

BIOTECHNOLOGY



3
FACTS

AN ENVIRONMENTAL AND ECONOMIC FIX

Professor Maria de Rosa develops innovative fertilizer
advancements that brighten the future of agriculture

First day of
Biotech Week
celebrate
“imagenation”



Biotech crops
Producing
sustainable
success



PHOTO: DEREK HODGSON



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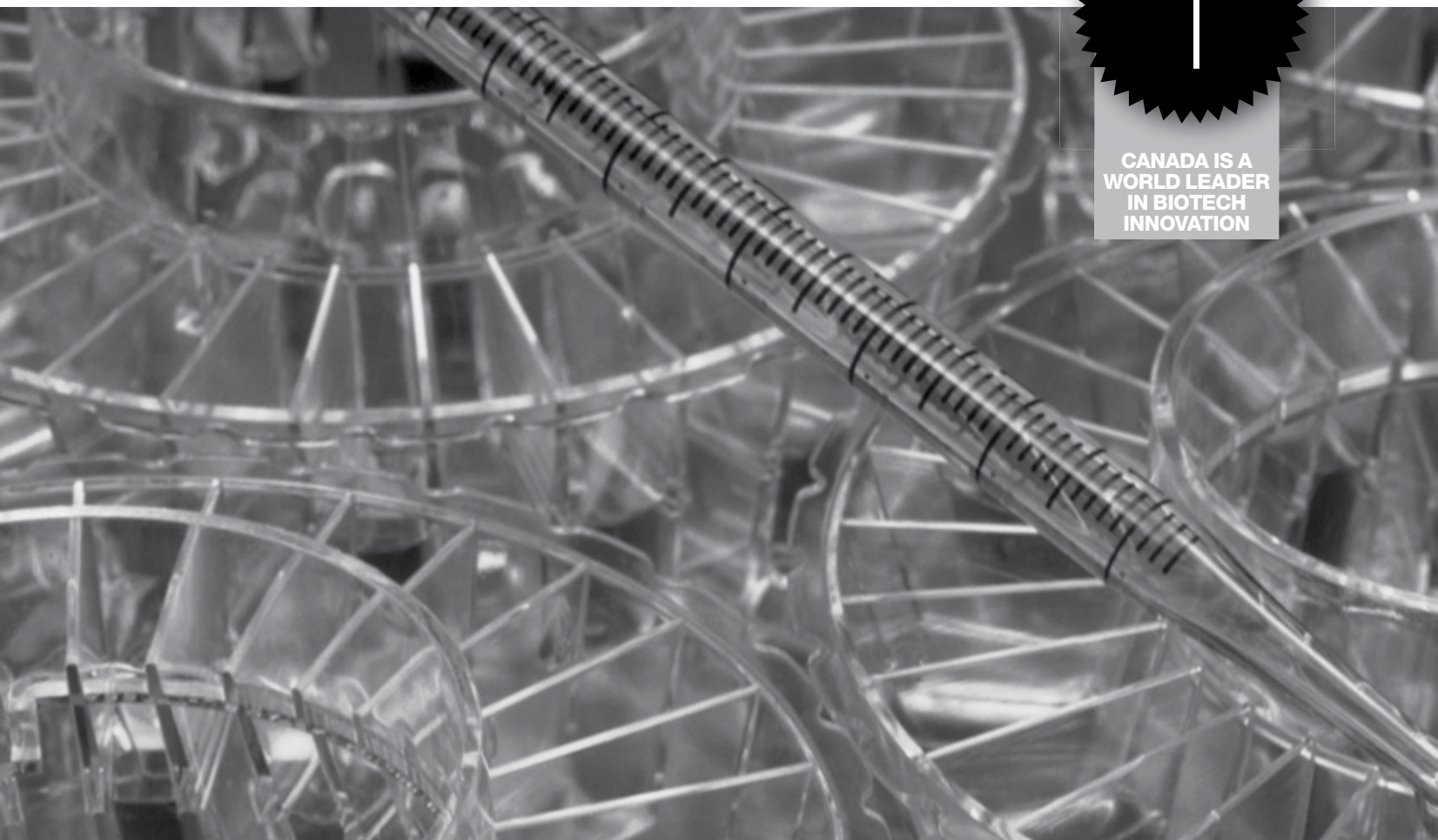
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CHALLENGES



FACT
1
CANADA IS A
WORLD LEADER
IN BIOTECH
INNOVATION

Canada-wide, **there are over 668** biotechnology companies, as well as over 400 research institutions, **leading discoveries** and bringing products into development and to market.

