institutions in the Mexico City region has been resistant to accepting private company finance to transform research outcomes into commercial applications. Indeed, at times it appears that most researchers consider it in some way “unethical” to do this. There is however a growing number of entrepreneurial scientists at the universities that are rejecting the traditional mindset and beginning to engage in research activities that lead to commercial technologies and applications. Their view appears to be that this is perfectly acceptable, provided that an adequate legal framework is in place that protects the Mexican talent behind the discovery. From the private sector perspective, this is a welcomed evolution, as many of the companies do not have the capacity for research in house. Increasingly, there are examples of Mexican based companies that work with public institutions to fund their research.

Case Study: Improved health through academic and commercial collaboration.

Laboratorios Silanes and the Biotechnology Institute at UNAM have created a successful partnership to develop anti-venoms against poisonous animals. Dr. Possani and other researchers at UNAM have used recombinant DNA technology to create anti-venoms for scorpions and other toxic animals. Laboratorios Silanes and their subsidiary Instituto Bioclon produces and manufactures anti-venoms with three products already on the market designated as Orphan Drugs by the FDA. The introduction of these technologies in the national health system in 1994 has contributed significantly to a decrease in the mortality rate from scorpion stings.

There is a growing life sciences industry base in Mexico City. In the pharmaceutical sector, Mexican companies make up approximately 10% of the total national sales, where they have established strengths in some niche areas. These companies typically have been in operation in Mexico for several years, and are well established in the local market. Examples of leading Mexican based pharmaceutical companies in the region include: Laboratorios Columbia which develops a variety of products including over-the-counter medication, prescription drugs, and food supplements; Laboratorios Silanes which has a niche strength in anti-venoms in addition to other pharmaceutical and diagnostic products; and Probiomed which is a spin-off from an established pharmaceutical company Proquifin and specializes in the development of bio-generics.

The large multinational pharmaceutical companies make up the remaining 90% of the sales market. The multinationals primarily have sales and distribution capabilities in the Mexico City region, however many companies are building on their internal R&D capabilities including Pfizer, Merck Sharpe & Dohme, Shering Plough, Eli Lilly, GSK, Aventis, and Novartis. Wholesale distributors and bioprocessing companies are also growing in Mexico City. Start-up companies from academic institutions however are very rare. One of these successes is Innovamedica, started in 2000, which researches and designs medical devices in collaboration with UAM.

Science and Innovation Focus

A broad spectrum of R&D activities in life sciences demonstrates considerable strength in the Mexico City region for basic research. Commercial development of this research, however, is limited by funding and access to industry partners.

The region is internationally recognized for genetics research in both medical and plant sciences. Medical research strengths include traditional areas such as cardiac, neurology, diabetes and cancer as well as the development of pharmacogenomic applications. Plant transgenic research is a strength, particularly in maize (through the International Maize and Wheat Improvement Center better known as CIMMyT), but there is significant resistance to GMOs in Mexico, so that each new development has tended to provoke a new law regulating it.

The region has several additional basic research strengths in health sciences sector. Researchers are developing expertise in niche markets for vaccines and diagnostic kit development. Examples include the development of anti-venoms from research at UNAM and developed by Silanes (previously described), and IVAX Research conducting clinical trials and pre-clinical studies in vaccines and other therapeutic areas.

Bioprocessing research is also an emerging strength with the example of Probiomed, a bio-generics company improving efficiency in developing pharmaceutical compounds by using recombinant proteins. An additional strength in the health sciences sector has been the applications of imaging technology within the field of biomedical engineering. Scientific investigators in this area are focusing on research and development for signal processing and imaging software.

Biotechnology applications are also being explored to address environmental issues. Water treatment and conservation is a primary focus for research at several institutions in Mexico City. Other research areas include soil contamination, air quality, forests and desert conservation.

Regional Organizations and Local Government Support

There is little evidence of a formal stakeholder network in the Mexico City region. Although the research community is collaborative, there is no recognized mechanism for researchers to network. More specifically, there is no mechanism for interaction and exchange between industry stakeholders and academia.

The national pharmaceutical industry association, CANIFARMA, is located in Mexico City. The association is comprised of 29 Mexican-based pharmaceutical companies, 34 multinational pharmaceutical companies, and another 103 medical device / laboratory / therapeutics companies. CANIFARMA represents and defends the general interests of the pharmaceutical industry in Mexico and works with the national government to create policies and programs that promote economic growth for Mexico, that at the same time address the best interest of the public.

Case Study: International Excellence in Agricultural Science

CIMMyT, the International Center for Maize and Wheat Improvement is a world famous center of excellence located near Mexico City in Texcocco. Its aim is to "help alleviate poverty by increasing the profitability, productivity, and sustainability of maize and wheat farming systems." Norman Borlaug, who has long been associated with CIMMyT and with the importance of practical results of research, won the 1970 Nobel Peace Prize for his work in bringing about the "Green Revolution." In addition to being an important plant gene bank, CIMMyT's research programs focus on dryland wheat, tropical ecosystems, irrigated high-potential systems and increasing food security. CIMMyT collaborates with institutions in more than twenty countries, highlighting the value of international partnerships in research and development.

The State Government of Mexico City tends to rely on the large concentration of life science organizations in the capital to carry out promotional activities on life sciences. However, earlier this year the State of Morelos Government demonstrated its ability to secure sufficient financial backing to organize a major science and technology conference, not only on a national level, but also with full international promotion. Indeed, any state with the right local conditions and a sufficiently ambitious governor has a good chance of obtaining some central federal funding from the Foreign Investment Council at ECONOMIA for a life sciences investment promotion event.

The Monterrey Region

Monterrey is one of Mexico's largest cities with a population of over one million people, and approximately four million people in the surrounding region. The city is located in the northeastern State of Nuevo Leon and is less than 100 miles from the Texas border. There is a long tradition of business and trade in the region with numerous examples of corporate growth and success in traditional commodity sectors such as cement, beer, ceramics, steel, and glass.

In life sciences, Monterrey has existing strengths clustered around the activities of the local universities and affiliated teaching hospitals. One of the five pillars of Governor José Natividad Gonzalez Parras's electoral campaign was to transform the State of Nuevo Leon from an industrial to a high tech culture. So there is currently a significant emphasis on building local capacity, not only to develop and attract commercial ventures in the life sciences sector, but also to leverage an overall strength in health delivery to surrounding regions and ultimately to the international community.

Local Infrastructure

Monterrey has significant capacity in life sciences infrastructure primarily due to the universities and teaching hospitals. Major investments are already concentrating on building infrastructure that will facilitate knowledge transfer and commercialization in the innovation and high technology sector including biotechnology.

Monterrey is home to strong academic institutions and teaching hospitals. In the region, there are three universities with medical schools (1 public, 2 private), each of which has separate affiliations with regional teaching hospitals. In some cases this has led to an overcapacity and underutilization of medical equipment in Monterrey, specifically for medical imaging (e.g. Monterrey has a total of 40 MRIs in the region, making it the highest per capita in North America).

Monterrey is building new infrastructure focused on knowledge translation and commercialization. The two largest life sciences related developments currently underway in Monterrey are being spearheaded by one of the private universities – the Monterrey Tech, through its Medical School, and the affiliated San Jose Hospital. The first project is the **Biotechnology Center** on the main campus of Monterrey Tech. This 4-story facility with basic research space is predominantly focused on food biotechnology (high value food additives), bioprocessing (design engineering and scale-up) and biopharmaceutical research. The Center will develop a lab for conducting bioequivalency testing in the near-term for generic drugs produced in Mexico. A long-term objective is to develop innovative drugs based on Mexican plant extracts used for millennia by local indigenous tribes. Business incubation space is also being

Case Study: Monterrey has mobilized leaders in the public and private sectors to build a science & technology park
With support from federal, state, and regional stakeholders the City of Knowledge S&T Park has the potential to become the largest high-technology infrastructure project in the country.

provided on one floor of the facility. The second project is the **Center for Innovation and Knowledge Transfer** to be located near the San Jose Hospital. This \$25M facility (250,000 square feet) is focused on creating new technologies and companies through international partnerships and networks.

In addition to individual university infrastructure projects, the state has mobilized regional leaders to participate in the development of a **Science & Technology Park**. As one of the key aspects of the City of Knowledge initiative (described below), the federal and state governments, along with the private sector are financing a (minimum) \$50 million S&T Park on 70 hectares of land by the airport. Construction began on 1 August 2005 and the park will provide research and incubation space for the 6 sectors outlined in the City of Knowledge initiative (namely biotechnology, nanotechnology, information technology, communications, robotics and health). Stage one will be coordinated by CONACyT with the local Ministry for Economic Development, in association with ITESM, the University of Monterrey (UdeM) and the University of Nuevo Leon (UANL). In particular, ITESM will establish an advanced materials facility with CEMEX (Mexico's leading cement manufacturer) and Arizona State University; a cyber-security centre with Carnegie Mellon, and it will also establish a Data Utility Center to serve the park itself. The UdeM will formalize its international collaboration with the University of Michigan, through an advanced packaging materials research center. For its part, CONACyT will create three new research centers in the park, focused on advanced materials, food production, and advanced manufacturing. The Northern Baja California State Government, also collaborating on the project, will place an office of the Ensenada Scientific Research and Higher Education Center there (CICESE). And INFOTEC, the federal government's e-government agency will set up its City for the Digital Society in the park. There are an additional 22 hectares of land adjacent to the proposed S&T park that has been designated for attracting large multinational companies to the region.^{xlii} The main challenges that remain will be to secure the required funding from the institutions and other partners, and to attract the companies that are strategically aligned with the objectives of the park.

Education and Training Base

Monterrey has three very strong yet independent academic institutions. Until recently, the three institutions have not had a strong history of collaboration. There has been some sharing of faculty and cross referrals among hospitals, but overall the institutions have developed somewhat independently of each other.

The University of Nuevo Leon (UANL) is a public institution affiliated with the University Hospital. The institution is over 150 years old and has the largest hospital in Northern Mexico. Research programs at the school formally started 35-40 years ago and provided training for MSc, PhD, and MD/PhD programs. Training included the basic health sciences (e.g. microbiology, pharmacology, toxicology, and embryology) and the clinical sciences (e.g. hematology, oncology, ophthalmology, reproductive biology and immunology).

