INSIDE THE BRAIN REPAIR CENTRE

Exploring New Pathways to Brain Protection and Repair
Thanks to novel approaches and new experimental techniques, our researchers and their colleagues around the world are making rapid and enormous strides toward understanding the brain and spinal cord and how these complex systems change with illness and age. This knowledge will lead to new technologies and treatments with the potential to save and transform lives.

The Brain Repair Centre aims to play a leadership role in achieving this ambitious vision. To do this, we must continue to be highly competitive in obtaining research dollars—not only from national and provincial granting agencies, but also through philanthropic organizations and individuals that share our vision.

We must ensure that our research environment continues to attract world-leading scientists and trainees to Halifax, where they can build sustainable and collaborative research programs and launch successful entrepreneurial ventures. Finally, we must engage more fully with the communities we seek to serve, so that we may share in our mutual successes.

We welcome your involvement and support!

www.brainrepair.ca

At the Brain Repair Centre, we envision a time when neurological diseases will be curable and preventable.
The Brain Repair Centre is a research institute at Dalhousie University in Halifax, N.S., involving more than 50 principal investigators, $9 million in annual outside funding, and 250 trainees and staff in a wide range of research pursuits. We’re building on our strong foundation of facilities, programs, talent and partnerships, to attract the world’s best neuroscientists and become Canada’s premier centre for neuroscience research.

There is a vast amount of brain-focused work underway in Halifax, in terms of fundamental science, clinical research, and drug and technology development. The Brain Repair Centre is a hub that unites these diverse interests and connects them to the wider community—including government agencies, the private sector, individuals, and societies representing people affected by neurological disorders—to build understanding and support for this research.

We are extremely grateful for the support we have already received, from private donors, Dalhousie Medical Research Foundation and the QEII Foundation. These donations have helped to fund the curiosity-driven research that is so vital to scientific discovery.

At the same time, the Brain Repair Centre encourages neuroscience innovation and commercialization, with funding from Nova Scotia Economic and Rural Development and Tourism. Thanks to this support, we are able to sponsor entrepreneurship training for young neuroscientists, host learning sessions for our members, and provide grants to researchers who are bringing international meetings to Halifax and developing promising new technologies and therapeutics.

Together with our partners, and with the engagement and support of the community, we have an opportunity to foster a vibrant neuroscience sector in Nova Scotia’s emerging knowledge economy. In so doing, we can also help our region cope with rising rates of neurological illness. I invite you inside the Brain Repair Centre to learn more about us and our vital role in achieving these goals.

Dr. Victor Rafuse
Director, Brain Repair Centre

As brain researchers, our members are united by the shared vision that, through unveiling the mysteries of the brain and spinal cord, we can create new compounds and technologies for protecting and repairing these complex and powerful, yet fragile, structures.
The Brain Repair Centre at a Glance

The Brain Repair Centre (BRC) is a hub, catalyst and driver for neuroscience research, collaboration, innovation and knowledge translation in Atlantic Canada.

The BRC mission is to provide programs, advice and services that:

- advance neuroscience discovery
- improve clinical care
- contribute to Nova Scotia’s economy through research, innovation and worldwide partnerships

**BRC Programs**

Since 2012, the BRC has launched a series of new programs that foster cohesion and the cross-pollination of ideas within the neuroscience community, and provide a base of knowledge and financial support to help researchers translate their ideas into viable products and services. These include:

- BRC Knowledge Translation Grants
- BRC Research, Dissemination & Commercialization Grants
- BRC Journal Clubs
- BRC learning and networking sessions (intellectual property and commercialization)
- BRC annual research and poster days

**BRC Partnerships**

In addition to its own programs, the BRC is forging new partnerships within the academic health sciences network and the broader community to advance neuroscience innovation and the well-being of people affected by neurological disorders. Over the past few years, the BRC has partnered with and/or financially supported such initiatives and organizations as:

- Summer Institute in Neurotechnology, Innovation & Commercialization (RADIANT CREATE)
- Brain Awareness Week
- ALS Society of Nova Scotia
- Alzheimer Society of Nova Scotia
- Canadian Paraplegic Association of Nova Scotia
- MS Society of Canada – Atlantic Division
- Parkinson Society Maritime Region

**Advocacy**

The BRC is ideally positioned to be a champion for brain health in the Maritimes and beyond. BRC members already play leadership roles in such groundbreaking initiatives as Nova Scotia’s new dementia strategy and support societies in their efforts to transfer knowledge and raise awareness and funds. The BRC is actively seeking opportunities to influence public policies that will help to prevent neurologic injury, promote healthy aging, and foster academic research and private enterprise in the life sciences sector.
BRC at a Glance

BRC Members’ Research Activities

The Brain Repair Centre is building programs and services to help its members succeed in their efforts to understand—and alleviate the burden of—neurological diseases.

