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NRC NEWSLINK

ISSN 1913-1607 SCIENCE AT WORK FOR CANADA SPRING 2007

Biosciences — PEI's "oil sands"

On Friday February 16, 2007 Premier Pat Binns heralded the opening of NRC's $13.5 million state-of-the-art biosciences facility as a doorway to great economic fortune for Prince Edward Island (PEI).

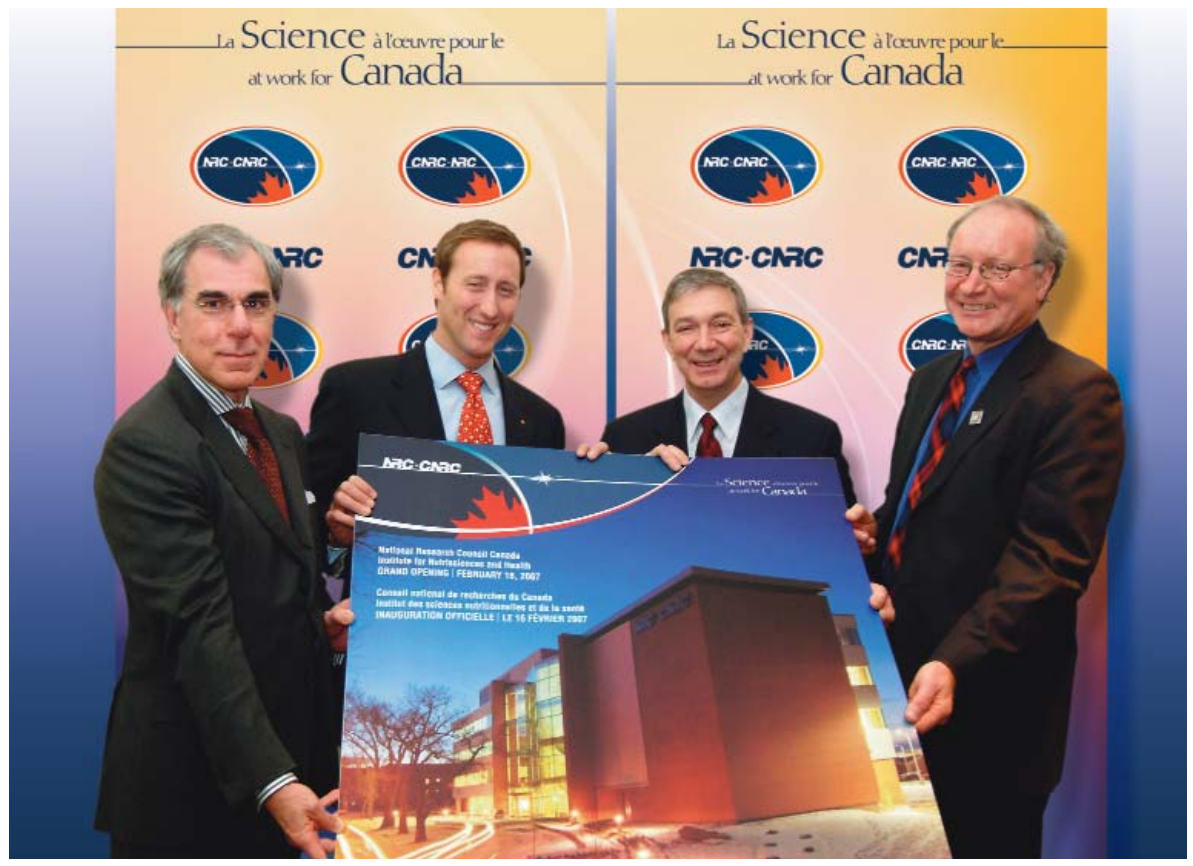
"I'm counting on this being our oil sands," Binns said, referring to Alberta's money machine. "This is our way to prosperity."

The Premier highlighted the economic significance of the growing PEI biosciences cluster which now has the NRC Institute for Nutrisciences and Health as its hub on the campus of the University of PEI (UPEI). "For years, we've wanted to develop a bioscience industry in the province and commercialize products to sell in higher value markets," he added.

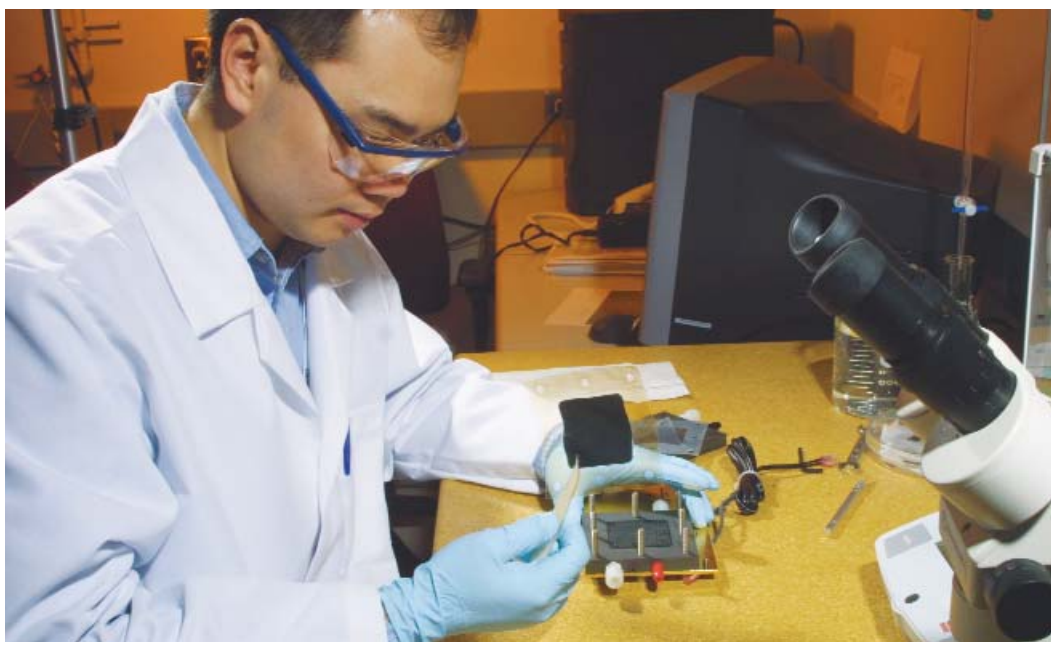
NRC unlocking Nature's potential to prevent disease

Long in the business of health-related R&D, NRC in PEI is now exploring the potential of compounds found in nature to prevent and treat disease. Top scientists at the new NRC facility are looking to compounds found in renewable resources for answers to Alzheimer's, Multiple Sclerosis, cardiovascular disease and other devastating and costly conditions.