Monterrey Tech (ITESM) is a private institution affiliated with and the San Jose Hospital. It is Mexico's largest private university, with an enviable reputation for producing internationally competitive professionals. Through its 33 campuses around the country and its Virtual University with worldwide access, Monterrey Tech provides educational services to over 96,000 students and correspondingly employs over 8,000 professors.^{xliii} The school is predominantly recognized for its expertise in engineering and process manufacturing. It has a small biotechnology graduate program with ~35 MSc and PhD students, but the program is rapidly expanding with the development of the new *Biotechnology Center*. The medical school is also expanding its research and training activities with the development of the new *Center for Innovation and Knowledge Transfer* which will build on alumni networks at institutions in the United States.

The University of Monterrey (UdeM) is a private institution affiliated with Christus Muguerza Hospital. The school was founded in 1969 and has 9,500 students enrolled in 91

bachelor programs, 13 medical residency programs (180 students), 12 masters programs (300 students), and no doctoral programs. The health sciences programs include medicine (basic sciences), nursing, psychology, and biomedical engineering.

Commercial / Industry Base

Commercialization of life sciences technologies is still at an early stage. The local industry base is still emerging and there are very few local life sciences firms. There is however very strong support from the state and within the community for the development of this sector.

Monterrey is working to improve commercialization. With the exception of a few individuals with patented technologies, there is no current evidence of local commercialization successes in the life sciences. There is however very much a change in the culture in Monterrey to have an increased focus on commercialization and knowledge transfer. Private institutions such as ITESM have been very open to pursuing commercial developments, as demonstrated with the investments in new infrastructure. Throughout Monterrey both public and private institutions have begun to adopt a commercial mandate. UANL, the leading public institution, is also promoting increased partnership. They are currently creating a catalogue of ongoing research activities to showcase to industry in order to promote research strengths and facilitate research partnerships.

The limited number of life sciences companies in the region will create challenges for academia spinning out technologies.

The local receptor capacity for technologies emerging from academic institutions is still very low. There are a few chemical and food related companies in the region that have worked with institutions in the region on research projects. However, for the most part Monterrey is dependent on partnerships with companies from outside the region. One exception to this is the presence of GE Medical. Located just outside the city of Monterrey, the company manufactures medical imaging equipment for the parent company in the US. The company provides job opportunities for life sciences graduates, with a specific focus on biomedical engineering and the convergence of electronic technologies. However, this company has had limited interaction with local academic research institutions and has not so far played a role as a potential recipient for new technologies.

Case Study: Mexican based GE Medical is facing competitive pressures from China

GE Medical is one of few examples of a large life sciences company located in the Monterrey region. It employs highly skilled workers and provides good wages; however the company is increasingly feeling pressure to lower production costs in order to compete with emerging regions such as China.

Case Study: Local investment in seed production attracted the interest of Monsanto and created an opportunity for biotechnology applications

Monterrey based entrepreneur Alfonso Romo Garza established Seminis, a leading seed company in the mid to late 1990's by acquiring companies throughout the US, Europe, Asia and South America. The company was developing a range of crops with traits such as herbicide, virus, insect or fungus resistance, as well as food with "improved" characteristics. Biotechnology application came into play in 1997 through collaborative agreements with Monsanto to use their genetic engineering technology. Following a financial slump in 2003, Monsanto eventually purchased the company in 2005, making them the world's largest seed producer.

This example illustrates that the Monterrey region has the capacity to build global biotechnology companies through local investments; however the research, infrastructure and facilities were all acquired outside of Mexico.

Science and Innovation Focus

R&D activities in Monterrey are at an embryonic stage of development, however all institutions are working to build on these strengths internally, as well as to take advantage of partnership opportunities with international institutions and companies.

Monterrey has strengths in basic health sciences research. Within the Northeastern Mexican states, Monterrey is the leading jurisdiction in almost all areas of health research. Institutional strengths at UANL include genomics research and at ITESM include cancer and cardiovascular disease. ITESM is also developing a medical devices strategy to build on the convergence of strengths in engineering and medicine. Together the UANL and ITESM medical schools have positioned Monterrey as the national leader in transplantation research.

The region has significant capacity for late stage clinical trials, with a growing capacity for early stage clinical trials. Due to the proximity to the US, and the distinct Mexican population base, all the teaching hospitals in Monterrey participate as one of several sites in Phase III and IV multi-center clinical trials, and continue to develop their clinical trials capacity. The National Association of Pharmaceutical Industries (AMIIF) published figures confirming Mexico's position as one of the top 10 centers in the world for clinical trials.

In 2005, there are 43,195 patients involved in clinical trials, up from 37,680 in 2004 representing an increase of around 25%. Nearly US\$ 85 million is spent per year on clinical trials in 20 therapeutic areas, such as infectious diseases, cardiovascular, oncology, endocrinology, gynecology, gastroenterology, immunology, neurology, allergies, dermatology, respiratory, rheumatology, urology, sleep rhythms and bone marrow metabolism. The national clinical trial program involves 1,151

Case Study: UNAL has established capacity for Phase I – IV clinical trials

Mexico is one of the top 10 countries in the world for clinical trials. One Mexican institution, UANL has engaged in approximately 60 clinical trials over the past three years, mostly in Phase III & IV, but about 8-10 in Phase II. They have recently built capacity for Phase I trials and are actively recruiting pharmaceutical companies.

The national clinical trial program involves 1,151 centers (937 public and 214 private) and actively occupies over 2,000 investigators. More than 400 clinical trial protocols are currently in operation in Mexico.^{xliv} In order for institutions in the Monterrey region to establish operations as a full Contract Research Organization (CRO), they need to build additional capacity for Phase I and II trials. As facilities with capacity for Phase I through IV trials are not readily available in Mexico, strengthened clinical trials capacity in Monterrey would give the region considerable advantage in attracting both national and international pharmaceutical companies. Areas of research would likely focus on most degenerative diseases such as obesity, diabetes, etc.

Monterrey has additional strengths in other areas of the life sciences. While the Monterrey region has significant strengths in the basic health services and sciences arena, there are additional areas related to the life sciences that are also emerging in the region. Strong research programs exist in food biotechnology, nutraceuticals, plant agriculture, and process engineering. These programs are being developed primarily through programs at ITESM, however there is also considerable strength in plant biotechnology at the UANL affiliated Center for Genomics Biotechnology in the State of Tamaulipas (about 100 miles north of Monterrey).

Regional Organizations and Local Government Support

There is a recognized need to build local capacity and attract commercial partners to the region. The state government has launched two initiatives to help build capacity in the life sciences. It is expected that these initiatives will help to promote collaboration, attract industry and facilitate commercialization.

The ***Council on Specialized Medical Services*** was created in early 2005 to increase collaboration among the hospitals and academic institutions in the state, and to promote the medical strengths of the region. The statewide council, representing 22 public and private institutions and 40 hospitals, is working together to formalize the region's ability to offer medical services to the national and international community.

The ***City of Knowledge*** concept was launched in 2004 to engage the public and private sectors in building innovation-based economies in the region. The initiative includes both physical infrastructure through the development of a science & technology park (described earlier), proactive networking within the local community to facilitate interaction and collaboration, and to promote the strengths of the region internationally to attract additional partners to participate in building knowledge based economies in the state.

Overall, the state government of Nuevo Leon has dedicated significant resources to promote the development of new knowledge-based economies in the Monterrey region.

The Guadalajara Region

Guadalajara is the second most populous city in Mexico with a population of over 4.6 million, and an estimated 8.9 million in the surrounding metropolitan area. The city is located in the Western-Pacific region of Mexico in the State of Jalisco. The city refers to itself as the Silicon Valley of Mexico with high technology companies such as General Electric, IBM, Hitachi, and Hewlett Packard. The region has promoted the development of high technology with a specific focus on the information technology and the life sciences sectors.

Guadalajara has a strong history of pharmaceutical manufacturing with many companies national and multi-national companies located in the region. Although these companies have well established product lines, there is increasing interest in the region to introduce new innovative technologies into the product pipeline.

Local Infrastructure

Guadalajara has infrastructure capacity for both life sciences research and large-scale manufacturing. The development of new infrastructure is primarily through investment from private companies in response to market demand.

Research centers in Guadalajara provide some infrastructure for basic research and development. The University of Guadalajara, the Autonomous University of Guadalajara, CIATEJ (one of the CONACyT research centers) and the IMSS Western Mexico Center for Biotechnology (IMSS-CIBO) are the four primary institutes for life sciences R&D in the Guadalajara region.

Private companies provide the majority of life sciences infrastructure capacity for this region. Most companies in this region have achieved a mature stage of development and have well-established manufacturing facilities for chemical based pharmaceuticals ranging from human therapeutics, to nutraceuticals, to veterinary products. This capacity also includes some capacity for manufacturing human and veterinarian vaccines. Many of these companies are located in the surrounding regions of Guadalajara with some in high-technology industry parks (although most companies in these parks are information technology companies). Manufacturing facilities for these companies are all compliant with GMP regulations and facilities continue to be built and renovated in response to market demand. The following are just two examples of how companies are ensuring that they have the most advanced facilities to meet their needs. The Collins Group

of companies just recently completed the building of an entirely new manufacturing facility for chemical pharmaceuticals and vaccines. The Ifaco Group of companies is expanding its manufacturing capacity to include R&D facilities to work with tissue culture and recombinant proteins for the development of new biological products. Boehringer Ingelheim, the German multinational, has a major veterinary medicine manufacturing operation in the region and uses its Guadalajara operation as an international research center for its avian products.

Education and Training Base

Guadalajara is home to many academic training institutions, including a campus for Monterrey Tech. Together these institutions bring a diverse capacity for life sciences training in the region.

University programs in life sciences research are located primarily at The University of Guadalajara (UdeG) and the Autonomous University of Guadalajara (UAG). UdeG is an independent public university with strong undergraduate and graduate programs in many areas of basic biology and health research. UdeG plays a leading role in the promotion of life sciences research in the region and is engaged in research partnerships with many local companies. UAG is a private university with many graduate and undergraduate programs that attract students from around the world (almost 20% of the students are foreign). The school has a strong international medical program targeted at training students from the United States. To date they have trained over 8,000 physicians currently residing in the United States.

The Jesuit University of Guadalajara (ITESO) is a private institution that provides management training for technology innovation. Although ITESO does not have life sciences related research programs, the school has a strong background in business and marketing. The school is interested in providing advisory services to companies (by using student researchers) to help them increase their competitiveness. Over the next 3-5 years, it is envisioned that 2000 students (currently 8500 students enrolled at the school) will be trained in providing advisory services in existing technologies and creating linkages for commercialization. Although this program will include all high technology sectors, they believe that their market research and management training will be a key contribution to the development of the life sciences sector.

Case Study: ITESO leverages business training to help develop life sciences companies in Guadalajara.

By working directly with small and medium sized companies in the region, students are providing valuable insights on market opportunities that help companies to improve their competitiveness.