Snapshot of BRC Survey Results

In early 2014, the BRC surveyed its most active members to learn more about their research programs, funding, teams and aspirations. Roughly three-quarters of the members provided information, summarized in brief below:

Funding: $9 Million per Year

Together, the lead investigators hold an estimated $9 million per year in external peer-reviewed grant funding—an average of $236,000 per lead investigator per year (primarily from Canadian Institutes of Health Research, NSERC, Atlantic Canada Opportunities Agency, Nova Scotia Health Research Foundation). Research shows 70 per cent of grant funding goes to salaries for research trainees and staff.

Trainees: 423 Graduated to Date

To date, the lead investigators have supervised or co-supervised 423 masters students, PhD students and postdoctoral fellows to successful completion of their programs—an average of 11 per lead investigator.

Current Employment: 235 Trainees and Staff

The lead investigators run research programs involving 235 trainees (students, fellows) and staff (research associates and technicians) —an average of eight trainees/staff per lead investigator.

Patents: 40 Secured and Pending

The lead investigators collectively hold or are in the process of securing intellectual property on 40+ innovations. These include a range of devices and compounds for diagnostic, neuro-protective and therapeutic uses.

Research areas:

- Aging
- Alzheimer/dementia
- ALS
- Attention, memory, learning
- Brain cancer
- Epilepsy
- Ethics
- Fundamental neuroscience
- Imaging
- Motor control
- Motor neuron disease
- Multiple sclerosis
- Neurodevelopmental disorders
- Neuro-rehabilitation
- Pain
- Parkinson’s disease
- Psychiatric disorders
- Spinal cord function
- Stress
- Stroke
- Traumatic brain injury
- Traumatic spine injury
- Vision
Curiosity: the Gateway to Discovery

Curious Minds in Neuroscience at Dalhousie

Curiosity is the driving force behind scientific discovery, which in turn leads to medical and technological breakthroughs. The Brain Repair Centre’s members are keenly aware that a deeper understanding of the normal functioning of the brain and nervous system is the gateway to effective means of preventing, diagnosing and treating neurological disease. The Brain Repair Centre therefore seeks to strengthen curiosity-driven neuroscience research at Dalhousie University and its affiliated teaching hospitals.

Dalhousie University, the IWK and QEII Health Sciences Centre are home to a vibrant neuroscience research community, with principal investigators, research associates and trainees passionately dedicated to revealing the mysteries of the brain. In broad strokes, their research aims to shed light on:

- how neurons arise and form complex networks in the developing nervous system
- how the brain focuses attention, learns and forms memories
- how the brain processes sensory inputs (through sight, smell, taste, touch and sound)
- how the brain and nervous system change with age, injury, environmental factors and disease
- how circuits in the spinal cord control movement
- how the brain and nervous system can be protected and restored in the face of age, injury and disease

The Brain Repair Centre’s role in supporting curiosity-driven research:

- connecting researchers from diverse fields, to share ideas and find common ground for collaborations, through such activities as networking sessions and journal clubs
- helping to establish and maintain sophisticated shared research facilities that would be too expensive for one researcher to establish, staff and maintain
- raising the profile of neuroscience research, helping to attract top scientific talent from across Canada and around the world
- being champions of neuroscience research

Getting a grip on hand function: Dr. Rob Brownstone (left) and Dr. Tuan Bui (right) made headlines with their serendipitous discovery of the spinal cord circuit that controls hand grasp (published in Neuron, April, 2013). This landmark discovery underlines how curiosity can lead researchers down unexpected trails to clinically relevant findings. Dr. Brownstone has since secured nearly $1 million from the Canadian Institutes of Health Research to learn more about how the spinal cord controls movement, including the ability to use our hands.
No one else in Canada is studying ALS in such a way, from so many complementary angles,” says BRC director, Dr. Victor Rafuse. He played a lead role in building the ALS research group, which includes Dr. Rob Brownstone, who came to Dalhousie from the University of Manitoba in 2000, Dr. James Fawcett, who joined Dalhousie from the University of Toronto in 2006, Dr. Ying Zhang, who came from the Salk Institute in San Diego in 2010, and Dr. Turgay Akay, who came to Halifax from Columbia University in New York in 2014.