Continued on page 2



Several dignitaries celebrated the February 16 opening of the NRC Institute for Nutrisciences and Health in Charlottetown. From left to right: NRC President Dr. Pierre Coulombe; the Honourable Peter MacKay, Minister of Foreign Affairs and Minister of the Atlantic Canada Opportunities Agency; the Honourable Pat Binns, Premier of PEI; and UPEI President, Dr. Wade MacLauchlan.



Dr. Titichai Navessin is assembling a fuel cell to assess a novel Membrane Electrode Assembly (MEA). The MEA – the "heart" of the fuel cell – is where fuel is converted to electricity.

Vancouver — Canada's gateway to green energy

Widespread adoption of hydrogen and fuel cell technology could dramatically reduce our dependence on non-renewable hydrocarbon fuels, slash greenhouse gas emissions and improve urban air quality. NRC has set its sights on finding just such "green" solutions through the new Hydrogen and Fuel Cell Gateway at the NRC Institute for Fuel Cell Innovation in Vancouver. Set to open this May, NRC partnered with Natural Resources Canada, Industry Canada, the Government of British Columbia and Hydrogen and Fuel Cells Canada to bring this technology demonstration centre on line for Canadian industry.

The Gateway will be launched during the Hydrogen & Fuel Cells 2007 International Conference and Trade Show, April 29 to May 2.

Conference participants visiting the Gateway will see state-of-the-art hydrogen and fuel cell products and technologies in action. The Gateway will feature the latest scientific breakthroughs, commercialization opportunities and research and development initiatives from prominent hydrogen and fuel cell experts from around the world.

As Chris Curtis, Vice-President of Hydrogen & Fuel Cells Canada, points out: "Raising awareness of hydrogen and fuel cell technologies is crucial for their development and commercialization. The Hydrogen and Fuel Cell Gateway will illustrate the benefits of hydrogen and fuel cells — reducing the impacts of climate change, addressing air pollution, providing secure and reliable energy, and encouraging innovation-based job growth."

Bringing fuel cells into the mainstream

With global energy consumption forecasted to rise 60 percent by 2020, the time is right for NRC's approach to partnerships in developing clean, sustainable energy alternatives.

NRC began bringing the elements together in 1998 when it organized a task force to help make fuel cells and hydrogen technologies a mainstream solution. By 2003-2004 NRC had managed to secure $215 million to establish a hydrogen and fuel cell technologies cluster in Vancouver.

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President's outlook

Dr. Pierre Coulombe
National Research Council Canada

National R&D programs: the way of the future

We are all aware that science and technology can shape our collective ability to address global challenges and the competitiveness of industries and nations.

Throughout history, waves of innovation — many based on S&T developments — have significantly altered the global social and economic order.

These waves never act in isolation. Because disciplines are converging, we have now entered the realm of multidisciplinary science and horizontal initiatives. This isn't just the Canadian way. It is a paradigm shift being felt around the world.

It is widely believed that because of the convergence of science and technology, the early decades of the 21st century will see vast improvements in human abilities, societal outcomes, productivity and quality of life.

Industry and universities see NRC as the best suited national organization to lead a national program in bioproducts research.

With limited resources, we need to maximize our impact. It is not surprising then that multidisciplinary and horizontal research programs are becoming the way of the future. Networked collaboration — both across Canada and globally — is common in most fields of research.

In recent years, NRC has contributed substantially to the development of Canadian technologies and their commercialization on a global scale.

NRC can point to an impressive record of leading-edge discoveries — from the first pacemaker in the 1950s to recent breakthroughs in vaccines for meningitis, cancer therapies and research that could change the management of heart arrhythmias.

NRC is proud of its achievements, but it is also looking to the future.

One of NRC's goals is to make a significant contribution to Canada's priorities for this century – specifically, on health and wellness, sustainable energy and the environment.

To do so, NRC has developed a new strategy to drive its efforts to deliver even greater value from here to 2011. More than a year in the making, it is based on in-depth analyses and extensive consultations with stakeholders and decision makers in government, the academic community and the business sector.

The strategy, "Science at Work for Canada," has three main goals:

- contribute to the competitiveness of Canadian industry in key sectors and to the economic viability of communities;
- strengthen Canada's innovation system;
- make significant contributions to national priority areas critical to Canada's future.

The strategy identifies seven R&D priority areas under three sectors:

- health and wellness: chronic diseases, agri-food, and water;
- sustainable energy: hydrogen and biofuels;
- protection of our environment: development of environmental technologies and bioproducts.

To help us meet our goals in these key sectors, we will launch national programs where NRC can use its research excellence, partnerships and multidisciplinary approach to build the critical mass needed to generate tangible results for Canadians.

Our first national program will focus on bioproducts. And, in the spirit of this new model for doing business at NRC, we are seeking the support of other federal partners to co-lead this initiative.

Industry and universities, after major consultations with government, felt that NRC was the best suited national organization to lead in this key area of development. NRC is already heavily involved in bioproducts research. In fact, we are already making important strides in industrial oils, enzymes, bio-polymer foams, energy from waste materials, and other areas.

Together, by centring our efforts on this broad field, we will increase Canada's potential to develop applications leading toward sustainable energy and a healthier environment.