Additional training opportunities are provided through the CONACyT research center CIATEJ. The independent, not-for-profit research center is focused on the development of agro-industrial technologies. The center is not an academic training facility but it still provides graduate training for a small number of students each year in applied research for plant technologies.

Commercial / Industry Base

The industry base in Guadalajara is at a mature stage of development with large established companies bringing significant capacity for manufacturing and development. Industry in Guadalajara has been receptive to collaborations with academia to meet their research needs however; there is little evidence of smaller entrepreneurial life sciences companies.

Multinational pharmaceutical companies contribute to the significant manufacturing capacity in Guadalajara. This region is home to manufacturing facilities for many of the large multinational pharmaceutical companies including Boehringer Ingelheim and Fresenius Kabi. Guadalajara has been selected by multinationals as an ideal location for manufacturing primarily

for two reasons. First, there is a large pool of highly skilled workers in the region due to the presence of multiple large pharmaceutical manufacturing plants. Secondly, often multinationals acquire an existing facility that has already been established and is operating in Guadalajara. It is usually cheaper to continue building upon the existing capacity than to relocate to another region. However, the multinational pharmaceutical companies are typically based in the Mexico City region, as they want to access regulatory officials in federal government. Apart from using researchers as key opinion leaders, multinationals have limited interaction with academia and minimal in-house research in Mexico.

Many well established national pharmaceutical companies are located in Guadalajara. National companies in Mexico focus primarily on the development of generic pharmaceutical compounds and are all suppliers to the IMSS. National companies are able to meet 90% of the demand for pharmaceuticals in Mexico; however, multinationals make higher profits by selling higher margin patented drugs to the remaining 10% of the demand.^{xiv} As there are no private controls in Mexico, multinationals are able to sell their drugs at a profit, while national companies are limited to the pricing established by IMSS. National companies are also beginning to feel the pressure from manufacturing competition in China and India, and they are becoming more interested in innovation as a new business model. These competitive pressures and a desire to innovate are felt in all regions in Mexico, however it is specifically relevant to Guadalajara given the higher proportion of national pharmaceutical companies located in the region. Although there are a few examples of research initiatives with these national companies, investment in research and development is still very limited.

Science and Innovation Focus

Guadalajara has many strengths in basic medical research. At the University of Guadalajara, the Center for Molecular Biology focuses primarily on diagnostic tools and clinical practice methods. The UdeG has a strong working group in applied genomics, and has a particular expertise in gene therapy. This group has made very impressive inroads in human liver cirrhosis and is currently engaged in clinical trials at the UdeG's research hospitals, two separate units of Hospital Civil. Dr Juan Armendáriz Borunda, the group leader is the recipient of several national and international awards and he holds the highest grant ever awarded by COECyT-JAL in the field of biotechnology.

As the biggest IMSS sponsored research center, IMSS-CIBO is the largest research center in the region and among the largest in the country. The center focuses on studying major issues for Mexican health, including diabetes, tuberculosis, and cancer. Over the past five years, the Center has been actively pursuing collaboration with national and international pharmaceutical firms.

Plant and agricultural research is strong in the region, primarily through work at CIATEJ. The institution works directly with industry partners to research and develop solutions for local issues such as bird vaccines (the state is the largest producer of chickens with more than 40 million eggs per year), and testing tequila plants for genetic diseases. Recently the center expanded to include research programs in pharmaceutical technologies, primarily in the area of animal vaccines.

Regional Organizations and Local Government Support

The state science and technology council (COECyT-JAL) in collaboration with the state department of economic development have undertaken a technology cluster assessment study which found that they have strengths in the areas of information technology and the life sciences. As an outcome of the study, the state has been involved in the promotion of these two sectors internationally and the attraction of related companies to the region. Until recently, these efforts have been driven primarily through the promotion of the existing capacity for manufacturing and

skilled workforce. Given new competitive pressures from lower cost regions in Asia, they started to focus on promoting innovation in the region as well.

In early 2005, with the support of the state and federal governments, Dr. Gregorio Cuevas Pacheco, a highly successful local entrepreneur, established Biocluster del Occidente, a regional cluster organization for Western Mexico. The objectives of Biocluster include:

- Facilitating cooperation among local academic and industry stakeholders
- Promoting technology commercialization and spin-outs
- Seeking partnerships with foreign academic and private sector organizations
- Attracting local and foreign capital to the regional industry

Initially Dr. Cuevas brought together academic/research stakeholders from UdeG, ITESO, and CIATEJ to establish an agreement on how the institutions would work together to engage local companies in innovative research initiatives. They had a first meeting in March, where they invited 12 national companies to discuss what they needed, and started to create linkages with the research institutions. At a second meeting in June they invited 27 companies to see if they could make linkages to address the local needs. The main areas of focus have been human, veterinarian and food technology.

Specific goals for the cluster include:

- Transferring 5 projects per year to companies
- Forming a new spin-out company every 2-3 years
- Improving the economic positioning of local companies by:
 - Expanding their product lines
 - Reducing development costs through partnerships
 - Connecting with companies and funding sources outside of Mexico

Highlights of Additional Regional Capacity in Mexico

Although this initiative has focused primarily on the three regions described above, there are several other regions throughout the country that are recognized for their strengths in the life sciences sector.

The border states have contributed significantly to cross-border activity between the US and Mexico for many years. Beyond traditional markets, border states have participated in health and life sciences initiatives, as well as training of human resources. Examples of strengths along the border states include:

- **Northern Baja California** – As a result of the growing life sciences cluster in San Diego, the Tijuana region has benefited significantly from cross-border activity. The region has built significant capacity for manufacturing medical devices and other biomedical equipment.
- **Sonora** – Arizona has worked closely with Sonora for many years exploring research and commercialization partnerships in high technology areas. In addition to activities with universities, The Arizona Mexico Commission has developed a joint strategic plan and cooperative initiatives in many sectors including economic development, education and health.
- **Coahuila** – In addition to partnering on innovation with the US, border states such as Coahuila are also working with partners from Europe and Japan.

Many other states within Mexico are building regional capacity for innovation and are creating partnerships with the US, as well as other European and Latin American countries. Examples of other states involved in developing a regional life sciences capacity include:

- **Guanajuato** – The cities of Leon and Celaya are the state’s primary location for research centers and universities. As the Bajío Corredor is the principal agricultural producer and supplier of Mexico City, research has naturally focused on seed, plants and food technology. In recent years, the region has developed several technology alternatives for wheat, corn, and bean.
- **Queretaro** – Only an hour or so drive north of Mexico City, in 2006 it will be linked by electrified rail to the capital. Its proximity has already resulted in dramatic industrial growth which the state government has had the foresight to control and channel towards the “clean” industries. Therefore the region has attracted significant federal investment for biological and health sciences research and is active in international research forums.
- **San Luis Potosí** – The field of “bioprospecting” attracts significant international interest to this region. It involves researchers collecting and testing varieties of plants to discover medicinal properties that can be used to develop new therapeutics.
- **Puebla** – The University of the Americas in Puebla offers a Masters of Biotechnology program that includes the areas of medicine, biology, chemistry, agriculture, engineering, and food sciences. The objective of the program is to have students develop strategies for new biotechnologies that can be applied to priority areas for Mexico.
- **Yucatan** – The region is home to research centers that focus primarily on researching plant biotechnologies and the University of Merida in the state capital is recognized nationally as the center of excellence in agricultural technology.

Capacity for life sciences innovation continues to grow throughout Mexico creating numerous opportunities for cross-border partnerships.

Regional Assessment Summary

The **Mexico City Region** (including the states of Mexico and Morelos) has a strong base at both the knowledge creation and industrialization stages of the life cycle. The strength in research at the knowledge creation stage is demonstrated primarily by the disproportionately high allocation of funding, patents, and other resources to the region. The Biotechnology Institute at UNAM in the State of Morelos, for example, has made significant contributions to basic research. Mature companies in the region, both national and multinational companies, anchor a strong sales and distribution network for pharmaceutical products. However, there is limited evidence for innovation at the technology transfer and commercialization stages in the middle of the life cycle. There are only a few examples of smaller companies operating in the region. The capital and human resource talent required to support the development of companies through the technology transfer and commercialization stages of development are not readily available.

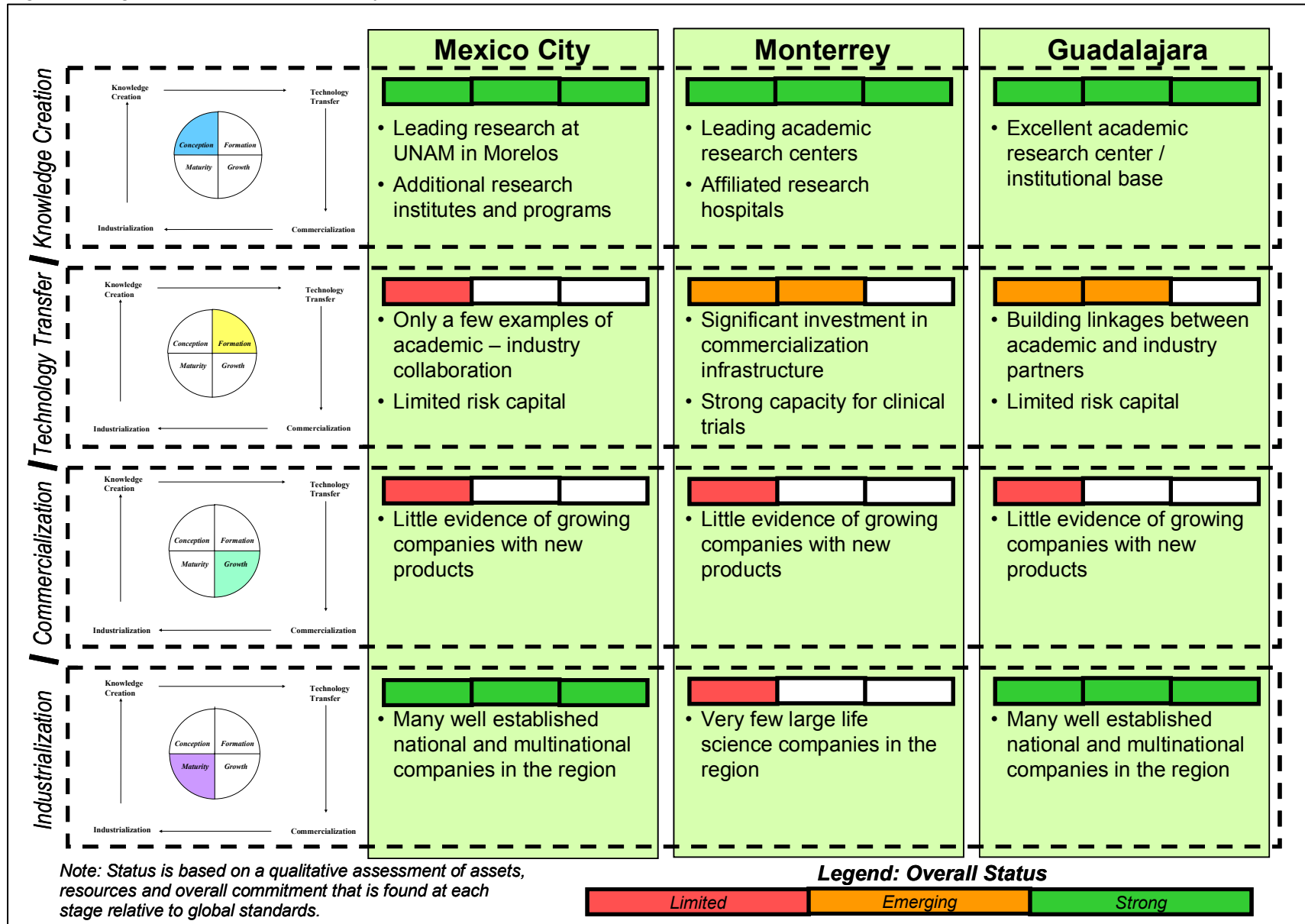
With its leading research institutions and affiliated research hospitals, the **Monterrey Region** also has strengths in research and discovery at the knowledge creation stage of the life cycle. In addition, there is evidence of innovation emerging at the technology transfer stage due to considerable recent investments in these activities by local institutions. Both public and private sector leaders have embraced the life sciences sector as a regional industry development target.