Together with Dr. Devanand Pinto at the National Research Council in Halifax, the researchers are discovering the molecular makeup of motor neurons—nerve cells in the brain and spinal cord that control movement—and how their function is disrupted by ALS-related genetic mutations. At the same time, they’re learning how ALS affects the excitation of motor neurons, the motor neuron-to-muscle connection, and the ability to move—while developing new techniques for exploring ALS and how to treat it.

“There is currently only one drug available for ALS patients, which can extend life by several months,” notes Dr. Rafuse. “Our goal is to help find ways to extend life by several years.”

In fact, the Dalhousie/BRC researchers are collaborating with the universities of Montreal, Laval and Calgary, as well as Harvard, to screen compounds that could potentially be used in treating ALS. This collaboration will use new high-throughput ALS drug-screening technology that Dr. Zhang is developing with support from a BRC Knowledge Translation Grant (see related story, page 14).

Meanwhile, the group’s newest member, Dr. Akay, is working with a revolutionary model he’s developed to study the process of muscle de-innervation and its effects on the ability to move, over time. He’s also learning how circuits in the spinal cord adapt to the massive loss of motor neurons in ALS, in which as many as half of the motor neurons are dead before any symptoms emerge. “If we could enhance this compensation mechanism, we could improve quality of life for people living with ALS,” he says.

Among his numerous ALS projects, Dr. Rafuse is exploring new strategies for re-innervating muscles and even bypassing the motor-neuron-to-muscle connection—for example, to help the diaphragm function. “It’s early days,” he says, “but we have a strong group with a lot of synergy to propel the work forward.”

A unique group of neuroscientists at Dalhousie’s Brain Repair Centre is revealing the mechanisms that cause ALS (amyotrophic lateral sclerosis, or Lou Gehrig’s disease), a fatal neurodegenerative disease that results in progressive muscle paralysis. Most people with the disease eventually succumb to respiratory failure.
“The neurons themselves are healthy in schizophrenia, but the connections among them are not right,” explains Dr. James Fawcett, a Canada Research Chair in the neurobiology of brain repair and an associate professor in the Department of Pharmacology at Dalhousie Medical School. “We want to know how this happens.”

Dr. Fawcett is working closely with Dr. Stefan Krueger, a Canada Research Chair in synaptic plasticity and associate professor in Dalhousie’s Department of Physiology & Biophysics, to track the specific proteins and interactions that lead to the unusual patterns of synaptic connections found in schizophrenia. They’re particularly interested in the role of actin, a protein that provides cells with their structure. In the nervous system, actin helps regulate the outgrowth of axons from the body of the nerve cell. These long fibres form synaptic connections with small threadlike dendrites on neighbouring nerve cells, so messages can travel from cell to cell.

“We’re identifying molecules that regulate actin to make synaptic connections stronger,” notes Dr. Krueger, who explores how and why the brain forms new synapses and deletes existing ones in an ongoing adaptive process known as synaptic plasticity. “This is important knowledge not just for understanding schizophrenia and other conditions involving disregulated synaptic connections—such as epilepsy and autism spectrum disorders—but for understanding how we learn and how our brains change constantly over time.”

Based on molecules they’ve identified so far, Dr. Fawcett is developing experimental models of schizophrenia that will allow him and Dr. Krueger to pinpoint the effects of various molecules on synaptic connections.

“We want to identify molecules that could be blocked or enhanced to adjust the synaptic connections so the brain functions better,” says Dr. Fawcett. “While our research is driven by the desire to understand the fundamental workings of the brain, our ultimate goal is to make discoveries that will lead to new treatments and healthier brains.”
Brain Repair Centre Journal Clubs

In 2013, the Brain Repair Centre launched a journal club program to encourage frequent and wide-ranging scientific discussion within the university neuroscience community. Journal clubs are an academic mainstay that bring researchers and trainees together to discuss the latest scientific evidence, as published in leading journals.