Biotechnology paves the way for innovation

Within the pages of national dailies, the word innovation is thrown about generously. What is innovation, why does it matter and is there a value to this ‘innovation economy’ pundits claim to be the new wave?

Innovation matters because applying changes in knowledge and applications for new technology to old industries is the currency of the twenty-first century economy. It may be about productivity, but it is equally about ecologically sound and sustainable advances. These are biotech.

National discoveries

Across the economy, biotechnology leads product and process innovation. Canada-wide, over 668 biotechnology companies, as well as over 400 research institutions, are leading discoveries and bringing products into development and to market.

While science is not often associated with business, the business of science in Canada is booming. The bio-

based economy has a \$84.7 billion dollar value-6.9 percent of the GDP-and involves 1 million Canadian jobs in the development and use of bio-based health products, agricultural technologies, fuels and new manufacturing and industrial processes. This multi-billion economic impact, together with Canada’s large natural resource supply and innovative and entrepreneurial population, has made Canada into one of the top five global biotechnology markets.

A rapidly-growing economy

By applying biological processes, traditional industries improve their practices and new products and processes emerge. A new bio-economy is rapidly growing in Canada and across the globe. We see it in materials and chemicals as bio-based materials are being converted into new building products, fine chemicals and textiles. We see it in health care where genetic research opens up new treatments, provides vaccines for new diseases and accurately diagnoses illness. We see it in energy where biofuels provide cleaner, sustainable and affordable alternatives by reusing waste or finding



Peter Brenders
President & CEO, BIOTECCanada

“Canada-wide, over 668 biotechnology companies , as well as over 400 research institutions, are leading discoveries and bringing products into development and to market.”

new energy sources. We see it in food safety and security, where biotechnology is creating advances in food sciences and animal health that improve human and animal health alike. And we’re seeing it crop production where genetic advances have helped farmers grow and sustain their crops, and harvest more from their fields using less fuel and chemicals.

As the bio-economy provides new options for Canada’s lifestyle and economy, like any disruptive technology, it involves change. What kind of innovation do we want and value? Innovation introduces change. The biotech industry believes we should explore new possibilities together.

National Biotechnology Week

We invite you to join us during our annual National Biotechnology Week, as the industry celebrates Canada’s long history of innovative business achievement. Learn more about biotechnology in all its forms by joining us in your community for events, conferences and contests...and by turning the page to hear first hand from those in the business about the technologies driving innovation today and for our future.

Biotech crops lead to economic success

When Canadian scientists pioneered the development of canola in 1974, no one could have guessed how important it would become.

The canola industry today is worth more than \$14 billion to the economy. The total value of canola seed, oil and meal exports is about \$2 billion. Depending on the year, canola is either Canada’s first or second most valuable field crop (vying for top spot with wheat).

Over 90 percent of all canola grown in Canada is herbicide tolerant (the first herbicide tolerant canola variety was developed in 1995, allowing farmers to kill weeds with herbicide, without destroying the crop). “This means that the soil has to be tilled less, reducing water loss and soil erosion. Over time this has meant reduced use of herbicides,” says CBI Canada Secretariat Janice Tranberg.

The canola industry aims to have at least 15 million acres under pro-

duction by 2015, with average yields of 40 bushels per acre. Of that production, 6.5 million tons will be for export, and 7.5 million tons for crushing, with 5 million tons going to food and 2 million for biodiesel, says the Canola Council of Canada.

Oilseeds as fuel?

There is interesting innovation going on in several fronts across the country, including work on oilseed crops to create oils that will be used in hydraulic fuels.

For example, Linnaeus Plant Science in Saskatoon is creating a genetically modified oilseeds crop that will manufacture lubricants, plastics, nylon and greases. It was reported earlier this year that the company began a pilot project with Toronto Community Housing to use vegetable-based hydraulic fluids in 200 trash compactors.