The region is still challenged with limited assets at the commercialization and industrialization stages of development, as there are still very few life sciences companies based in the region.

The **Guadalajara Region** is best known for its strength at the industrialization stage of the innovation life cycle. With the manufacturing and operations of many national and multinational pharmaceutical companies, the region has well-established physical resources and human capital to support pharmaceutical production. At the commercialization stage of development however there is little evidence of new companies or products in development. But, with the emergence of the Biocluster organization, regional interest seems to be evolving towards embracing more firms at earlier stages of the life cycle. Research and discoveries are also strong at the knowledge creation stage with an excellent base of academic research centers and institutions. There is also evidence of emerging activity at the technology transfer stage of the life cycle with an increased focus on building academic and industry partnerships.

See the regional assessment in Figure 6.

Figure 6: Regional Assessment Summary



CROSS-BORDER PARTNERSHIPS

Perspective on Cross-border Partnerships

There is significant interest from US partners to engage in cross-border activities with Mexico. Based on existing partnerships and programs, there is already a strong foundation on which collaborations can continue to grow and develop. Border states have already established close ties with their neighboring communities and there is an inherent need to continue to build on these ties for the benefit of communities on both sides. Issues of education, skills training, labor, and health services are all issues that need to be addressed collaboratively by the border regions. Beyond the border states there is interest from institutions across the country to either build on the existing partnerships that have been established, or to engage new partners on both sides of the border.

Although partners on both sides of the border have benefited from collaborative initiatives, there are still limitations that will prevent future benefits from these engagements. Due to the fact that partnerships occur beyond national boundaries, stakeholders are forced to deal with issues such as national security in terms of visa applications, and funding regulations that prevent the use of funds outside of the country. Therefore, despite the need for engaging in cross-border activity, there are still factors that impede the ability to grow international partnerships.

Existing Framework for Cross-border Partnerships

Cross-border partnerships between Mexico and the United States have existed for many years and extend well beyond the life sciences sector. These partnerships have continued to increase in recent years, accelerated by the signing of the NAFTA treaty. There have been several initiatives specifically directed at increasing collaborations for innovative research and development. The following examples describe the various cross-border interactions focused on life sciences innovation.

- The ***United States – Mexico Foundation for Science (FUMEC)*** was created in 1992 as a bi-national, non-governmental body, through an agreement between Mexico and the United States to promote and support scientific and technological collaboration between both countries. The mission of the organization is to foster innovative cooperation in science and technology that contributes to solving issues of bi-national interest. To accomplish this the organization has outlined objectives including:
 - Identify and develop opportunities for bi-national cooperation in science and technology;
 - Promote the development of stakeholder and information networks; to identify and support management of bi-national financial resources, in order to sustain programs that can lead to medium range solutions;
 - Study, facilitate and promote science and technology policy-making that enhances and strengthens bi-national cooperation between the United States and Mexico; and
 - Base programs and actions firmly in communities and local institutions to ensure continuity and permanence.

FUMEC currently has three programs implemented - Environment and Health; Technology Based Economic Opportunities; and Human Resources Development in Science and Technology.^{xvi}

- **CONACyT research partnerships** have been established between many of the leading academic institutions in the US. Together with US institutions, CONACyT has established programs to invest in cross-border collaboration. Research training grants to fund graduate level education for Mexican students has been targeted at leading schools including Harvard, John Hopkins, Stanford, Yale, and the Baylor College of Medicine. Additional funding has been provided for collaborative research grants with institutions primarily along the border states including UT Austin, Texas A&M, and the University of Arizona.
- The **USAID (US Agency for International Development) TIES (Training, Internships, Exchanges, and Scholarships) Program** is a \$50 million, eight-year program between the US government, US and Mexican educational institutions, and the private sector. The program enhances the capacity of higher education institutions in both countries to examine mutual development problems, work in strategic alliances to develop solutions, and to create a basis for Mexico to benefit more from NAFTA and the planned FTAA.^{xlvii} The program provides both university and college scholarships. This program has enhanced linkages with more than 100 institutions in the US and Mexico (approximately 50 on each side). These partnerships have significantly benefited the border states, but they also stretch throughout both countries including: US institutions in Indiana, Iowa, Michigan, Pennsylvania, Illinois, Connecticut, and Wisconsin; and Mexican institutions in Puebla, Jalisco, Morelos, Colima, and Yucatan.
- **State and municipal partnerships along border states** have been developed. Given the proximity of cities and regions many of the local communities or even bordering states have created partnerships to enhance economic activity in the cross-border region. Examples of partnerships include:
 - Academic partnerships for training and education through the TIPS program. Often border cities have a different perspective than other institutions throughout each country. At UTEP for example, Mexican students often travel across the border each day for school as opposed to studying away from home for a term.
 - Collaborative health programs to address health issues that are specific to the regional population and environment have also been developed. For example South Texas is working closely with the Northeastern Mexican states to collaborate in health education and training.
 - The states of Arizona and Sonora have jointly developed a successful collaboration in economic development that has survived beyond the terms of the state governors. The two states are currently working together to establish a western trade route that extends north to Canada and south through Mexico.
 - San Diego and Tijuana have collaborated in their regional development building regional innovation clusters that span across the border region.
- The **United States-Mexico Border Health Commission (USMBHC)** was created as a bi-national health commission in July 2000, with the signing of an agreement by the Secretary of Health and Human Services of the United States and the Secretary of Health of Mexico. On December 21, 2004 the Commission was designated as a Public International Organization by Executive Order of the President.^{xlviii} In the Summer of 2005, members of the commission identified the following priority issues: disease and injury prevention; immunizations; cervical cancer; migrant health; obesity; access to health care; health disparities; advocacy; ongoing communication and dialogue; Commission's leadership role; and development of partnerships and alliances with academic institutions.
- The **Bi-National Sustainability Laboratory, Inc.** has a mission to convert emerging technologies to economic development along the US-Mexico Border. Its programs include: science education to develop a workforce for emerging technology sectors; strengthening and expansion of local business and finance infrastructures to support new industries;

identification and development of application-oriented technologies that can be spun into new businesses; and entrepreneurial support programs to develop the cadre of leaders of these businesses. Projects have been initiated to focus on business and social infrastructure development (e.g. IP, education, market, financing, etc.) as well as technology identification, development and commercialization (e.g. controlled environment agriculture, advanced manufacturing, public health, secure commerce, etc.).^{xlix}

- **Informal academic networks** are another way in which researchers in both countries interact. These networks are based on personal relationships, built primarily from Mexican students or faculty who have studied in the US, or have relocated to the US, and maintain contact with their original institutions in Mexico. Through these informal alumni networks Mexican researchers are able to collaborate with institutions throughout the US. Although alumni links help to build the network, partnerships are also informally established among researchers in similar fields. Collaborations through these informal networks consist primarily of student exchanges, small joint research efforts, and sharing research results. There are relatively few examples of large collaborative research projects through these informal networks.
- **Small Business Development Center (SBDC)** is a US based program that institutions such as UT San Antonio are working with Mexican institutions to establish in order to help small businesses. Management services are provided to small business owners by local organizations that donate their time, and also through hired consultants for specialized expertise. Funding for these programs is divided 50% federal contribution and 50% matching from the state, municipalities, or academic institutions. Currently these programs have been launched in Mexico based on institutional, municipal or state funding, and a proposal for funding has been presented to the ECONOMIA.

Cross-border partnerships for Mexico also go beyond the United States into Canada, Europe and Latin America. Partnering in Canada and Europe has primarily been through informal researcher networks, while Latin America is seen more as an expanding market opportunity for new innovative products and health services.

Future Outlook for Cross-border Partnerships

Over the next 3 to 5 years, the US-Mexico cross-border region is seeking to create an environment that will support:

- A **seamless flow of health care solutions** that address priority issues for the population demographics of the border region. Solutions that arise from institutions on either side of the border should be made available to the entire border population.
- **Modernized effective collaborations** between Mexican and US partners that will efficiently use and leverage infrastructure, intellectual property, management and investment on both sides of the border.
- **Bi-national policies** that encourage and invest in the discovery, development and delivery of life sciences products and services.
- **Real time connectivity** among US and Mexican researchers, institutions, enterprises and investors, leading to a vibrant community of innovation.