The Brain Repair Centre Journal Club Program provides small annual grants to neuroscience-focused journal clubs. To qualify for the funding, the clubs must foster connections across the neuroscience community by inviting participation from a wide range of groups and disciplines.

So far, the Brain Repair Centre supports four journal clubs:

- **Atlantic Mobility Action Project Journal Club** gathers researchers, students and technical staff with an interest in the neurobiology of the brain and spinal cord and the underpinnings of potential treatments for movement disorders.

- **Interdisciplinary Science Journal Club** includes professionals, academics and trainees in a wide range of fields to discuss such topics as cognitive and motor training and rehabilitation, aging, stroke, exercise and therapeutic uses of technology.

- **Undergraduate Neuroscience Journal Club** engages students on a broad range of topics, from molecular and cellular interactions, to behaviour and cognition—often with an emphasis on neurological disorders.

- **Vision Science Journal Club** provides a venue for investigators and trainees with a strong interest in the retina and visual system to discuss new findings about the pathologic mechanisms of—and potential therapeutic strategies for—diseases affecting the eye.

**Benefits of journal clubs:**

- Journal clubs broaden horizons and inspire new avenues of investigation.

- Because so many excellent papers are published every day, no one researcher has the time or expertise to screen and assess them all—journal clubs share the load among many so the entire group benefits from each member’s efforts.

- Examining the “best of the best” papers provides researchers with excellent examples of how to conduct and present top-quality research.

- Young researchers and trainees often present the papers, building confidence and important communications skills, while senior investigators share perspectives gained through experience.
Great science requires not only great creativity but great connectivity as well, to bring brilliant minds together to solve mysteries and generate ideas. The Brain Repair Centre plays an important role as a hub for connecting scientists and clinicians and building a more cohesive, impactful research community. This also involves helping local researchers bring international conferences to Halifax, and engaging the broader community in the larger research mission.

To strengthen its role as a hub for neuroscience research, the BRC organized a series of events in 2013 that brought members of the neuroscience community together with the local life sciences, economic development and patient advocacy communities. In addition to offering a venue for diverse groups to explore shared priorities and learn about new developments, initiatives and funding opportunities in the neuroscience community, the sessions provided participants with insights into knowledge translation. Topics included:

- protecting intellectual property
- connecting clinical, scientific, engineering and business expertise to expedite knowledge transfer for better patient care
- joint industrial-government funding partnerships for graduate students and postdoctoral fellows (through Mitacs)
- updates on new neuroscience recruits and a new Canada Research Chair position for neuroscience at Dalhousie
- announcement of the new BRC Journal Club Program and Scotiabank’s sponsorship of the BRC Research, Dissemination & Commercialization Grants
- presentations from the 2013 BRC Knowledge Translation Grant recipients

BRC events have brought together scientists, clinicians and trainees, along with representatives from such organizations as Nova Scotia Economic and Rural Development and Tourism (NSERDT), the Canadian Trade Commissioner Service, Atlantic Canada Opportunities Agency, Dalhousie Industry Liaison & Innovation, BioNova, BIOTIC, a number of private neuroscience-oriented companies, and the Canadian Paraplegic Association, MS Society, ALS Society, Parkinson Society, and Alzheimer Society, among others.
In 2013, the BRC expanded the scope of its annual research day, inviting representatives of the broader life sciences, economic development and patient advocacy communities to take part in a series of panel discussions on issues of importance to Nova Scotians.

Engaging the Community

Panelists: Kimberley Carter, ALS Society; Lloyd Brown, Alzheimer Society; Robert Shaw, Parkinson’s Society; Mike Cullen, MS Society. Panelists explained the challenges their organizations are facing as the number of people who need their help continues to expand. The panelists—each representing a provincial or regional division of a national body—all agreed their local efforts could be enhanced by working in partnership with the BRC and researchers studying the diseases and disorders they represent.

Pathway to the Patient

Panelists: Laura Fraser, Chronicle Herald; Scott Moffitt, BioNova; Kenneth Rockwood, Dalhousie Medical School/Capital Health. This panel explored the challenges that Nova Scotia will face in the future to provide quality care that meets the needs of its steadily aging population. Dr. Rockwood emphasized the need to involve patients and care providers in tracking symptoms, needs and responses to treatments.