At NRC, we see national programs as an excellent means of meeting the needs of Canadians while helping Canadian industry compete more effectively on the world stage. ■

Biosciences — PEI's "oil sands"

Continued from page 1

Six researchers at the new facility, with a seventh arriving in June, are focusing on three research streams — neurological conditions, obesity-related disorders, and infection and immunity. At the NRC site, NRC scientists are joined by colleagues from Agriculture and Agri-food Canada and UPEI. The three organizations have taken a bold step beyond traditional bureaucratic boundaries to create a research "dream team" that can apply their expertise to every point in the bioactives research continuum. Some of them concentrate on the discovery side — *Which plants or marine-based resources contain beneficial compounds?* — while others take what appears to be an effective compound and test it to determine how it acts and why. Still others are involved in the later stages where the most promising compounds have been identified and screened and are ready for pre-clinical testing.

PEI — a "natural" location for NRC

Prince Edward Island was a natural choice for the new NRC research facility. In addition to the province's considerable plant- and marine-based resources, PEI has considerable R&D expertise in veterinary and human medicine, agriculture, fisheries, food quality and safety. On PEI, bioscience is not viewed as a replacement for, but rather, a way to enhance the province's primary industries of farming, fishing and forestry.

Local government and academic research organizations as well as private sector companies are working together as the PEI BioAlliance to promote the growing cluster and attract new business.

Good science, good health, good business

NRC contributes by finding firms to commercialize its discoveries and helping companies transform their own ideas into marketable goods. In Charlottetown, NRC has allocated considerable lab space for scientists from nutrisciences-related companies, giving them access to top-notch R&D expertise and cutting-edge equipment. The opportunity to work closely with NRC can make all the difference in a company's chances of commercializing a new product.

The private sector incubator space at the new facility is already nearing capacity with clients such as Chemaphor Inc., Novartis and the recently opened Atlantic Centre for Bioproducts Valuation.

Making it to market

The PEI BioAlliance has set its sights on a global nutrition market valued at more than US$182 billion, according to the Nutrition Business Journal. In advanced economies, the nutrition market is growing at more than 8 percent annually, while in emerging economies, the annual rate of growth exceeds 12 percent.

Despite the encouraging market, discovering and commercializing bioactives is no easy job.

"In the biopharmaceutical world, only one out of 10,000 new chemical compounds or drugs discovered in the science phase ever reaches the market," says Tony Lucas, a PEI-based bioscience business consultant, "and less than one in ten biotech startups with a bright idea ever becomes a viable company."

NRC is determined to change that fact. The more linkages, resources and innovation support NRC and its BioAlliance partners can offer, the better a firm's chances for success.

Where will it go from here?

The PEI cluster can already boast some impressive job and revenue figures. Today, 650 people are employed in the sector – 400 with 20 private sector companies, and 250 with 10 public sector organizations. In 2005, the PEI bioresources cluster generated $61 million in private sector revenues.

Bioresources are renewable, naturally occurring land- and marine-based resources. A vibrant and rapidly growing industry has emerged around converting these resources into new pharmaceuticals, nutraceuticals and dietary supplements.

In a few short years, these figures could increase dramatically. The BioAlliance has set targets for 2010: 1,000 private sector employees, $200 million in private sector revenues, and an R&D expenditure increase from $40 million to $60 million. NRC will play a key role in helping this new industry reach these targets.

Can PEI's bioscience cluster compete on the international stage? "We're already gaining traction and turning heads," says NRC-INH Research Director, Dr. Michael Mayne, a native Islander who moved home to run NRC's research program. "It's true there are considerable challenges in making something like this work, but in this case, geography is not one of them. Remember, the Mayo Clinic got its start in a farmer's field." ■

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SUPPORTING INNOVATIVE COMPANIES

Value of NRC-IRAP clients five times greater than non-clients, new pilot study shows

Companies that tap NRC's industrial support programs deliver substantially greater shareholder value than those that don't, according to a landmark pilot study recently completed by NRC in collaboration with Statistics Canada.

The study – comparing the progress of roughly 700 NRC-IRAP clients in the Pacific Region against more than 370,000 similar non-clients across Canada – is the first ever benchmarking study to measure the quantitative impact of NRC-IRAP.

"The pilot study yields overwhelming evidence that NRC-IRAP clients are outperforming non-clients in almost every measure of business success," remarks Denise Guillemette, project lead and Manager of Strategic Research and Intelligence with NRC-IRAP.

Among various gauges of business success, both the value and growth of shareholder equity are where NRC-IRAP clients truly stand apart from non-clients, the study shows.

At an average shareholder equity of $5.1 million in 2002, the NRC-IRAP clients were more than five times more valuable than non-clients, which averaged only $880,000 in equity. And during the period between 1998 and 2002, average shareholder equity for the NRC-IRAP clients soared almost 170 percent. That's more than four times the rate of growth for small non-clients.

"While we tend to gauge success on revenue and job growth alone, shareholder value may well contribute to the longevity of emerging technology companies," suggests Guillemette. "They have to be able to survive a long product development cycle during which they could well have no earnings."

NRC gives young firms a huge step up

The NRC Industrial Research Assistance Program (NRC-IRAP) is Canada's premier innovation assistance program for small and medium-sized enterprises (SMEs).

NRC-IRAP provides non-repayable contributions to Canadian SMEs that intend to use new technology in services, products and processes in Canadian and international markets. NRC-IRAP also provides mentoring and invests in research and pre-competitive development technical projects. NRC-IRAP's partner organizations also receive contributions to provide technical and research assistance to Canadian SMEs.

The findings on shareholder equity confirm what NRC-IRAP staff has known for decades. Companies that receive support from NRC-IRAP have an edge in capital markets because, when NRC sees the merit of the research and helps guide it, investor confidence rises.

"A company that receives NRC-IRAP support is far more attractive to prospective investors," adds Guillemette. "They can feel comfortable that we've undertaken considerable due diligence to mitigate risks before authorizing NRC-IRAP funding."