International Assessment Summary

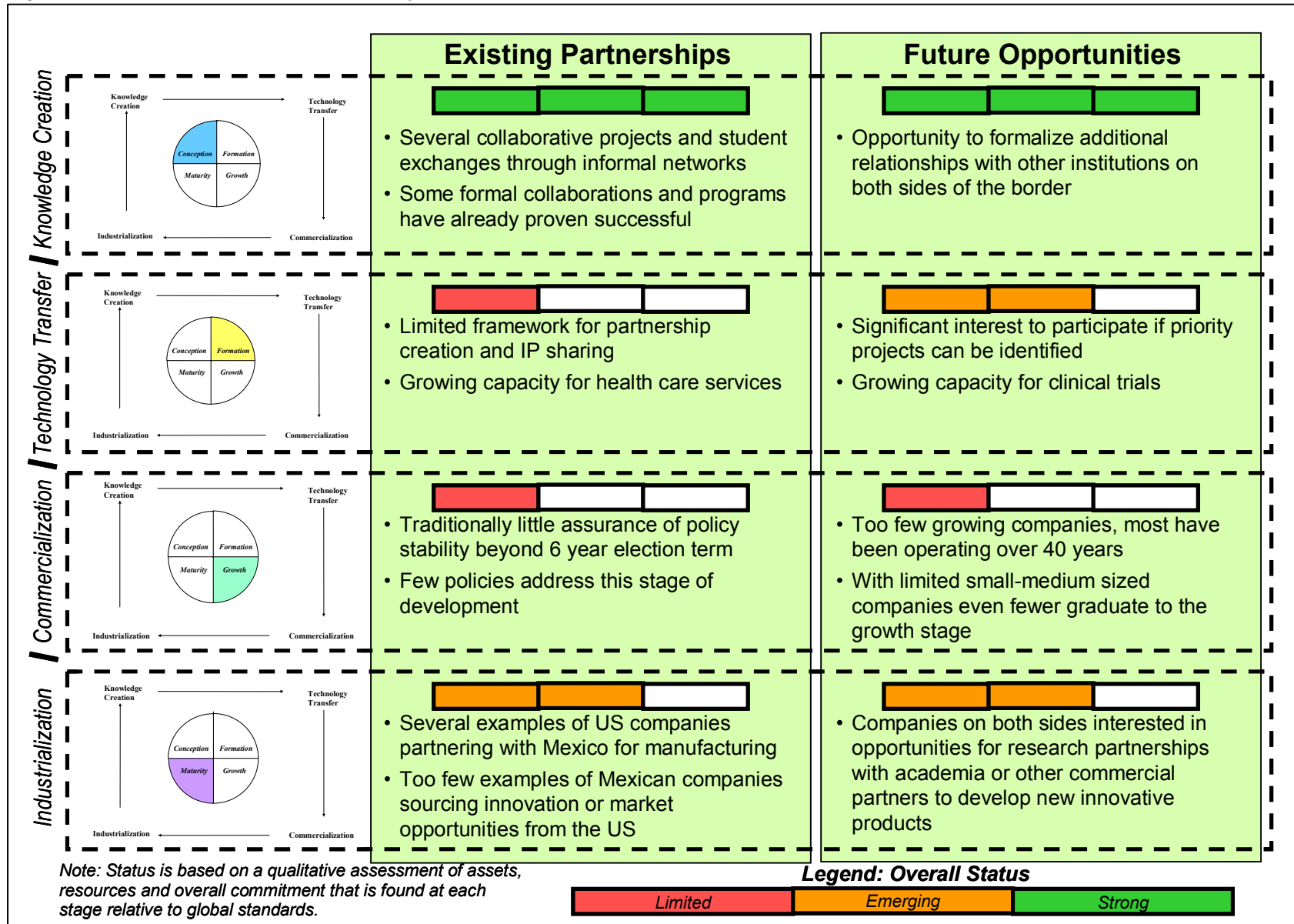
Collaboration among US and Mexican stakeholders is seen both at the border state level as well as the broader national level. The border states share strong similarities in the population base and health issues, often arising from common genetic traits and environmental factors. These similarities have spurred a significant number of cross-border research partnerships and public policy efforts. At a national level, priority health issues are similar for populations in both countries, establishing a rationale for collaboration.

Existing partnerships are very strong at the knowledge creation stage of the innovation life cycle due to several informal collaborative projects and student exchanges as well as formal collaboration with US academic institutions through CONACyT (the National Science and Technology Council for Mexico). At the technology transfer and commercialization stages however, there is only a limited capacity for collaboration. This is due to a limited framework, on both the US and Mexico side of the border, for establishing partnerships and sharing intellectual property. At the industrialization stage of the life cycle, there is a policy framework for US companies working with Mexico for manufacturing; however there are still too few examples of Mexican companies sourcing innovations or market opportunities from the US.

The most immediate **future opportunities** for cross-border innovation are linked to strengthening existing partnerships focused on research. In the short to medium term, there are cross-border opportunities for joint health care delivery and training through the use of communications technology that enables both telemedicine and distance learning. In addition, there is emerging capacity at the technology transfer stage of development, with growing opportunities for clinical trials and additional health services, supported by significant interest on both sides of the border. The industrialization stage offers an emerging capacity with established companies on both sides of the border interested in research collaborations to develop and distribute new products.

See international assessment in Figure 7.

Figure 7: International Assessment Summary



CHALLENGES FOR ADVANCING LIFE SCIENCES IN MEXICO

Our assessment shows challenges for advancing the life sciences sector in Mexico occur throughout the innovation life cycle. It is expected that a region will experience challenges at each stage of development. The ability to address these challenges will determine how well the country and the life science regions advance their innovation economies.

This section highlights the key challenges Mexican life science sector presently faces. These challenges may change over time. However as the country develops a strong focus on the sector, it should be able to better anticipate challenges and develop initiatives to mitigate them.

Knowledge Creation

Investments in research & development are too low for competitive growth. As previously described, the total amount of R&D investment in Mexico is 0.4% of GDP, significantly lower than 2.7% in US and 2.2% in EU.¹ There is a significant demand for funding from academic institutions that cannot be met with the existing programs. It is estimated that current funding supports approximately 10% of eligible projects in academia. In addition, the private sector has not played a significant role in R&D. National companies develop and manufacture primarily generic compounds and products, with limited investment in new innovation. Multinational companies typically finance their research activities outside of Mexico.

Timely access to funding and required equipment is a challenge for most institutions. Despite significant infrastructure assets, access to new equipment and materials is often delayed due to lengthy negotiations for disbursements granted from funding agencies and long wait times for imported goods through Customs. In general, leading edge equipment that is required to remain competitive in life sciences research is not readily available to the researchers who need them. This lack of access is particularly acute for young researchers who are new in their careers.

Little alignment of the priorities and objectives of the federal and state governments. Although various players in the Mexican life sciences sector have identified research priorities, resources from the various state and federal agencies have not been aligned to focus on these areas. Funding is not linked to disease issues or targeted outcomes, which has resulted in an inefficient use of resources. The limited alignment and collaboration of resources and expertise from other regions in Mexico has resulted in the centralization of research activities. Mexico has not capitalized on the core competencies in various regions throughout the country.

Technology Transfer

The research and commercial objectives of industry and academia are not well aligned. Innovation and research arising from local universities is underutilized by the commercial sector in Mexico. Companies do not yet realize the opportunities for new innovation and technologies, and universities do not always develop applications for their research. There are a few examples of medical innovations from universities spinning off in niche areas for Mexican-based pharmaceutical companies; however there is little evidence of multinational or local pharmaceutical companies working with local universities in collaborative R&D activities. In the plant biotechnology sector, there has been significant push back from the public regarding the development of transgenic plants. As the laws in Mexico require that transgenic projects be reviewed on a case-by-case basis, and as there is significant pressure from the public against the development of this technology, the result has been that very few companies are working in this

arena. The few technologies that arise from plant biotechnology are typically sold to companies in the US. Food biotechnology is an area that has benefited somewhat from industrial partnerships, but only with small projects at the individual researcher level. In the area of environmental biotechnologies, there is limited demand for commercial products, as there are few companies working in this area due to minimal financial resources and very few national policies for environmental remediation.

Interaction among academic and industry partners is incipient in Mexico. There is not a long history of business working with academia. CONACyT has been working to improve this linkage, requiring private sector participation in many of their funding programs; however, the mindset that academic research should not be influenced by the commercial sector is still strong. The academic community has yet to find the right balance between curiosity-driven research, and research driven by market demand and public need. There is also lack of entrepreneurial culture, which limits the movement of novel research to the commercial sector. Companies (both new and established) often depend too much on investment from the government and are not always willing to assume the investment risk themselves. This culture creates a distinct line between academic research and commercial development, with little or no overlap between the two. Without this overlapping interaction among academic and industry partners, novel innovations will not readily advance in the marketplace.

There is no standardized legal framework to facilitate interaction among research and commercial partners. Given the different cultural mindset among academic and industry partners, it is very difficult for these parties to communicate and interact. Recently there have been a growing number of individuals both in academia and industry who recognize the value of partnership. However, academic institutions have not developed standard practices for industrial involvement. Currently contracts are negotiated on a case by case basis, and there are no public sector guidelines to outline how intellectual property should be shared, how public funding and infrastructure can be used for commercial activities, how research personnel are compensated for working on private sector contracts, and other similar issues. Private universities and research institutions (e.g. Monterrey Tech) have been better equipped to deal with these questions and are able to negotiate private contracts faster.

Risk capital for early stage ventures is not readily accessible and difficult to source. Angel and venture capital for the life sciences sector has not been an area for significant investment in Mexico. Although private investment capital does exist in Mexico, the case has not yet successfully been made for significant investment in the life sciences sector. As it takes most life sciences companies a minimum of 10 years before they become profitable, the time frame for realizing a reasonable return on investment is too long for most investors. This may be another area to promote cross-border collaboration by attracting US-based angel groups and venture capitalists to consider Mexican investments.

Commercialization

Patenting does not adequately protect companies from having others infringe on their intellectual property. As previously described, the enforcement of the patent law is not sufficient to deter companies from infringement. The process required to dispute patent infringement takes several years and requires significant resources from the company. Often the investment required to dispute a patent is not worth the investment, as there are minimal consequences for the infringing company. Often infringing companies are ordered to stop, but the disputing company does not get sufficiently compensated for lost profits and legal costs.

The Mexican business environment does not adequately support pharmaceutical innovation by national or multinational firms. The few Mexican pharmaceutical companies who have entered the generics field are supported by a national policy that requires the public health sector to buy generics where possible. Still, local firms with growth aspirations typically

have to look to international alliances to finance R&D or support export strategies. In contrast, there are many domestic firms that provide inexpensive “similar” medicines, compounds that are similar though not necessarily equivalent to the patented drug. These similar manufacturers have been able to grow and generate high profits by avoiding the costs of bioequivalency testing. However, a recent change in Mexican federal law will essentially end the practice of legal “similar” production as all drugs on the market need to undergo bioequivalence testing.

The multinationals have an uneasy relationship with the generic companies and are hostile toward the similar manufacturers. Despite the greater financial resources available to the multinationals, a disproportionately high amount of human and financial resource is taken up with direct governmental lobbying in order to sustain favorable legal conditions. For example, there was a move last year to reduce patent life from 20 to 15 years – this was fought off, but permission was granted for local generics companies to start permit procedures up to a year before patent expiry. The new bio-equivalence requirement was a triumph for the multinationals, but it turned bittersweet due to a five-year grace period that was included in the final rules.