Lessons Learned Commercializing Neuroscience

Panelists: David Roach, DMF Medical; Neil Ritchie, Invicta Health; Steven Beyea, BIOTIC. These panelists shared their experiences of what’s required to successfully commercialize the fruits of research—such as an innovative product or service—in the neuroscience field. Having a great technology and a big market are not enough—all the pieces have to fit together and the business has to be properly structured and financed, with the right partners and players to make it work.

The BRC began hosting an annual research and poster day in 2012, to bring the neuroscience research community together to share the latest findings and new directions.
Scientific conferences are one of the most important ways for researchers to build international networks and share their findings, with the express purpose of advancing scientific knowledge, clinical practice and/or health care policy. Conferences also provide a venue for researchers to shine the light on their intellectual property and connect with potential industrial partners, while bringing business to the host city’s hotels, restaurants and shops.

BRC Research, Dissemination & Commercialization Grants

It requires enormous time, effort and financial resources to mount a successful scientific conference. With funding from Nova Scotia Economic and Rural Development and Tourism, BRC launched the BRC Research, Dissemination and Commercialization Grants (RD&C) in 2013 to support members in their efforts to attract major conferences to Halifax.

The BRC was able to expand its RD&C grant program in 2013, thanks to Scotiabank, which provided $20,000 to the program to be awarded in two $10,000 grants to the top-ranking RD&C application in 2014 and 2015.

The BRC has awarded three RD&C grants to date:

2013 Canadian Spinal Cord Conference
The BRC was a lead sponsor of the 2013 Canadian Spinal Cord Conference. This event attracted 80 scientists, clinicians and trainees from across the country to share the latest developments in the understanding of spinal cord development and function, how to limit and repair damage in injury and disease, and how to restore lost function.

9th International Motoneuron Meeting
Most recently held in Sydney, Australia, the International Motoneuron Meeting is the premier scientific event for exploring new frontiers in the understanding of the nervous system’s control of movement and how this can be protected or restored in neurologic injury and disease. Dr. James Fawcett and Dr. Rob Brownstone received the 2014 Scotiabank-BRC RD&C grant to organize and host this meeting in Halifax in June 2014. This event attracted hundreds of leading clinicians and researchers, while drawing international attention to top-notch mobility research in Halifax.

BIOMAG 2014
BIOTIC scientific lead Dr. Steven Beyea received a 2014 BRC RD&C grant to help him and his co-chairs across Canada organize and host BIOMAG 2014, the 19th international biomagnetism conference, in Halifax in August 2014. This conference drew more than 700 delegates from 30 countries to share the latest developments and applications of biomagnetism technology—such as imaging brain function in children with brain injuries.
Engaging with Health Societies

In 2013 and 2014, the BRC began expanding its efforts to connect with the broader community—particularly the community affected by nervous system diseases. In addition to inviting health societies to participate in its events, the BRC began meeting with these organizations to see how they and the BRC can work together to promote initiatives that will benefit people who are coping with neurological disease.

“We’re fostering a much higher level of community engagement,” says BRC’s director, Dr. Victor Rafuse. “People are eager to learn about the research that’s happening here, locally, and they want to know how they can help. At the same time, we’re looking for new ways to help them.”

Supporting Non-Profits’ Programs

One of the BRC’s first steps was to offer its website to the health societies as a forum for sharing information about upcoming education and fundraising events. This was greeted enthusiastically by the non-profit community, as was the BRC’s next offer: to provide small grants in support of societies’ programming. For example, the BRC supported the 2014 Parkinson Disease Education and Awareness Conference and hosted the 2014 “Kick ALS” Web-a-Thon at the Life Sciences Research Institute in April. In May, the BRC sponsored an MS education session called “Working Toward Better Health.” Dalhousie physiatrist and BRC member, Dr. Christine Short (above with MS Society HRM chapter leaders Susan Martin, and Theresa Dunham), spoke about how people with MS can manage the barriers that make it difficult to incorporate exercise into their daily lives. Other presenters provided new information about nutrition and exercise for people with MS.