In addition to shareholder equity, the NRC-IRAP clients surpassed non-clients in revenue and employment growth as well as R&D expenditures and personnel. R&D investment among clients averaged $906,000 in 2002, or more than double the R&D outlays of non-clients.

As a benchmarking exercise, says Guillemette, the methodology works and the results are sufficiently robust and defensible. She was pleased that the client data set was based on a significant statistical population of 700 organizations.

The findings also provided NRC-IRAP with the confidence to extend the regional pilot exercise to a full-blown national study. As a result, the national study will explore the more than 10,000 clients who received NRC-IRAP contributions and advice between 1993 and 1999. The study will then trace the progress of those that survived during the five-year period up to 2004.

In parallel with the national study, NRC plans to conduct several socio-economic impact assessments of NRC-IRAP as the program officially marks its 60th anniversary this year. A complete toolkit of analytical methods will be put to work, including benefit-cost, input-output, econometric, risk and sensitivity, and comparative analyses.

These assessments will be spearheaded by Frederick (Rick) Kijek, an economic analyst with 25 years experience in both the public and private sectors. Kijek joined NRC last summer, becoming the organization's first ever full-time economist.

"We are developing multiple lines of evidence to support the socio-economic impact of NRC-IRAP investments," explains Kijek. "Once completed, we will apply the same methodologies to measure the impact of NRC's research programs."

"At the end of the day, we intend to deliver the quantitative results NRC needs to prioritize its future investments." ■

UPCOMING EVENTS

April to June 2007

International Symposium on Polymeric Materials for Regenerative Medicine, April 2-4, 2007 in Boucherville, Quebec.
This symposium will bring together leading scientists and materials science engineers involved in developing polymeric materials for use in regenerative medicine. For details: **www.reseaumateriauxquebec.ca/PMRM2007/html/home.htm**

Advanced Materials Crossroads 2007, April 11-12, 2007 in Sainte-Hyacinthe, Quebec.
Professionals from across Quebec and Canada are invited to participate in this event where five conferences unique to the industry will be held in the same location. This is an exclusive opportunity to learn about the latest developments in materials research and innovation.
For details: **http://www.reseaumateriauxquebec.ca/index2.php?s=4**

Crossroad Conference 2007, June 13-14, 2007 in Montréal, Quebec.
The Crossroad of Biotechnology Symposium in Montréal brings together business leaders and leading scientists in the fields of health, environment and bioprocesses. This year, the meeting will focus on novel therapeutic strategies based on the disruption of protein-protein interactions. For details: **www.crossroadbiotech.ca**

Canada Nanoscience & Nanotechnology Forum, June 18-20, 2007 in Waterloo, Ontario.
The fourth annual NanoForum Canada will include presentations on the latest achievements and ideas in nanoscience and nanotechnology in Canada.
For details: **www.uofaweb.ualberta.ca/nanoforum**

Science of the skies

NRC is Canada's top authority on astronomy and astrophysics research. In Victoria and Penticton, NRC operates the astronomical observatories established by the Government of Canada, providing access to the Canadian and international research community. Through NRC, Canada is a partner in the seven-nation Gemini Observatory, the Canada-France-Hawaii Telescope and the James Clerk Maxwell Telescope.

What lies beyond our planet Earth?

Astronomy seeks to answer intriguing questions about the universe and celestial objects. To learn more, visit NRC's Student Science & Tech website at: **www.nrc-cnrc.gc.ca/education/skies/canadianskies_e.html**

Skygazing: Astronomy through the Seasons

Find out what's happening in the sky each week from down-to-Earth NRC astronomer, Ken Tapping. To receive Skygazing by e-mail every Wednesday, subscribe today at **www.nrc-cnrc.gc.ca/education/teachers/t-subscription_e.html**

NUTRISCIENCES AND HEALTH2007

Bioprospecting for Neuroprotectants

The National Research Council of Canada Nutrisciences and Health facility will host Nutrisciences and Health 2007: ***Bioprospecting for Neuroprotectants*** in beautiful Prince Edward Island, Canada, **July 10-12, 2007**.

Designed for members of the academic, corporate, government, and research communities, the conference program will be of particular interest to those involved in or interested in pursuing research and development in bioactives-based health research as it relates to the field of neuroscience.

International experts will present on topics such as:
- **neurodegeneration**
- **neuroinflammation**
- **genomics and nutrition**
- **bioprospecting**
- **product development**

A few of the confirmed speakers:
- **Mark Mattson, National Institute on Aging**
- **Rémi Quirion, CIHR**
- **Jim Kaput, NutraGenomics, Inc.**
- **James Joseph, USDA**
- **Russell Kerr, University of Prince Edward Island**

For more details or to register for Nutrisciences and Health 2007, contact:

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LEADING-EDGE R&D

Saving lives with bioinformatics

"The hope is that in isolating these markers we can detect cancer sooner," explains Dr. Belacel. NRC and ACRI jointly hold a patent on the biomarker for prostate cancer. The same method has now been used to identify the colon cancer biomarkers for which a patent is pending.

NRC researcher Dr. Nabil Belacel developed the algorithm used to identify cancer biomarkers.

NRC researchers and cancer specialists in New Brunswick have developed a remarkable new technology for diagnosing prostate cancer with far greater accuracy. Now that the Atlantic Innovation Fund is providing $2.9 million to help commercialize the new technology, NRC researchers hope to work with a private sector partner to develop a practical, point-of-care, diagnostic tool.

The discovery lay in the marriage of math and biology. Dr. Nabil Belacel, a mathematician and researcher with the NRC Institute for Information Technology, used a powerful algorithm he developed to identify the patterns of gene expression — biomarkers — unique to prostate cancer. Doctors at the Atlantic Cancer Research Institute (ACRI) then used their DNA microarray technology to validate the findings. The result? A 'marker panel' of eight genes that can identify prostate cancer tumours with 96 percent accuracy — a huge improvement over traditional methods.

"The current benchmark test, the Prostate Specific Antigen (PSA) test, produces numerous false positives that can lead to costly and sometimes unnecessary invasive procedures," notes Dr. Belacel.