Sustainable Chemistry Alliance’s President and CEO Murray McLaughlin says sustainable chemistry is exciting because “we use different pro-

cesses that allow companies to reduce greenhouse gases, and reduce waste materials.”

“We see this as a tremendous opportunity because it relies on natural resources. It is an opportunity for us to create value and create jobs. Canada is already a world leader in ordinary oilseed agriculture,” McLaughlin said.

Genetically modified oilseed plants also have an enhanced oil output, meaning higher profits for farmers.

Managing public perceptions

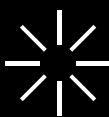
Last week, science reports trumpeted the news of genetically modified salmon which will grow twice as fast as “normal” salmon. The fish has not yet been approved for human consumption.

There was, understandably, disquiet in some quarters about the health effects of eating “tampered” fish. Such news reminds us that despite the impressive strides in biotechnology, a sometimes skittish public has

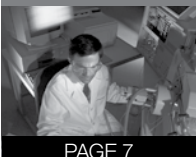
to be skilfully managed and provided with solid information.

However, the Canadian public is getting better educated and more savvy says Tranberg. Speaking from a plant science perspective, she says, “We get criticised as an industry, but we believe we can provide solutions to the world’s problems. The next big issue is really focused on water, so we are developing crops that use less water yet produce the same amount. “Many people claim these products are not safe, but a lot of money, time and research and development have gone into perfecting these varieties.”

She adds that Biotech crops are the most intensively studied by regulatory agencies around the world and so far, not a single peer-reviewed study has shown the negative effects of such crops.



WE RECOMMEND



PAGE 7

Human resources
Talented people are the cornerstone of biotech. So why is the industry experiencing such a shortage?

“Ironically, the industry’s main competitor for the brightest and the best, is the Canadian government, at the Federal and provincial levels.”

Vaccine leaders **p. 5**
Canadian firms make vaccine breakthroughs.

The bio-economy **p. 7**
Biotechnology is big business. And Canada is a frontrunner.

MEDIA PLANET

BIOTECHNOLOGY
1ST EDITION SEPTEMBER 2010

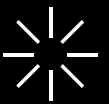
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Distributed within:
National Post, September 2010
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CANADIAN BIOTECH



■ In 2008, researchers at Toronto Mount Sinai Hospital lead an international team that discovers how to grow stem cells from an individual’s skin. This development overcomes the need to extract stem cells from embryos or women’s eggs.

■ Canada is one of more than 130 countries to sign the Cartagena Protocol on Biosafety, joining in 2001. This agreement establishes the precautionary principle as a way nations can balance the economic benefits of biotechnology with the potential risks to public health.

■ The first genetically engineered potato, resistant to the Colorado potato beetle, was sold in Canada in 1995. Canada is the first country in the world to grow commercial biotech crops, with herbicide-tolerant canola.

Source: BIOTECCanada



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INSPIRATION

GROWING

INNOVATION

FACT
2
BIOTECH
CREATES ENVI-
RONMENTAL
SOLUTIONS

Question: How is biotech causing positive change in agriculture and the environment?
Answer: New advancements in innovative fertilizer release methods are minimizing waste.

Getting to the root of the problem

In an oft-cited 1986 television interview, Prince Charles revealed, to popular derision, that he talks to his plants. Predictably, he became the butt of endless jokes in the British press. After all, everybody knew that plants are not sentient beings, so why communicate with something that could not respond?

It turns out that Prince Charles instinctively knew a thing or two about plants. Science has now shown that plants do communicate. The question is, can we understand their language? Carleton University Associate Professor Maria DeRosa says we can and we do. Equally important, this knowledge has huge financial implications for agriculture.

She cites research undertaken by project lead Carlos Monreal at Agriculture and Agri-Food Canada as proof.

“He [Monreal] was working on the current problems with fertilizers, and knew from his research that crops emit chemical signals from their roots when they need fertilizers. He understands those signals, but needed help to develop coating for the fertilizer that can recognize and respond to those signals,” she says.



Maria de Rosa
Associate professor, chemistry and biochemistry, Carleton University

“Most plants utilize less than one-half of the nitrogen applied by growers and much of the remaining nitrogen leaches into the air...”

Little advances in fertilizers
While the plant science arena has grown exponentially, there have been little corresponding advances in commercial fertilizer products since the green revolution in the 1970s.