The Brain Repair Centre’s members have a long history of involvement with the community. Over the years, they have shared their expertise through a variety of public education programs and given generously of their time and energy to volunteer on health society boards and take part in fundraising events. The Brain Repair Centre has also been a long-time contributor to Brain Awareness Week, providing funding support, helping to organize and promote events, and hosting laboratory tours.
Recognizing the potential of made-in-Nova-Scotia neuro-innovation to save millions of health care dollars while fuelling a growing knowledge economy, Nova Scotia Economic and Rural Development and Tourism has provided the Brain Repair Centre with funding for programs that support entrepreneurship and technology transfer in the neuroscience sector.

Santosh Murthy, BIOTIC

Bridging the Gap from Mind to Market

The Journey From Mind to Market

An idea’s journey from an innovator’s mind to the open market is long and arduous—especially in the realm of brain technologies. It can take years of fundamental research to understand a problem well enough to devise an effective solution. This may be followed by years of working with engineers, clinicians and other experts to develop, test and fine-tune drugs and devices to ensure they’re safe and effective. And this is just the beginning.

Once researchers have proven an innovation will work in principle, they must prove it is feasible to make and market. Along the road to commercialization, they must protect the intellectual property and may need to find industrial partners, secure investment, start a company, negotiate agreements, and other complex tasks outside their typical area of expertise.

Help Along the Way

As a hub for neuroscience innovation, the BRC provides its members with opportunities to learn the ins and outs of commercialization and to connect with people and organizations in the broader community who can help them transform their ideas into reality.

In addition to learning and networking opportunities (see pages 8, 9 and 19), BRC provides direct funding to researchers through its unique knowledge translation grant program.

Brain Repair Centre Knowledge Translation Grants

Brain Repair Centre Knowledge Translation Grants help researchers launch their innovations as commercially viable services and technologies that will help people. Funded by Nova Scotia Economic and Rural Development and Tourism and launched in 2013, the BRC awards the grants through an annual competition. An arms-length scientific-review committee judges the applications and awards up to three $30,000 knowledge translation grants each year. Successful applicants can use the knowledge translation grants to patent their inventions, conduct proof-of-principle or market studies, engineer prototypes, and take other steps along the path to commercialization.
Sultan Darvesh, 2013 Recipient

Intense curiosity about the brain led Dr. Sultan Darvesh to discover that a brain enzyme called butyrylcholine-sterase (BChE) accumulates uniquely among the plaques and tangles of Alzheimer’s disease. After years of study, he and his team found a compound that binds to BChE and lights up in imaging scans to reveal the disease in the living brain. Now, with help from a BRC Knowledge Translation Grant, he’s turning this finding into a technology with the revolutionary power to diagnose Alzheimer’s disease before it progresses to serious impairment.

The BRC grant has enabled Dr. Darvesh to secure the patent on the BChE-binding compound and conduct proof-of-principle studies with collaborators in the Biomedical Translational Imaging Centre (BIOTIC) at the IWK and QEII Health Sciences Centre. This in turn helped him leverage $100,000 from the Canadian Institutes of Health Research and $25,000 from Innovacorp. He plans to begin clinical studies in 2016.

“This project has traction,” says Dr. Darvesh, a QEII neurologist and professor at Dalhousie Medical School who was recently named Dalhousie Medical Research Foundation-Irene MacDonald Sobey Chair in Curative Approaches to Alzheimer’s Disease. “The lack of a tool for diagnosing Alzheimer in the living brain has led to the failure of all clinical trials for an anti-Alzheimer drug to date. With a diagnostic tool in hand, we will have the means to see which drugs are working to halt or reverse the disease. Then, we will have the diagnostic and therapeutic power to prevent an epidemic.”

Dr. Darvesh works closely with Treventis Corporation, launched in Halifax in 2010 to develop diagnostics and therapeutics for Alzheimer’s disease. He now heads the diagnostic arm in Halifax, while Dr. Don Weaver heads the therapeutic arm in Toronto. “We have access to a much larger network of collaborators and investors now,” notes Dr. Darvesh of the firm’s geographic expansion—and recent infusion of $4.3 million from the Wellcome Trust and other private sources. “It’s an exciting venture.” www.treventis.com

“The knowledge translation grant from the Brain Repair Centre provided us with the support we needed to secure a patent and gain proof that our diagnostic strategy for Alzheimer works. With these key items in hand, we were able to attract funding to take our technology to the next level.”