The mathematical algorithm developed by NRC is unique. Thanks to the successful collaboration of NRC and ACRI, the technology could lead to faster turnaround times and greater accuracy, reducing invasive procedures aimed at making an accurate diagnosis. This technology could potentially replace the PSA test, which still requires a tissue sample.

Researchers still need to confirm the ability to isolate proteins in other media such as blood and urine before a non-invasive test can be developed. Once confirmed, however, a private sector partner — likely a diagnostics company — would develop test kits.

"The hope is that in isolating these markers we can detect cancer sooner," explains Dr. Belacel.

NRC and ACRI jointly hold a patent on the biomarker for prostate cancer. The same method has now been used to identify the colon cancer biomarkers, for which a patent is pending. ACRI will receive $2.9 million over three years from the Atlantic Innovation Fund for Genomically Guided Biomarker Discovery for Cancer, the collaborative project with NRC. The next step for NRC will be to further validate the prostate cancer biomarker with the intent to secure a partner for commercialization. NRC will also use a similar algorithm to identify and validate biomarker panels for breast, ovarian, lymphoma and lung cancers. The ultimate goal is to provide a multiple-cancer diagnostic panel.

"This technology will potentially lead to early screening and even predictive testing. It also has the potential to lead to treatment regimes tailored to fit individuals," explains Dr. Belacel. "It could revolutionize the way cancers, malignancies and other diseases are categorized and treated so that it is not based on symptoms or the location of the disease but rather on the underlying genetic causes of the disease." ■

Fuels for a greener future

Climate change and pollution are fuelling considerable research on what we put into car engines and what comes out the tailpipes.

NRC researchers are working to pin down the characteristics of various candidates for the next generation of automotive fuels, looking for the ones that will deliver the best road performance with the least impact on the environment. Their work involves innovative analytical methods, new engine designs and alternative fuels such as bio-fuels and fuels from oil sands. The outcome of this research will set the stage for the next generation of automotive technology that increases combustion efficiency and reduces pollution to an unprecedented extent.

Dr. Hailin Li, at NRC, explores the behaviour of both conventional and alternative fuels in a special single-cylinder engine that enables him to manipulate aspects of the combustion process.

"We're trying to understand the effect of various fuels on lean burn combustion," he says. "We need to find the right fuel chemistry to ensure these fuels will burn efficiently at lower combustion temperatures." A fuel that is burned completely within the engine emits far less than one that burns only partially.

How cold weather affects fuel is also important to Canadian drivers, given how severe our winter can be. In fact, our typical winter temperatures may limit the adoption of fuels that incorporate novel blending components derived from certain agricultural raw materials, since they tend to form a waxy build-up at low temperatures.

Such operating limitations may hamper the marketability of some alternative fuels, even if such fuels emit lower levels of pollutants, such as particulates.

"We need to find the right fuel chemistry to ensure fuels will burn efficiently at lower combustion temperatures," says Li. A fuel that burns completely in the engine emits far less soot than one that burns only partially.

In his research to characterize fuels, Li is using laser-induced incandescence (LII) to measure particulates. "Using this technology, we can measure soot emissions from a traveling vehicle at parts per quadrillion," notes Li.

Even if this seems like an excessive degree of precision, laser-induced incandescence is well suited to the analysis of innovative engine designs like the one Li is studying at NRC — a high-pressure low-combustion temperature engine that can reduce soot emissions to almost zero.

Stuart Neill, a senior research officer at NRC, is sure that the diesel engines making their way onto the North American market in coming years will be nothing like the loud, polluting power plants of decades ago. Even the sulphur content of today's diesel fuel is a fraction of what it once was.

Yet that makes it all the more necessary to examine changes in the chemical makeup of fuels in conjunction with changes to new engine designs. Neill concludes that the success of these efforts may be all but invisible to most of us, which would suit drivers and vehicle manufacturers just fine.

"With these new engines, you can barely tell it's a diesel," he says. "And with microprocessor control, the engine switches between different combustion modes without the user being aware of it. They don't know it, but they're polluting less." ■

NRC researcher, Dr. Hailin Li, predicts that innovative engine designs could be on the market within the next decade, reducing emissions significantly.

LEADING-EDGE R&D

NRC helps reinforce tough vehicle emission standards

NRC researchers have created a technology that's helping enforce some of the world's toughest vehicle emission standards.

"Environmental agencies are setting standards for emission levels that are so low and detailed they can't be measured with previously used technologies," says Greg Smallwood, who leads NRC's Ottawa-based combustion research team. "This is why they're so excited about our technology."

NRC patented the optically-based technology, known as laser-induced incandescence (LII), and licensed it to California-based Artium Technologies. In 2005, based on the NRC technology, Artium released a simple, portable LII instrument no bigger than a brief case – making it available to a broad range of users, from regulatory agencies to vehicle engine designers.

California's Air Resources Board has used Artium's commercial LII system to evaluate heavy-duty truck performance under the State's new not-to-exceed emissions standard. The system allowed for reliable on-road, real-time data to be collected and analyzed.

NRC has also collaborated with Environment Canada, using LII to measure particulate emissions from advanced technology vehicles. These vehicles use new engine designs and fuels, such as those produced from Canada's oil sands.

Tests conducted with this NRC technology have provided key insights to the tradeoffs between improved fuel efficiency and increased particulate emissions. "This technology makes it possible to measure the emissions of soot from the exhaust of a traveling vehicle at parts per *quadrillion*," says Smallwood.

NRC's Greg Smallwood and Reg Smith use an NRC-patented technology to measure particulates in vehicle emissions – in the lab and on the road.

"This technology makes it possible to measure the emissions of soot from the exhaust of a traveling vehicle at parts per quadrillion," says Greg Smallwood, who leads NRC's Ottawa-based combustion research team.

NRC is now developing a unique, portable high-sensitivity LII-based sensor that Environment Canada researchers can use for detailed air quality measurements.