Meanwhile, over half of Mexico’s population is technically below the poverty line, according to the World Health Organization definition. They cannot afford innovative drugs, there are not enough generics to meet demand and, while the “similares” hit the right price point, their quality is uncertain. The alternative is to use the IMSS (which is notorious for inadequate drug availability) or affiliate to the Seguro Popular (which at present does not cover all illnesses).

In addition, it is difficult for Mexican firms to access government demand because of the laborious procurement processes. Further, local small producers face bureaucratic hurdles in establishing production facilities and obtaining sanitary licenses to manufacture.

Financing is also difficult for local firms. The commercial and development banks remain unyielding on documentary requirements and high interest rates, although recently the Ministry of the Economy has made some advance in supporting credit lines for SMEs, in order to obviate the need for guarantees. Given the cost and barriers to efficient business operation, Mexican firms typically spend little on research and development. Even though partnering with multinationals offers a way to minimize innovation investments, there is little collaboration between local and multinational firms, and seemingly little recognition of the potential benefits of partnership.

Despite graduate level training, students are often not able to find work opportunities with industry. Very few of the students have found employment doing research in industry. There is concern is that there will not be any job opportunities for graduates. Very few graduates (estimated at 10%) make the successful transition to a career in industry and there is a risk that many of them will pursue opportunities outside of Mexico. Researchers are pursuing opportunities in the United States, as well as Latin America, which has become the natural “export” market for researchers (and their discoveries).

Industrialization

Regions are struggling to make linkages locally, nationally, and internationally. Geographic cluster regions need to have a formalized network community in order to stimulate and facilitate linkages. The Guadalajara region has launched a cluster organization, Biocluster del Occidente, to link academic and industry partners. The Monterrey region has started to build formalized networks with the City of Knowledge initiative and the Council on Specialized Medical Services. At the national level, organizations such as CANIFARMA have played a role in linking Mexican companies with international players. Still, the promise of regional networks has not yet been fully realized. Regions would benefit from more institutionalized mechanism to interact locally, and concerted efforts create linkages with other national and international regions.

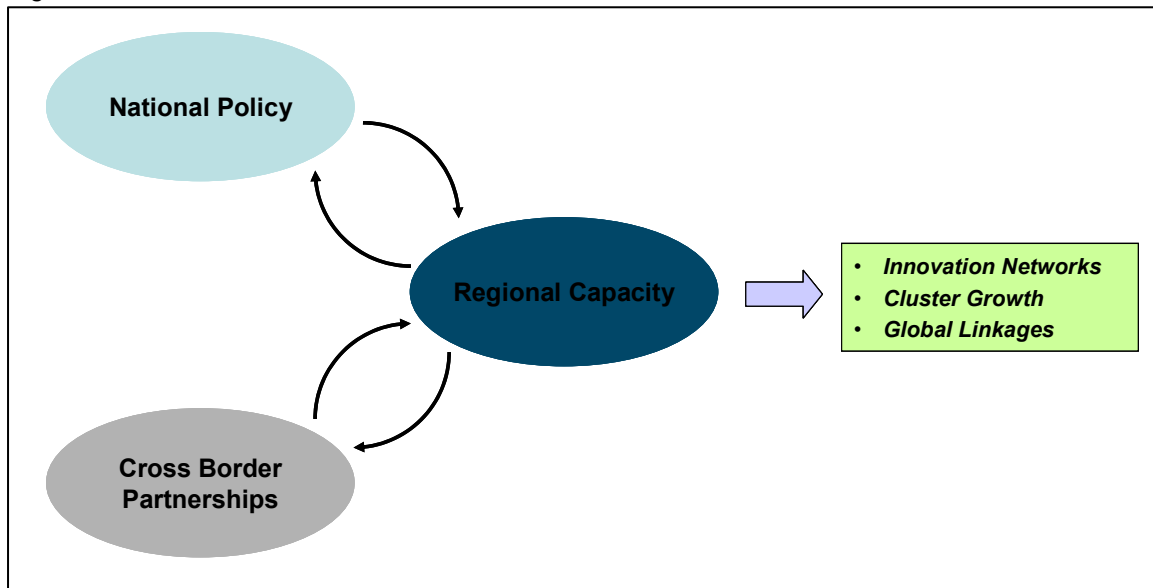
International partners do not fully understand Mexico's role in the global life sciences marketplace. Mexico has not defined how they are playing in the marketplace. It is unclear, for example, how they are competing on manufacturing versus on innovation and how they have prioritized the competitive positioning for each. With competing regions in China and India, and with concerns about the continuity of policies beyond the 6-year election time frame, international regions have difficulty understanding Mexico's strategic priorities. Generally speaking, Mexico suffers from a lack of information internationally, and from prejudices based on debt crises years ago. The country has not proactively sought to change this perception by supporting trade missions to its main export markets, or devising new ways to attract key players to visit.

Mexican researchers and companies must overcome any external perceptions of substandard quality and expertise. There is still a perception by some on the United States side of the border that Mexican based research and technologies are not at the same quality as US based research. Showcasing regional strengths and expertise will be important for educating prospective partners in the US.

RECOMMENDATIONS

Life sciences innovation happens in a regional context – where the academic, commercial, non-profit and public sector agents involved in innovation directly interact. However, national policy plays a critical role that impacts a region's ability to innovate. In addition, cross-border partnerships will play a critical role in a region's ability to become globally competitive. Therefore, it is important for issues to be addressed at each of the regional, national, and cross-border levels in order to enable growth of life sciences clusters in Mexico and the United States.

Figure 8: Recommendations to Enable Cluster Growth



Regional Capacity

Recommendation #1a: Each region should establish local network organizations that facilitate interactions with local stakeholders from government, academia, industry, labor and the not-for-profit sector. Regional network organizations within Mexico should interact to fully leverage national assets.

A formal network organization should be established in each of the developing regions in order to stimulate local collaboration and partnerships. These organizations (also known as Regional Innovation Networks or RINs) have proven to be a best practice in regions that are focused on building innovation-based economies. Their mandate includes hosting local forums, workshops, and other programs that facilitate information exchange, service provision and knowledge sharing. The organization also acts as an interface to brand and market the strengths of the region, as well as to connect with other regions both nationally and internationally. Regional organizations have been recently established in Monterrey, with the *Council on Specialized Medical Services*, and in Guadalajara with the Biocluster del Occidente. These are both excellent examples of regional initiatives that should be further developed. These organizations can become even more effective if they link with each other to become conduits for sharing regional assets and best practices.

Recommendation #1b: Each region should prioritize specific life science areas of focus for their local networks of innovation.

While all regions should establish regional networking mechanisms, the focus of those mechanisms may differ from region to region depending on how each region is positioned in the innovation life cycle. Networking mechanisms should build on the existing strengths of the region.

Implementation

Challenge Area	Recommended Tactics	Timeframe	Suggested Pilot Region
Knowledge Creation	<ul style="list-style-type: none"> ▪ Host international academic conferences in areas of strength (e.g. diabetes, infectious disease) ▪ Create local, national, and international research partnerships in priority areas for Mexico 	<ul style="list-style-type: none"> ▪ 1-2 years ▪ 1-2 years 	<ul style="list-style-type: none"> ▪ Mexico City ▪ All regions
Technology Transfer	<ul style="list-style-type: none"> ▪ Academic-industry forums to showcase new academic innovation and to assess local industry needs ▪ Tap into local capital groups (not necessarily in life sciences sector) who may be attracted to supporting projects 	<ul style="list-style-type: none"> ▪ 1-2 years ▪ 2-4 years 	<ul style="list-style-type: none"> ▪ Guadalajara ▪ Monterrey
Commercialization	<ul style="list-style-type: none"> ▪ Create programs that link industry leaders to mentor small business ▪ Host and attend partnering conferences to link local companies with commercial and capital partners in other regions and countries. 	<ul style="list-style-type: none"> ▪ 3-5 years ▪ 3-5 years 	<ul style="list-style-type: none"> ▪ Mexico City ▪ To be determined
Industrialization	<ul style="list-style-type: none"> ▪ Create a regional model for networking that can be replicated in other regions and can also be used to form linkages among various regions in Mexico ▪ Host forums that provide communication to the media and the public to educate them on the benefits of life sciences innovation, and to showcase local successes ▪ Seek participation from other regions to establish partnerships with multinational groups or international regions 	<ul style="list-style-type: none"> ▪ 1-2 years ▪ 1-2 years ▪ 1-2 years 	<ul style="list-style-type: none"> ▪ Guadalajara ▪ Monterrey ▪ Mexico City

National Policy

Recommendation #2: Align federal funding for life science research with the health challenges faced by the Mexican population. Prioritize key areas of medical need for greater research expenditure.

A plan outlining the priorities for life sciences investment should be identified and adopted at the federal policy level. This plan must include participation of all stakeholder groups (government departments and institutions, academia, industry, labor, not-for-profit organizations). There has been general agreement on many priority issues in Mexico, however there needs to be consensus on a plan in order to guide resource allocations over the next 10 years. Areas of greatest medical need in Mexico (e.g. diabetes, obesity) should be prioritized. The overall investment in R&D must also be increase to a percent of GDP that is better aligned with other OECD countries.

Implementation

Challenge Area	Recommended Tactics	Timeframe	Suggested Champion
Knowledge Creation	<ul style="list-style-type: none"> ▪ Increase federal and state government investment in basic research projects, training of research personnel, research facilities & infrastructure, public research organizations, etc. ▪ Encourage participation and investment from private sector into basic research activities 	<ul style="list-style-type: none"> ▪ 2-4 years ▪ 3-5 years 	<ul style="list-style-type: none"> ▪ Federal and state governments ▪ Private sector
Technology Transfer	<ul style="list-style-type: none"> ▪ Increase federal and state government investment in technology transfer programs, academic-industry linkage programs, student-industry internship training programs, research parks, commercial innovation centers, etc. ▪ Encourage participation and investment from private sector into the above programs 	<ul style="list-style-type: none"> ▪ 1-2 years ▪ 2-4 years 	<ul style="list-style-type: none"> ▪ Federal and state governments ▪ Private sector
Commercialization	<ul style="list-style-type: none"> ▪ Provide public support for companies investing in R&D (e.g. continue to provide federal tax credits for R&D, provide support programs to facilitate international trade, provide programs for low interest loan guarantees for company expansion projects that support innovation) 	<ul style="list-style-type: none"> ▪ 3-5 years 	<ul style="list-style-type: none"> ▪ Federal government
Industrialization	<ul style="list-style-type: none"> ▪ Expand R&D investments to leverage economies in different parts of the country and to tap into a deeper pool of resources and knowledge 	<ul style="list-style-type: none"> ▪ 3-5 years 	<ul style="list-style-type: none"> ▪ All stakeholders

Recommendation #3: Establish a policy framework and process that increases the commercialization of academic research and the transfer of technologies to the private sector

Building on its present efforts to promote technology development, the Mexican federal government should develop a coordinated policy framework for technology transfer and commercialization. This policy should establish a basis upon which both public and private research institutions develop policies for moving innovation to the commercial sphere through licensing, new venture creation, and joint-ventures. This policy should encourage research institutions and private sector companies to collaborate with each other to advance innovative discoveries. Metrics should be established to monitor the activity among academic and industry partners to ensure increased commercial outcomes from investments in academic research.