—Dr. Sultan Darvesh
Ying Zhang, 2013 Recipient

A BRC Knowledge Translation Grant is helping Dr. Ying Zhang launch a new technology for rapidly screening potential treatments for ALS (Lou Gehrig’s disease), a fatal disease that destroys motor neurons and the ability to move. So far, the grant has helped her refine the screening technology, develop computer programs for analyzing the data it generates, and begin the process of filing a patent.

The new drug-screening technology is based on the observations of Dr. Zhang’s collaborator, Dr. Victor Rafuse. Dr. Rafuse and his team found that motor neurons die if they lose their synaptic connection to the muscles they activate. Therefore, effective drugs must not only preserve motor neurons, they must also preserve the synaptic connections, which are just as threatened in ALS. “We are among the first to develop a means of evaluating potential drugs for their ability to preserve these essential synaptic connections in ALS,” notes Dr. Zhang, an assistant professor in Dalhousie’s Department of Medical Neurosciences.

On the strength of this new technology, the researchers have joined a collaborative ALS drug-discovery program. They’ll be working with the Université de Montréal, Université Laval and the University of Calgary to fast-track the screening of FDA-approved compounds for their effectiveness against ALS.

“It’s exciting to see our work moving so quickly to real-world application,” says Dr. Zhang. “This technology offers a fast, inexpensive alternative to animal models in the early stages of drug development, so researchers around the world can cast a wider net in their search for treatments—not just for ALS, but for spinal cord injuries and other neurological disorders as well.”

“Support from the Brain Repair Centre is helping me pursue this new direction—as a basic scientist, it’s exciting to see how our efforts to understand motor neurons and muscle innervation can open the door to new technologies with clinical applications.”

—Dr. Ying Zhang

BRC Knowledge Translation Grants in Action

Speeding the Search for a Synapse-Saving Drug

Above: muscle cells
Above right: Dr. Ying Zhang and her team
Dalhousie neuroscientist Dr. Alan Fine has invented a high-resolution microscope that can be made to fit on the tip of a biopsy probe. He and his team have been able to engineer such a small device by taking the radical approach of developing a microscope that has no lens.

"By using a so-called ‘near-field’ imaging approach, we’ve been able to eliminate the lens," says Dr. Fine, a professor in the departments of Physiology & Biophysics, Medicine (Division of Neurology), Pediatrics and the School of Biomedical Engineering. "This solves the problem we have struggled with for centuries in microscopy—the diffraction of light—which causes a blur that degrades the resolution of even the most powerful lens-based microscopes."

Dr. Fine’s lensless microscopes achieve a degree of resolution and magnification that has until now only been possible with very bulky, expensive equipment.

“We’re capturing images of micron-scale features using a device that costs orders of magnitude less than traditional microscopes and can be the size of a cell phone, a memory stick, or even a toothpick,” says Dr. Fine, who has launched a spinoff company, Alentic Microscience, to commercialize the lensless microscopy technology.

Dr. Fine and his collaborators foresee strong demand for devices incorporating this lensless technology, in research as well as in patient care. With support from a BRC Knowledge Translation Grant, Dr. Fine and his team are making the devices more robust and compact, exploring potential applications, and validating performance against current standards. One application he aims to explore is the device’s potential to be used during brain surgery, to improve the safe, efficient and thorough removal of cancerous tissues from the brain.

In addition to his work in microscopy, Dr. Fine studies the fundamental mechanisms of learning and memory.

“Introducing a Revolutionary Lensless Microscope

Alan Fine, 2013 Recipient

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Alan Fine, 2013 Recipient

By using a so-called ‘near-field’ imaging approach, we’ve been able to eliminate the lens,” says Dr. Fine, a professor in the departments of Physiology & Biophysics, Medicine (Division of Neurology), Pediatrics and the School of Biomedical Engineering. "This solves the problem we have struggled with for centuries in microscopy—the diffraction of light—which causes a blur that degrades the resolution of even the most powerful lens-based microscopes."

Dr. Fine’s lensless microscopes achieve a degree of resolution and magnification that has until now only been possible with very bulky, expensive equipment.

“We’re capturing images of micron-scale features using a device that costs orders of magnitude less than traditional microscopes and can be the size of a cell phone, a memory stick, or even a toothpick,” says Dr. Fine, who has launched a spinoff company, Alentic Microscience, to commercialize the lensless microscopy technology.