DeRosa, whose work on fertilizer research won her one of this year’s Early Researcher Awards, by the Ontario Government, says revolutionizing fertilizers will be a big step forward for farmers and the environment. While fertilizers help farmers achieve high crop yields, they have a detrimental impact on the environment. “A large percentage of fertilizer nitrogen is wasted due to the inefficient timing of fertilizer release,” she says.

“Most plants utilize less than one-half of the nitrogen applied by growers, and much of the remaining nitrogen leaches into the air, soil and water, posing a threat to the environ-

ment,” she explains.
The economic losses to Canadian farmers alone are staggering. Estimates range from \$680 million to \$1.13 billion per year. Yet, economists have calculated that just by increasing their crops’ ability to utilize nitrogen by 20 percent, farmers worldwide can improve their economic performance by about \$4.7 billion every year.

Timing is everything
DeRosa’s laboratory is working on developing biosensors that will trigger the release of nutrients from fertilizers when it recognizes the appropriate chemical signals being emitted by the crop roots. These biosensors, called aptamers, are coated by a biodegradable polymer film which will be permeable, allowing the nutrients to pass into the plant roots. With the nutrients so protected, only the required amount will be absorbed by the plant roots, minimizing waste.

DeRosa says that if everything goes well, they will be ready to move out of the research laboratory into the greenhouse within the next five years. “And if that works well, we will be ready to take this out into the market five years after that.”

In the long term, she says, this work could provide the basis of a new paradigm for fertilizer delivery and insights provided by this project could be applied to other areas of controlled release, such as drug delivery.

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Charles Duell
United States Commissioner of Patents, 1899

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It isn’t true now.



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DIRTY WORK
Maria de Rosa is developing a fertilizer that will increase farm yields and decrease waste.
PHOTO: DEREK HODGSON



DON'T MISS

Canadian biotechnology firms leading vaccine innovation

A simple shot is all it takes to prevent disease and improve public health. With more than 25 infectious diseases preventable by vaccines—and more expected to be added in the coming decade—the importance of research in that area is top of mind in several leading Canadian biotechnology companies.

In late 2009 and early 2010, vaccines exploded into the public eye with the arrival of H1N1, a potentially fatal strain of avian influenza that sparked the first rapid mass immunization campaign in Canada. Canada's Sanofi-Pasteur, which is headquartered in France, is billed as the world's largest influenza-vaccine producer, at 170 million doses in 2008. Sanofi-Pasteur is currently licensing Fluzone High-Dose, an influenza vaccine where each dose includes an antigen to bump up the efficacy, in the United States and will "presumably" do the same in Canada in the coming months according to Rob Van Exan, Sanofi's director of immunization.

Fellow firm Novartis Canada is focusing on keeping its Agriflu vaccine preservative-free.

Novartis is pushing forward into several fronts, including a new Meningococcal B vaccine touted as a "multi-component" booster able to protect against several strains of the disease, which is deadly to infants.

Like Sanofi-Pasteur, Halifax's Immunovaccine is working on formulating influenza vaccines with antigens and dreams of at-

tacking a condition that doesn't yet have a cure. With cancer among the leading causes of death for seniors over the age of 65, Immunovaccine is targeting a vaccine that would prevent it from happening in the first place.

Meanwhile, Variation Biotechnologies is working in stealth mode in offices in Gatineau, Que. and Boston, working to make a secret formula that will make vaccines stable at room temperature—even warm temperatures—instead of having to be frozen.

Quebec City's Medicago recently got attention from the United States' DARPA (Defence Advanced Research Projects Agency) for its plan to grow H1N1 and H5N1 vaccines from tobacco leaves. The company is now raising money for a \$42-million facility in North Carolina, which will give it more access to U.S.-based grants given the American presence.

The dizzying array of new vaccines available, with innovative manufacturing processes and new conditions targeted, will make it difficult for Health Canada to keep up in the coming years, added Sanofi's Van Exan. With vaccines coming out for everything for Alzheimer's to tobacco addiction, he added, there is "a very thick pipeline hitting much broader areas than we are used to. So the question within the context of public health is: how we are going to deal with that? The last couple of years are just the tip of the iceberg."