As well, NRC researchers are going beyond LII technology, pushing the boundaries of particulate science by using LII and other laser-based techniques to develop ways to identify the size, concentration and structure of particulates. This information will ultimately help us better understand their health impacts.

To learn more about this technology and the continuing work of NRC in this field, read *NRC Scientists Pinpoint Particulates* at

http://www.nrc-cnrc.gc.ca/higlights/2006/0603particulates_e.html

AWARD-WINNING TECHNOLOGY FOR LICENCE

Unique bacterial tag team fights chlorinated solvent pollution

Scientists have long understood that microorganisms — naturally occurring bacteria — can be used in a process called environmental bioremediation to clean up contaminated sites, particularly those poisoned by chlorinated solvents. But until recently, most bioremediation processes have been either too costly, not entirely effective, or both.

Now, NRC has engineered an innovative approach to employing pollution-hungry bacteria that overcomes both the cost and efficacy shortcomings of traditional techniques, giving Canada a decided advantage in the burgeoning field of bioremediation.

Developed by environmental bio-engineers at NRC's Biotechnology Research Institute, this unique technology permits a greener approach to cleansing groundwater contaminated with chlorinated solvents because the by-products — carbon dioxide, water and chloride salts — are relatively benign compared to those generated by traditional methods.

For their efforts, the NRC team earned top honours in the new technologies available for licensing category of the NRC Business Case Challenge 2006.

Since then, NRC has licensed the technology, under a partially exclusive arrangement, to Sanexen Environmental Services, a specialist in PCB management and contaminated site characterization and remediation. The Quebec-based company will demonstrate the technology at a well-known, contaminated site in the province.

As NRC's solution moves into full-scale commercialization, the market is ripe. In the United States alone, the bioremediation segment of the overall soil and groundwater remediation business is set to double to over US$1.3 billion by 2010. And in Canada, the federal government has committed $3.5 billion over 10 years to clean up contaminated sites.

The NRC technology uses a two-in-one bioremediation technique that almost completely removes chlorinated solvents from the treated water. Presently, bioremediation techniques on the market use either aerobic or anaerobic bacteria — alone, or consecutively. Normally, these bacteria can't co-exist because one requires oxygen while the other requires an oxygen-free environment.

NRC has engineered an innovative approach to employing pollution-hungry bacteria that overcomes both the cost and efficacy shortcomings of traditional techniques, giving Canada a decided advantage in the burgeoning field of bioremediation.

The NRC technology capitalizes on the insight that under just the right conditions, these bacteria can work together synergistically, as opposed to sequentially.

"Although at first glance it's counter-intuitive, our technology is based on the fact that aerobic and strict anaerobic microorganisms can grow together in a single natural habitat," says Dr. Serge Guiot, Head of the NRC-BRI Environmental Bioengineering Group.

"Biogranules" are naturally occurring microscopic aggregations of bacteria that form a biofilm. What Dr. Guiot's team discovered is that these granules provide a natural tag-team environment for aerobic and anaerobic bacteria. The aerobic bacteria live on the oxygen-rich surface of the granule, while anaerobic ones live in the oxygen-free core.

This means that for bioremediation, the biogranules deliver a one-two punch that's the basis of the technology, notes Dr. Guiot. The anaerobic bacteria begin the breakdown of the chlorinated solvents and the aerobic bacteria finish the job, digesting the by-products of their cousins' work.

The patented NRC technology stimulates and accelerates this natural biodegradation by using electrolysis of water (electrically splitting H_2O) to fuel the various bacteria with oxygen and hydrogen. The hydrogen is used by anaerobic methanogenic bacteria to dechlorinate the solvents and to produce methane. In turn, the methane and oxygen energize the aerobic decomposition of the end-products of the anaerobic breakdown.

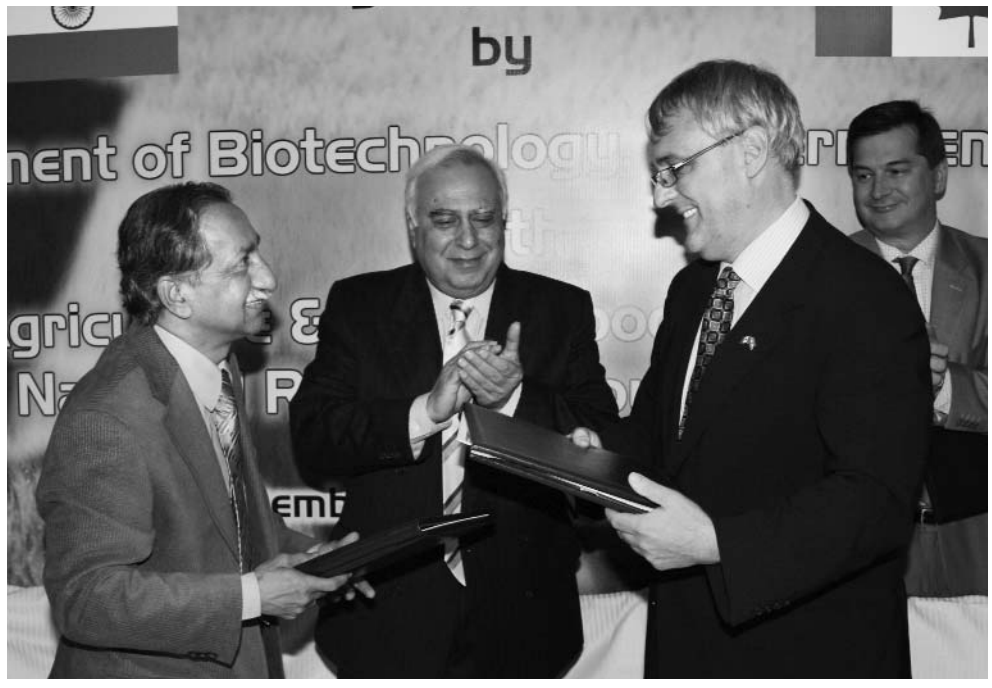
In pilot tests, this technology reduced chlorinated-solvent contamination in moderately and highly contaminated water to levels below regulatory guidelines.