Implementation

Challenge Area	Recommended Tactics	Timeframe	Suggested Champion
Knowledge Creation	<ul style="list-style-type: none"> ▪ Recognize and reward researchers who achieve commercial based metrics such as patents, industry grants, spin-off companies, etc. in addition to scientific metrics ▪ Amend the evaluation criteria for researchers at both at the national (National System of Researchers) and institutional level to include commercial metrics 	<ul style="list-style-type: none"> ▪ 1-2 years ▪ 1-2 years 	<ul style="list-style-type: none"> ▪ All stakeholders ▪ Academia
Technology Transfer	<ul style="list-style-type: none"> ▪ Educate universities and research centers on the value of research and technology and help them to understand how to capitalize on it ▪ Review and amend internal regulations at universities and research centers to enable technology transfer to commercial partners ▪ Invest in training and recruiting technology transfer personnel at universities and research centers 	<ul style="list-style-type: none"> ▪ 1-2 years ▪ 1-2 years ▪ 2-4 years 	<ul style="list-style-type: none"> ▪ Governments and academia ▪ Academia ▪ Academia and governments
Commercialization	<ul style="list-style-type: none"> ▪ Establish a fund that SMEs can source to obtain technical assistance from universities 	<ul style="list-style-type: none"> ▪ 3-5 years 	<ul style="list-style-type: none"> ▪ Federal and state governments
Industrialization	<ul style="list-style-type: none"> ▪ Create a forum that will stimulate and enable collaboration and partnerships among multiple academic institutions and industry consortia 	<ul style="list-style-type: none"> ▪ 1-2 years 	<ul style="list-style-type: none"> ▪ State governments and academia

Recommendation #4: Establish national policies and regulations to accelerate innovation that are aligned with best-in-class international policies.

There is significant demand for new innovative health products, however they are not always funded by the national social security programs and are limited to a small percentage of private payers. In order to ensure the successful development of innovative health products, they will also need to be funded through the federal social security programs. Standards of care in federal health programs should include new and innovative products to the extent that medical and economic benefits have been proven beyond available generics. Other innovative technologies for agricultural and environment issues also need to be supported by federal policies in order to succeed in the Mexican marketplace.

Policies on intellectual property and regulatory approval are essential to enable competitive growth and foreign investment. Therefore is critical that these policies be enforced.

Implementation

Challenge Area	Recommended Tactics	Timeframe	Suggested Champion
Knowledge Creation	<ul style="list-style-type: none"> Link investment in R&D directly to regional health issues or other innovation priorities supported by the federal government 	<ul style="list-style-type: none"> 1-2 years 	<ul style="list-style-type: none"> Federal government
Technology Transfer	<ul style="list-style-type: none"> Reform the regulatory approval process to ensure that delays are minimized and that priority products are brought to market efficiently 	<ul style="list-style-type: none"> 2-4 years 	<ul style="list-style-type: none"> Federal government
Commercialization	<ul style="list-style-type: none"> Improve IP protection by establishing stronger deterrents for patent infringement 	<ul style="list-style-type: none"> 2-4 years 	<ul style="list-style-type: none"> Federal government
Industrialization	<ul style="list-style-type: none"> Increase awareness in the general population about the importance of R&D and how it directly benefits them 	<ul style="list-style-type: none"> 2-4 years 	<ul style="list-style-type: none"> Federal government
	<ul style="list-style-type: none"> Publish the priority medical areas on which Mexico is focusing, market success stories of advancements and monitor improvements 	<ul style="list-style-type: none"> 3-5 years 	<ul style="list-style-type: none"> Federal government

Cross-border Partnerships

Recommendation #5: Build strategic cross-border partnerships to develop and deploy products and services that improve health care outcomes.

International partnerships, initially focused on the United States, should be expanded to address priority medical areas of concern for both countries (e.g. diabetes, cancer, infectious disease). These partnerships should build on areas of strengths of all partners and should focus on addressing the needs of both countries. In addition to research partnerships, consider strengthening training efforts for key occupations like nursing and pharmacy.

Implementation

Challenge Area	Recommended Tactics	Timeframe	Suggested Champion
Knowledge Creation	<ul style="list-style-type: none"> ▪ Develop and invest in three priority projects (that are translational and applied) for collaboration with US institutions. Do not spread resources thinly over multiple opportunities but select priority areas for strategic investment. Institutions on both the Mexican and US side should compete for these projects to ensure the best partnerships move forward. 	<ul style="list-style-type: none"> ▪ 1-2 years 	<ul style="list-style-type: none"> ▪ US and Mexican federal governments
Technology Transfer	<ul style="list-style-type: none"> ▪ Formalize more research arrangements between US and Mexican institutions (primarily regarding IP and technology transfer) and establish a framework that will allow institutions to work together and limit additional bureaucracy 	<ul style="list-style-type: none"> ▪ 2-4 years 	<ul style="list-style-type: none"> ▪ US and Mexican academic institutions
Commercialization	<ul style="list-style-type: none"> ▪ Identify mutually beneficial proof-of-concept / design / manufacturing / logistics pathways for US and Mexican private sector and industry 	<ul style="list-style-type: none"> ▪ 3-5 years 	<ul style="list-style-type: none"> ▪ US and Mexican companies
Industrialization	<ul style="list-style-type: none"> ▪ Based on national policy and regional capacity, resolve the key barriers to capital investment, ownership, and cross-border markets ▪ Develop a low-cost, highly accessible cross-border broadband infrastructure to support collaboration in life sciences and other industries 	<ul style="list-style-type: none"> ▪ 3-5 years 	<ul style="list-style-type: none"> ▪ US and Mexican federal governments

CALL TO ACTION

The analysis undertaken through this initiative unambiguously shows that Mexico has the assets and institutions necessary to develop and implement a vibrant national life sciences sector strategy. The top level talent, research institutions, financial capital, government policy tools and private sector interest exist. The country is on the right track. However, Mexican life science assets have not been organized nor integrated in a way that optimizes the national capacity for development. For the full potential of Mexican life sciences to be realized, leaders from the academic, business, and public sectors must come together in a coordinated effort to create a system that will support innovation and commercialization.

This initiative is a call to action to those leaders.

The report lays out a roadmap of policy and process recommendations that we believe will foster a fertile environment for life sciences innovation within Mexico. It suggests that partnerships at the regional, national, and cross-border levels will be critical in improving both the health and wealth of the Mexican people. We believe that building strong ties across the US and Mexican sector will help both countries.

Implementing these recommendations and realizing the vision outlined in this report may be difficult, but with the appropriate leadership commitment and coordination, we are confident it can be accomplished.

Suggested Projects for Short Term Implementation

To build on the momentum generated from this report, some projects that lend themselves to short-term implementation and impact have been selected from the list of recommendations. They are highlighted below.

- ***Initiate the development of a National Life Sciences Agenda:*** The federal government should guide the development of a national strategy with significant input from state governments, academic institutions and most importantly the private sector. As an initial priority study for 2006, the private sector should be consulted to gain a better understand as to why there is not greater investment and participation in research. The study should address why there is a culture of risk aversion in regards to investing in new technologies, and how this culture can be altered to encourage risk investment and entrepreneurial activity.
- ***Identify priority areas for cross-border partnership:*** In consultation with prospective partner institutions from the US and Mexico, define three priority medical areas for investment that have implications for both countries. This process should be driven by the appropriate federal government departments (or programs) from each country. Applicants (comprised of a consortium of partners from both countries) should propose specific projects in these priority areas. The proposals should outline the specific needs and research objectives, and propose a budget to finance a large-scale initiative over the course of 3-4 years. Proposals should also identify expected discoveries or innovations and how they will create commercial opportunities and societal benefits for communities on both sides of the border. This process should bring leaders from government, academia, industry and not-for-profit organizations together at an annual cross-border life science and health care summit to continually reassess priorities and to monitor the progress of funded projects.

- **Host academic / industry forums in priority disease and technology areas:** On important disease and technology areas, Mexico should host forums designed to bring together the academic and business leaders addressing them. These forums should focus on a specific shared priority area for Mexico and the US and they should include participation from academic and industry partners from both countries. An explicit goal of these forums should be to foster stronger relationships between business and academic participants.
- **Revise national researcher assessment process to include innovation metrics:** The National System of Investigators assessment process should be revised to incorporate commercial innovation in the evaluation of researchers. Researchers should be rewarded for patenting novel discoveries and developing innovative technologies with commercial applications along with their success in peer-reviewed publishing. Mexican universities and partners should inaugurate an annual awards ceremony to recognize researchers whose efforts have led to commercial applications as a way to offer additional recognition and to attract greater private sector involvement in the university-based innovation endeavor.
- **Build an online “Community of Innovation” to track assets and resources in each region:** An online inventory of researchers, infrastructure, projects, and new technologies should be established for each region. This database should be publicly accessible and will require ongoing monitoring and updates. This resource will require participation from federal government departments and agencies (to source up to date information on grant funding, patents, etc.) as well as the regional organizations (to provide up to date information on research projects, collaborations, and spin-off companies in the region). The database will allow local and external partners to quickly identify opportunities for collaboration with local companies and institutions.

APPENDIX I

Initiative Steering Committee Members

Co-Chairs

Manuel Ruiz de Chavez
President
Fundacion Mexicana para la Salud

Grey Warner
Senior Vice President
Latin America Human Health
Merck & Co., Inc.