ELIZABETH HOWELL
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break through with industry focus

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PANEL OF EXPERTS

	Andy Adler Professor, Canada research chair, P.Eng. Carleton University		Clare McCurley Associate, Deeth Williams Wall		Garold Breit Executive Director, Technology Transer Office, University of Manitoba	
Question 1: What role does Canada play in the field of Biotechnology?	Unfortunately , Canada has a small role in biotech. The strongest contribution from Canada is at a research level, where we have many top notch researchers. We also have quite a few companies, both large (primarily in pharma) and small. However, there isn't really a strong biotech cluster in Canada.		A leader , in stem cell research, cancer therapeutics and vaccines, and in biotechnological advancements in agriculture, Canada boasts many cutting edge academic research institutions and biotechnology and bio-pharmaceutical companies. Biotech clusters and innovation networks encourage collaboration among various institutions and investigators. But there is a gap in funding between the essential basic discoveries and development of a final product. Developing and commercializing a biotechnology product, including obtaining intellectual property protection, can cost \$1.5 billion. Venture capital, the primary source of funding for emerging biotechnology firms, has dropped 75 percent since 2007.		Fortunately, Canada is uniquely positioned to assume a leadership role in biotechnology. Canada provides higher education (especially post-secondary and science focused) to a larger percentage of our population, we enjoy strong Federal support for basic and applied research and we are located in a landmass that consumes more than 40% most therapeutics and diagnostics. Moreover, in the recent past, Canadians have become more aware of the urgent need to innovate and to commercialize. We have also come to understand the importance of partnering in this globalized market. Now, we work to become the "partner of choice" to innovators	
Question 2: What exciting changes do you see taking place in the near future?	The most exciting , for me, is "personalized medicine". Here we have detailed information on each patient (via DNA sequencing or via wireless monitoring equipment) that allow tailoring or care to the patient. The other one is the democratization, the way more medical information is available to patients, who, in turn, ask for more say in their care.		An increasing number of innovator patents for biologics, which include gene-based medicinal products such as vaccines, gene therapy and recombinant therapeutic proteins, are nearing expiration. So there is increased interest in developing subsequent entry biologics (SEBs) or "biosimilars" - similar although not equivalent copies of the biologics. The first SEB approved by Health Canada in April 2009 was a recombinant human-growth hormone, and in March 2010, Health Canada provided a guidance document for SEB submission requirements and the principles for SEB approval by reliance on innovator clinical data. The focus of future drug litigation in Canada will likely shift from battles over conventional pharmaceuticals to battles over biologics.		Today, the globe grapples with the need to feed a hungry world and to provide new levels of patient care to aging populations (consider, the population of Western countries above 65 years will double over the next few years). North America and, specifically, Canada has been gearing up to make significant contributions in both areas ... from the development of Canola breedstocks, the treatment of Rh(D) disease (a childhood genetic scourge from 4 decades ago) and the elucidation of SARS, Canadians have been on the forefront of the application of biotechnology to the world's problems.	
Question 3: What is the significance of biotechnology to the everyday Canadian?	Because medicine is so conservative, the impact of the technology is not yet felt, except by seeing new equipment in hospitals. I expect to see a bigger wave of changes happen. Many will take place first in poorer countries (with less medical establishment) and will be imported from there.		Biotechnology affects Canadians on a daily basis, from the foods we eat, to the household products we use and the medical treatment we receive. The Canadian bio-economy is worth an estimated \$78.3 billion (source: www.biotech.ca) and developments in biotechnology play a major role in health care, such as immuno-therapies, vaccines and drug delivery systems; cleaner industry and energy sources, such as bio-fuels and alternative solutions for oil spill cleanup; and sustainable agriculture, such as genetically modified crops with pest-resistance and increased yields.		Over the past few years, we have witnessed an intriguing paradox. Just as we have seen the emergence of new, life-threatening infectious diseases, we have also become familiar with the old nemeses that plague our aged. And, beyond the obvious humanitarian reasons to do so, we understand the financial devastation that these challenges bring. I believe that all Canadians have come to understand the importance of developing new understandings of these challenges, new modes to manage these threats (in all of our communities) and new cures to alleviate their devastating effects.	