"We're excited about the effectiveness of the technology we've shown in the lab," says Dr. Guiot. "We've demonstrated proof-of-concept and the technology is now ready for full-scale field trials." ■

GLOBAL REACH

Linking Canadian researchers and companies to global S&T network

The capacity to demonstrate S&T strength to the world determines Canada's ability to compete for skilled workers and investment capital. It also opens the door to global knowledge-sharing networks that operate on the leading edge of science and technology.



From left to right: Dr. S. Natesh, Advisor, Department of Biotechnology, Government of India; Mr. Shri Kapil Sibal, Minister of Science and Technology and Earth Sciences, Government of India; Dr. Roman Szumski, V-P of Life Sciences, NRC, and Mr. Kenneth McCartney, Deputy High Commissioner, Canadian High Commission, New Delhi, India.

NRC has recently struck two new collaborative research agreements with India and China, nations that have already demonstrated impressive R&D capacity in distinct fields. Through these agreements, NRC hopes to bring some of the world's best minds together to accelerate discovery and innovation in areas that are critically important to all nations.

The India link

In December 2006, NRC and the government of India signed an agreement to extend scientific collaboration in biotechnology. The agreement, a natural progression in the relationship between both countries' scientific communities, will strengthen research in an area in which both Canada and India have shown excellent capacity.

"We have embarked on major research programs leading to improved products across a wide array of sectors," noted Dr. Roman Szumski, Vice-President of Life Sciences at NRC. "By combining our efforts, we can take advantage of each country's strengths and advance the biotech field."

NRC and Indian scientists will focus on finding ways to harness the properties of plants to improve human and animal health. They will also conduct research toward understanding and exploiting the genomics (hereditary information encoded in DNA cells) of certain plants. Combined work in the area of vaccine design, production and delivery systems, and biodevices is also being considered.

Team Canada in China

In January, NRC participated in a Team Canada visit to Shanghai and Beijing where it played an important role in two new agreements: the Canada-China S&T Accord and the Joint Training Program.

NRC President Dr. Pierre Coulombe co-chaired the Canada-China Joint Committee overseeing the S&T Accord. "The agreement provides a framework to strengthen collaboration between Canadian and Chinese research institutions and technology-based companies," he noted, adding that the collaboration would help accelerate scientific discovery and commercial applications in areas of social and economic benefit to both countries.

The S&T Accord focuses on areas of research that are NRC priorities – clean energy; environmental technologies; health and life sciences; and biotechnology, agrifoods and bioproducts.

A second agreement, between NRC and China's Ministry of Education, has established a joint training program that will involve an exchange of Canadian and Chinese researchers.

During Team Canada's visit to China, NRC also participated in "green" technology seminars, which focused primarily on R&D and commercial opportunities for fuel cell and hydrogen technologies.

NRC President, Dr. Pierre Coulombe, and Dr. Wu Qidi, Vice-Minister of the Chinese Ministry of Education, sign an agreement to train high-level Chinese personnel in NRC labs.

NRC works continuously to increase innovation in Canada through strategic R&D alliances in other countries. International research collaborations generate greater foreign investment in Canada's economy and lead to stronger S&T networks from which Canadian researchers and companies may benefit. ■

SCIENCE OUTREACH

A student team sets up their prototype vehicle for testing while Sylvain Boudreau, emcee and NRC engineer, looks on.

NRC Engineering Challenge brings science to youth

To bring National Engineering Week alive for young people, NRC goes into the classroom to help inspire the next generation of scientists and engineers. The NRC Engineering Challenge provides teachers with an engaging way to introduce science curriculum to young students.

The 2007 Challenge took place in February in the National Capital region and, for the first time, in Fredericton, New Brunswick. Professional engineers volunteered in elementary schools to engage students in designing and building a VOB — a Vehicle for Obstacle Bowling. Throughout February, student teams designed, constructed and tested their prototypes with the aid of engineer mentors.

On February 27, the "best in show" was selected in a final competition at the Canada Science and Technology Museum in Ottawa during National Engineering Week.

The challenge for students, of ages 10 to 12, is to build a workable prototype from common crafts materials and items they find in recycle bins. In past years, enthusiastic youth have addressed simulated real-life problems by constructing a vehicle to carry fragile cargo in the Arctic, a catapult to propel samples from Mars to Earth, and a car powered by a rubber band. ■

WORKING WITH INDUSTRY

NRC gives back to the construction industry —

Designing healthy buildings that reduce environmental impacts

NRC has created some new tools for next-generation building projects, but they won't fit in your tool belt. Daylight 1-2-3 and IA-Quest are computer programs to help architects and building engineers create buildings that are environmentally friendly, comfortable to live in, and suitable for the Canadian climate.

Sustainable building technologies are in increasing demand, particularly among government and corporate clients who want to promote a healthier, less resource-intensive lifestyle. Scientific evidence about the environmental value of green building practices is growing. And, it won't be as costly to build "green" as you would think.

Maximize your sunshine with Daylight 1-2-3

The soon to be released Daylight 1-2-3 software, created by NRC and Natural Resources Canada, helps architects and engineers with no expertise in computer simulation make good lighting design decisions in commercial or public-use buildings.

Daylight 1-2-3 will soon be released to architects and building engineers via their community mailing lists.

Web exclusive:

Visit the NRC website soon to find out when and how to obtain this innovative software **http://irc.nrc-cnrc.gc.ca/ie/lighting/index_e.html**

The quest for better indoor air

We can point our finger at two culprits that affect indoor air quality: people; and materials — carpets, paints, ceiling tiles or furniture — that emit chemical substances. Obviously, we can't take the people out of the buildings. But we can do something to reduce the impact of the 100 to 1,000 volatile organic compounds (VOCs) emitted by materials.

IA-Quest offers solutions. Using the IA-Quest software, building designers first model the room and input the ventilation rates. Next, they populate the virtual room with new materials such as paint, carpet and furnishings. They run the simulation for as long they want, from a few hours to several months. IA-Quest gives a profile of the total VOCs in the room over time.