Participants

Jorge Amigo
Director
Mexican Institute of Industrial
Property

Martin Hernandez
Director
Health Sciences Division
Monterrey Institute of Technology

Hugo Barrera
Professor of Biochemistry
Autonomous University of Nuevo
Leon

Gerardo Jimenez Sanchez
Executive Director
Mexican National Institute of
Genomic Medicine

Michael Bowman
Chairman and President
Delaware Technology Park

Felicia Knaul
Principal Economist
Fundacion Mexicana para la Salud

Molly Broad
President
University of North Carolina

Tom Kowalski
President
Texas HealthCare and Biosciences
Institute

Debroah Clayton
Commissioner of Commercialization
and Innovation
State of Kentucky

Alan Larson
Distinguished Fellow
Council on Competitiveness

France A. Cordova
Chancellor
University of California, Riverside

Daniel Lederman
Senior Economist, Latin America
The World Bank

Patricia Faci Villalobos
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Canifarma

Marco Antonio Meraz
Director for Basic Science
CONACyT

Roberto Newell Garcia
Executive Director
Mexican Institute for
Competitiveness

Deborah Wince-Smith
President
Council on Competitiveness

Joe Panetta
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BIOCOMM San Diego

Bruce Wright
Executive Director
University of Arizona Research Park

Jaime Parada
CEO
Grupo Innovacion S.A.

Julie Meier Wright
President
San Diego Regional Economic
Development Corp.

Jose Luis Roman
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MSD Mexico

Mark Wrighton
Chancellor
Washington University in St. Louis

Pablo Rudomin
Board Member
US-Mexico Foundation for Science

Jesus Zacarias Villareal
President
Council on Specialized Medical
Devices of Nuevo Leon

Emilio Sacristan Rock
General Director
Innovamedica

Antonio Rene Zarate Negron
Director General
Monterrey International City of
Knowledge (Industrial Park)

John Stobo
President
University of Texas Medical Branch-
Galveston

APPENDIX II

List of Interviewees

Name	Title	Organization
Alarcón, Gustavo	Technical Secretary	Secretaria de Desarrollo Económico, Estado de Nuevo León
Alfanzo, Bruno	Research Director of Pharmacology and Pathology	Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV)
Alvarez, Mario Moises	Director, Biotechnology Center	Tecnológico de Monterrey (ITESM)
Alvarez Ochoa, Victor Guillermo	Plant Manager	Representaciones e Investigaciones Médicas S.A. de C.V. (RIMSA)
Angel Machuco, Miguel	General Director of Modernization	Government of Morelos
Arias, Carlos	Director	Biotechnology Institute, Universidad Autonoma de Mexico (UNAM)
Armendáriz Borunda, Juan	Director, Medical Molecular Biology Insititute	Universidad de Guadalajara
Azpiri Lopez, Jorge	Director	Christus Muguerza Hospital
Barcena Mastretta, Federico	Deputy Director General of Strategic Planning	NADRO S.A. de C.V.
Barrera, Hugo	Professor of Biochemistry	Autonomous University of Nuevo Leon (UANL)
Bolivar, Francisco	Coordinator of Biotechnology Committee, Senior Researcher	Biotechnology Institute, Universidad Autonoma de Mexico (UNAM)
Bowman, Michael	President	Delaware Technology Park
Broad, Molly	President	University of North Carolina
Camacho, Carlos	Director General	AgroBio Mexico, S.A
Canales Clariond, Gregorio	General Director of Foreign Investment	Ministry of the Economy
Cantú Segovia, Eloy	Secretary of Economic Development	Department of Economic Development, Government of the State of Nuevo Leon
Carreon Zepeda, Jaime	Group Vice President of Operations and Research	Laboratorios Columbia, S.A. de C.V

Name	Title	Organization
Carvajal; Raul	Coordinator of the Technology and Entrepreneurial Assistance Program	The US-Mexico Foundation for Science (FUMEC)
Cebreros, Alfonso	Director of Governmental Relations	Grupo Maseca
Contreras, Rosalinda	General Director	Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV)
Cruz Limón, Carlos	Rector	Tecnológico de Monterrey (ITESM)
Cuevas, Gregorio	Executive Director	Biocluster del Occidente
de Hoyos Koloffon, Gilberto	Partner	Torres & de Hoyos Koloffon (Abogados)
Dieck Assad, Ernesto	Director	Hospital San Jose
Diez Morodo, Valentin	Chairman	Mexican Institute for Competitiveness (IMCO)
Faci Villalobos, Patricia	President	CANIFARMA
Garcia Garibay, Mariano	Former Head of Biotechnology Department; Representative	Universidad Autónoma Metropolitana (UAM); Biotechnology and Bioengineering Mexican Society
Garcia Luna, Eduardo	Dean, Health Science Division	Universidad de Monterrey
Garcia, Richard	Assistant Vice President for South Texas Programs	University of Texas Health Sciences Center at San Antonio (UTHSCSA)
Goldsmith, Randy	President and CEO	San Antonio Technology Accelerator Initiative Network
Gonzales, Gerardo	Vicedean for Research, University Hospital	Autonomous University of Nuevo Leon (UANL)
Gonzales, Carlos	Development Manager	Boehringer Ingelheim Vetmedica, S.A. de C. V.
Gonzales, Jose Antonio	Rector	Autonomous University of Nuevo Leon (UANL)
Gschaedler, Anne	Researcher	Center for Research and Support for Technology and Design in the State of Jalisco (CIATEJ)
Gutierrez, Antonia	Researcher	Center for Research and Support for Technology and Design in the State of Jalisco (CIATEJ)
Hepner, Adrian	Director of Clinical Research, Latin America	IVAX Pharmaceuticals Mexico S.A. de C.V.
Hernandez, Martin	Dean of Medical School	Autonomous University of Nuevo Leon (UANL)

Name	Title	Organization
Herrera Montalvo, Luis Alonso	Director of Basic Research, Institute of Cancer Research	Institutos Nacionales de Salud (INSALUD)
Higuera, Inocencio	Deputy Director General	Consejo Nacional de Ciencia y Tecnología (CONACYT)
Knaul, Felicia	Principal Economist	Fundación Mexicana Para la Salud (FUNSALUD)
Kowalski, Thomas	President	Texas Healthcare and Bioscience Institute
Levinson, Daniel	Assistant Director	OCA Hospital
Lozano, Raul	Plant Manager	GE Medical Systems
Manzo Fontes, Arturo	Director of Biotechnology R&D	Grupo Ifaco
Manzo, Carlos	Director	Cryopharma
Martinez, Daniel	Research Director of Physiology and Neuroscience	Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV)
McKinley, Robert	Assistant Vice President, Institute for Economic Development	University of Texas at San Antonio (UTSA)
Medina, Veronica	Coordinator of Basic Sciences and Engineering Postgraduate, Electrical Engineering Department	Universidad Autónoma Metropolitana (UAM)
Moreno, Manuel	Development Manager	Productos Farmacéuticos Collins, S.A. de C.V
Muestre de Leon, Jose	Academic Secretary	Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV)
Narro Robles, Jose	Head of Faculty of Medicine	Universidad Nacional Autónoma de México (UNAM)
Natalicio, Diana	President	University of Texas at El Paso
Navario, Fernando	Research Director of Cell Biology	Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV)
Panetta., Joseph	President	BIOCOMM San Diego
Paniagua, Jorge	Director of Research	Laboratorios Silanes, S.A. de C.V.
Perez Cuevas, Ricardo	Coordinator of Health Policy	IMSS, IMSS Foundation
Pier, Eduardo	Undersecretary of Economic Analysis Unit	SALUD

Name	Title	Organization
Pinzon, Javier	General Manager	Innovamedica, S.A. de C.V.
Possani, Lourival	Senior Researcher	Biotechnology Institute, Universidad Autónoma de México (UNAM)
Proenza, Luis	President	University of Akron
Quintero, Rodolfo	Secretary of Research and Development, Coordination of Scientific Research	Universidad Nacional Autónoma de México (UNAM)
Ramirez, Jesus	Researcher	Center for Research and Support for Technology and Design in the State of Jalisco (CIATEJ)
Ramirez, Tonatiuh	Scientific Director	PROBIOMED, S.A. de C.V.
Revah, Sergio	Senior Researcher, Department of Hydraulic Processes	Universidad Autónoma Metropolitana (UAM)
Reyes Fuentes, Alejandro	Executive Secretary	IMSS Foundation
Rivera Martinez , Francisco	Coordinator for Research and Technology Innovation	ITESO Jesuit University of Guadalajara
Rivera, Francisco	Professor	ITESO Jesuit University of Guadalajara
Roman, Jose Luis	Managing Director	MSD Mexico
Roszbach, Oscar	Medical Coordinator	Mexican Chamber of Industry (CANACINTRA)
Ruelas, Enrique	Undersecretary for Innovation and Quality	Secretary of Health of Mexico
Ruiz-de-Chavez, Manuel	President	Fundacion Mexicana para la Salud (FUNSALUD)
Saldivar Rodriguez, Donato	Dean of Medical School	Autonomous University of Nuevo Leon (UANL)
Salinas, Mario Cesar	Department Head, Immunology	Autonomous University of Nuevo Leon (UANL)
Saltiel, Jenny	Secretary of Economic Development	Ministry of Economic Development of the D.F.
Senosiain, Hector	General Director	Laboratorios Senosiain
Slate, Peter	Managing Director	AZTE (Arizona State Technology Commercialization Center)
Soberon, Xavier	Former General Director; President	UNAM Morelos Science Academy

Name	Title	Organization
Solis, Eduardo	Chief of the Office for International Trade and Investment Promotion	Ministry of Economy, National Government of Mexico
Soto Borja, Dirk Hol	Director	Grupo Pisa
Tornero, Ruben	Scientific Director	Laboratorios Sophia
Torres Dominguez, Augustin	Director of Operations	Productos Farmacéuticos Collins, S.A. de C.V
Valverde, Consuelo	Coordinator of Scientific Development and Modernization	State Government of Morelos
VanDouven, Luc	Research Director of Biotechnology and Engineering	Centro de Investigacion y de Estudios Avanzados del IPN (CINVESTAV)
Vazquez Blanco, Manuel	Managing Director	Fresenius Kabi
Vazquez, Daniel	Partnership Director	Consultores Asesores Corporativos de Occidente S.C.
Vazquez, Jorge	Dean of Research, Faculty of Chemistry	Universidad Nacional Autónoma de México (UNAM)
Velázquez, Adriana	General Manager	National Center for Technological Excellence in Health (CENETEC)
Villareal Perez, Jesus Zacarias	General Project Director	Cuidado Internacional del Conocimiento
Walshok, Mary	Associate Vice Chancellor	University of California, San Diego
Wright, Bruce	Associate Vice-President for Economic Development	University of Arizona
Wrighton, Mark	Chancellor	Washington University in St. Louis
Zapanta, Al	President	US-Mexico Chamber of Commerce

Endnotes

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