The Advanced Foods and Materials Network (AFMNet) is Canada's national food and bio-materials research network. We bring together natural scientists, engineers, health researchers and social scientists to come up with new ideas and to develop new biology-based technologies and products that benefit Canadians.

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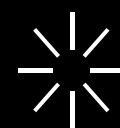
NEWS



FACT

3

CANADA COMPETES WITH THE US FOR BIOTECH TALENT



THE BIO-ECONOMY

Biotechnology is big business. International economists believe the bio-based economy is responsible for as much as one-third of the global economy.

The Organisation of Economic Development calculates that the bio economy will contribute between 10 to 14 new drugs each year over the next five years and will also be responsible for a tenth of all chemical production by 2030.

According to BioteCanada, the Canadian bio-economy is worth \$80 billion, accounting for more than 6.4 percent of the country's gross domestic product. It also supports 1 million Canadian jobs, directly and indirectly.

What is the bio-economy?

Biotechnology uses living things to create products or processes to help humans. The bio-economy harnesses processes, products and tools and applies these in fields like medical treatments, diagnostics, foods, energy, chemicals and industrial materials.

Biotechnology is revitalizing the healthcare, automotive, agriculture, forestry and manufacturing industries, providing options for more efficient, greener and cleaner products and processes. Some examples include car seat foam made from soybeans, bio-diesel, bio-pesticides made from pest-killing viruses, engine oils made from oilseed crops, trans fat-free cooking oil, renewable biomass energy sources and vaccines.

No cohesive strategy

In March, Ottawa announced that \$600 million would be spent over three years to help develop the innovation sector and attract talented people to strengthen Canada's R&D facilities. Still, Brenders is frustrated there is still no Federal biotechnology strategy.

"Other countries are building up their biotech capability [and fast]. We need to get back into the game and have a targeted approach and strategy. India and China are competing with us, so are Israel and the Nordic countries," he says.

The industry is highly entrepreneurial, but a targeted government focus could give it a major fillip, agrees Murray McLaughlin, President and CEO of the Sustainable Chemistry Alliance.

He says the lack of a biotechnology strategy manifests through piecemeal funding, lack of incentives, short term policies, and poor jobs growth potential.

"Sustainable chemistry is an opportunity for us to create value and create highly-skilled jobs in Canada," McLaughlin says. Instead, official attention seems to be focused on solar and wind power, which are easier to execute but are essentially short term solutions to our energy problem.

Protecting good ideas

A significant problem is an inefficient intellectual property regime. At the moment, a patent term is 17 years from the date it is granted. Meanwhile the costs and time needed length to bring a product to market has lengthened tremendously, says Sanofi Pasteur President Mark Lievonen.

It can take up to 10 years to commercialize a concept. Given that timeline, it leaves pioneering companies with precious little time to reap the profits of a successful idea, Lievonen says.

He hailed the modifications to section 116, which would remove double tax filing requirements and administrative delays, announced in the March Budget, as a start as Canadian biotech financing is dominated by US sources.

"We need a world class intellectual property regime and this is critical so that the industry can move forward. It really is time for government to review the legislation."

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SHOWCASE

The last two decades have seen the number of biotechnology companies in Canada increase by 77 percent. While the worldwide economic downturn that began in 2008 caused many businesses to slow, BIOTECANADA President Peter Brenders says the fastest growing sector is industrial biotechnology where biomass is used to create new fuels. "We have seen great growth especially over the last 24 months," he says.

He explains Canada's biotech innovations are also being recognised worldwide and this a reflection of the sector becoming more secure.

Yet surveys have shown that more than a third of biotechnology companies are experiencing a skills shortage, with preclinical research, marketing, sales and communications and manufacturing positions most often left unfilled.

The human resource challenge

Four in five biotechnology companies in Canada are small to medium-sized, with fewer than 50 full-time employees. Biotech companies may be involved in various stages of development of products, such as research and development, clinical/field trials and regulatory trials, production, manufacturing, commer-

cialization and marketing. Almost half the companies are in the bioscience/life science sector.

The median cost of training a staff member is about \$5,000, a not insignificant figure for a small operation. Companies with six to 20 fulltime staff were most likely to suffer the shortage of skilled/experienced workers.