Web exclusive:

IA-Quest is currently available for download at: **http://irc.nrc-cnrc.gc.ca/ie/iaq/iaquest_e.html**

New national building codes

In 2005, NRC released a new version of the National Building Codes with important changes that make the codes easier to apply to existing buildings and more accommodating to technological advances. Print and CD-ROM formats of the National Building Code of Canada 2005, the National Fire Code of Canada 2005 and the National Plumbing Code of Canada 2005 are available for purchase through NRC's virtual store at **www.nrc.gc.ca/virtualstore.**

Web exclusive:

You can learn more about NRC's healthy building research at: **http://www.nrc-cnrc.gc.ca/highlights/2007/0703greenbuildings_e.html**

Vancouver — Canada's gateway to green energy

Continued from page 1

The NRC cluster initiative is gaining partners and speed. Vancouver already has the world's most advanced cluster of companies and organizations focused on these new technologies.

Anchored by Ballard Power Systems, one of the world's leading fuel cell producers, the cluster accounts for more than 70 percent of the 1,800 Canadians employed in this growing industry.

NRC's building on the University of British Columbia campus exemplifies how things can be done without consuming oil and gas. Despite the energy demands of a research facility, it's powered by photovoltaic panels, underground heat pumps and a solid oxide fuel cell.

Why hydrogen?

Hydrogen has distinct advantages. It has the potential to be a clean fuel when used in energy applications such as fuel cells or modified internal combustion engines. It can be zero emissions, depending on method of production. It can be produced using methanol, natural gas, ethanol, petroleum and renewable feedstocks, allowing most regions of the world the means of producing it. It's safe to produce, store, transport and use in fuel cells and internal combustion engines. And it can store off-peak energy produced by solar, wind and tidal generation.

Canadian fuel cell and hydrogen technologies are already being put to the test. They're powering forklifts at Wal-Mart and transit buses across Europe, heating hot water in Japanese homes and ensuring uninterruptible power supply in telecommunications server rooms across the US.

Unlike fossil fuels, hydrogen-powered fuel cells don't produce particulates, carbon monoxide, nitrogen oxides or volatile organic compounds. With newly affluent and densely populated countries like China suddenly putting thousands more cars on the road each week, the need for clean fuel alternatives has become even more urgent. ■

About fuel cells

What do houses, flashlights, cars and laptops have in common? They can all be powered using fuel cells.

A fuel cell is an electrochemical energy conversion device that uses hydrogen or other fuels to produce electricity, water, and heat. It operates much like a battery but does not require electrical recharging. It can generate power almost indefinitely, as long as fuel is supplied.

A fuel cell can utilize a variety of fuels including hydrogen, natural gas, formira and methanol.

From the Hydrogen & Fuel Cells Canada website

NRC NEWSLINK

www.nrc-cnrc.gc.ca

NRC NewsLink is published four times a year by the National Research Council of Canada. It informs readers about the many NRC research and innovation programs, services and initiatives that serve the needs of industry, the economy and all Canadians.

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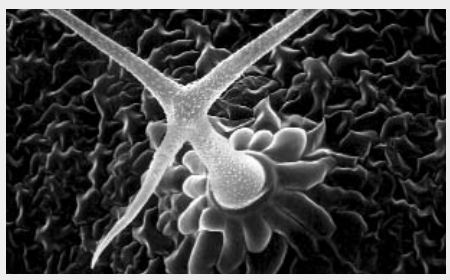
Recognized globally for research and innovation, NRC is a leader in the development of an innovative, knowledge-based economy for Canada through science and technology. NRC operates world-class research facilities as well as information, technology and innovation support networks coast to coast. Its outstanding people help turn ideas and knowledge into new products, processes and services, creating value for Canada. NRC works hand-in-hand with partners from industry, government and universities to help ignite the spark of innovation in communities across the land and to give Canadian companies a competitive edge in today's marketplace.

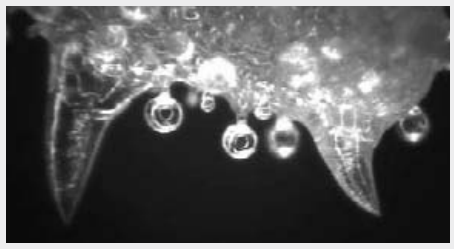
What's this?

Trichome cell



This is a leaf hair, a specialized cell called a trichome, seen through a scanning electron microscope. The photo on the right shows trichome cells on a geranium leaf.

Plants produce a wide variety of compounds that can be used as medicines, flavours, and ingredients for consumer goods. Many of these substances are produced in secretory tissues such as trichomes, resin canals, or laticifers. Understanding how plants make secretory tissues and how metabolites in them are stored and secreted could lead to plants being used to produce valuable natural products for medicines or supplements.



NRC celebrates its 90th

Few national organizations have as long and as accomplished a history as Canada's National Research Council.

What is now NRC was born in June 1916. The new Council was to advise the government on science-related activity, and perform and promote research that would develop industrial production and the utilization of natural resources in Canada. NRC, like our economy, has evolved a great deal since then.

Backed by nine decades of accomplishment, NRC now enjoys a global reputation as a unique and valued asset for science-based research and development. NRC's innovations have saved lives, transformed industrial processes and helped the environment — its extraordinary discoveries rank among the greatest in modern science.

NRC has long been the nation's leading R&D force in biotechnology, aerospace, manufacturing, construction, information and communications, ocean engineering and other areas. To remain at the forefront of research, NRC has also moved into important new fields including genomics, fuel cells, quantum information and computing, bioinformatics, photonics, nanotechnology, as well as environmental and sustainable development technologies.

Working through its 25 research institutes and technology centres, NRC performs world-class research to give Canadian industry a competitive edge while developing solutions to Canada's national S&T priorities.

Discover more about NRC's proud past, remarkable research and outstanding teams at **www.nrc-cnrc.gc.ca/aboutUs/nrc90/main_e.html**