In a recent BioTalent Canada survey, Splicing the Data, biotech companies nominated their top three human resources challenges as: a lack of required skill sets and experience (55.6 percent), insufficient capital and resources to hire the appropriate candidates (34.1 percent) and competition for qualified candidates (32.8 percent).

Broadening the biotechnology workforce

Ironically, the industry's main competitor for the brightest and the best, is the Canadian government, at the Federal and provincial levels, says BioTalent Canada's executive director, Colette Rivet. The next major competitor for talent is the US.

Brian Bloom, president and head of institutional sales at investment bank Bloom Burton agrees that there has been a lot of commentary about the management expertise, or lack thereof, in the Canadian biotech industry. He is optimistic about pros-

pects, though. "This situation will improve in time. We have had entrepreneurs and skilled professionals go to the US, but many of them come back too."

However, the trend towards virtual offices could also be a life saver for the biotech industry. Bloom said business models are always changing, and the single overarching trend has been the move towards virtual offices.

"There are so many consultants servicing the sector, and the truth is, you don't have to have everybody in-house. There are entire firms specialising in chemistry, or manufacturing. This has been a trend that has been going on for the past 10 years," Bloom adds.

Many Canadian companies are also taking the "virtual" scenario a step further: a recent article in Scientific American highlighted Canada's skill in forging collaborative partnerships with scientists and firms and in developing countries. Most of these ventures involve businesses and scientists in India, China and Latin America.

According to a Conference Board study published in January this year, Canada scored an overall 'C', and was ranked 10th out of 17 OECD countries because only 22 percent of the country's university graduates in 2006 were from science, math,

computer science, or engineering disciplines. The figure was 31 percent for Austria.

Those figures are sobering and they do have implications for companies trying to hire, but the students have to be encouraged while they are at school. Apart from trying to drum up interest in schools through school visits, BioTalent Canada has also identified several groups of potential employees for the biotech industry including women, Aboriginal peoples, US-trained professionals and internationally-trained professionals.

"We are working to increase awareness of science among Aboriginal peoples. At the moment, they are not taught science on the reserves. They're an important group as the Aboriginal people are the youngest and fastest growing group in Canada," Rivet adds.

A third of biotech companies surveyed also do not have standard human resource procedures, so "we have developed protocols on how to hire people, train them and equally important, retain them. Our focus is to try and make the process as simple as possible for companies."

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Biotech week celebrates Canada's bio-economy

Now in its seventh year, National Biotechnology Week is a celebration of the "imagenation" of Canada's biotechnology scientists, researchers and entrepreneurs.

This year, National Biotechnology Week runs from the 17th to the 24th of September and is filled with exciting events, lectures, facility tours and hands-on science experiments happening on a daily basis across the entire country. The week, produced in coordination with BIOTECANADA and its national organization partners include events for everyone. Popular events include student competitions, facility and company tours, meet the experts and leader events and provincial government recognition of the week. To find out more about what is happening in your area, visit www.imagenation.ca

Why biotechnology matters

When it comes to biotechnology, Ca-

nadians have much to celebrate. With over 668 firms and an employment network of over 1 million people, Canada's bio-economy contributes over \$84.7 billion or 6.5 percent of our GDP. To put this into perspective, biotechnology contributes as much to our economy as the oil and gas industry does.

The term bio-economy refers to the application of biotechnology processes, products and tools to create new methods of manufacturing and developing consumer products and services. The three primary components of Canada's bio-based economy are health, industrial processes and agriculture. Few people

understand just how often they interact with bio-related technology. From a car seat made from soybean foam to the therapies for Alzheimer's and cancer, biotechnology touches every aspect of our daily life.

It is important that Canadians be reminded of our important place in the history of biotechnology. It was in Toronto, in 1922, that Dr. Frederick Banting and his assistant Charles Best discovered insulin as a treatment for diabetes. In 1974, Canadian scientists Baldur Stefansson and Keith Downey developed an early form of canola, the world's first biotech crop. More recently, it was at Winnipeg's National Microbiology

Laboratory where the first genetic sequencing of the H1N1 flu virus was completed.

From coast to coast, Canada has a strong network of companies and individuals working to make sure we stay among the world's best in biotechnology. National Biotechnology Week is an important part of making sure we take the time to celebrate everything we have achieved in the past and everything we will achieve in the future.

Courtesy of
National Biotechnology Week



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