Dr. Fine and his collaborators foresee strong demand for devices incorporating this lensless technology, in research as well as in patient care. With support from a BRC Knowledge Translation Grant, Dr. Fine and his team are making the devices more robust and compact, exploring potential applications, and validating performance against current standards. One application he aims to explore is the device’s potential to be used during brain surgery, to improve the safe, efficient and thorough removal of cancerous tissues from the brain.

In addition to his work in microscopy, Dr. Fine studies the fundamental mechanisms of learning and memory.

“It’s difficult to find funding for pre-commercialization research, as there are very few sources available. The Brain Repair Centre Knowledge Translation Grants are filling a very important gap.”

—Dr. Alan Fine
Nova Scotia has one of the highest rates of stroke in Canada. It’s fitting that a Nova Scotia-based institute like the Brain Repair Centre is funding researchers from our own community to advance practical solutions.

—Dr. Shaun Boe

Shaun Boe and Timothy Bardouille, 2014 Recipients

While using MEG brain-imaging technology to learn how the brain changes after a stroke, Drs. Shaun Boe and Timothy Bardouille hit upon a potential game-changer in the field of post-stroke motor rehabilitation. Now, a knowledge translation grant from the BRC is helping them turn their idea into a portable device to help stroke survivors regain lost motor abilities.

“We’re developing an inexpensive, portable technology that combines a headset and smart phone to monitor brain activity and give people visual feedback on their mental efforts,” explains Dr. Bardouille, a physicist and brain-imaging researcher in the Biomedical Translational Imaging Centre (BIOTIC) at the IWK Health Centre. “This will help them fine tune their efforts for the best results.”

The portable device grew out of the researchers’ work with the massive MEG (magnetoencephalography) machine in BIOTIC’s IWK facility. “Using the MEG, we’ve been able to see how mental exercises activate the brain connections needed to re-establish control over movements,” says Dr. Bardouille.

The researchers will use the BRC Knowledge Translation Grant to develop the software and a working prototype of their device, while securing the intellectual property and seeking an industrial partner.

To rehabilitate motor abilities—such as holding a toothbrush and brushing your teeth—you actually have to fix the brain,” says Dr. Boe, a Dalhousie-Capital Health neuroscience researcher with clinical training in physiotherapy. “This means you have to rebuild the neural connections involved with this movement.”

Drs. Boe and Bardouille are designing a device to help patients use the power of guided mental imagery to improve their rehabilitation results, with less time on physical exercises.
We need new approaches to knowledge translation that allow researchers to take the outputs of research to patients faster. The BRC Knowledge Translation Grants are an important new tool to help accomplish this goal.”

—Dr. Michael Schmidt
George Robertson, Paola Marignani, 
Jian Wang, 2014 Recipients

After years of lab work to perfect a unique formulation of naturally sourced extracts, Dalhousie pharmacology professor Dr. George Robertson is taking his work to the next level. He and his collaborators are validating the effectiveness of this new formulation in preventing chemotherapy-induced hearing loss, with support from a BRC Knowledge Translation Grant.

“Neurons in the cochlea are exquisitely sensitive to the toxic effects of a common chemotherapy drug called cisplatin,” explains Dr. Robertson, adding that children are particularly vulnerable to these damaging effects. “When these neurons die, the brain cannot detect the vibrations moving through the cochlea and the neural connection required for hearing is lost.”

Dr. Robertson is working with Dalhousie Medical School cancer researcher, Dr. Paola Marignani, and Dr. Jian Wang, a professor in Dalhousie’s School of Human Communication Disorders. “It’s a great combination,” he notes. “I have the therapeutic compound, Dr. Marignani has the expertise in cancer and pre-clinical disease models, and Dr. Wang has the expertise and equipment to measure minute changes in hearing ability.”

Together, the researchers have shown how cisplatin damages the cochlear neurons—and how Dr. Robertson’s compound protects the neurons from this damage. The BRC Knowledge Translation Grant will allow them to complete pre-clinical studies and secure the intellectual property.

Dr. Robertson has found that his compound may protect the brain from the neuro-toxic effects of medications other than cisplatin, and that it also protects neurons from damage in multiple sclerosis (MS). “I believe there are many neuroprotective applications for this compound,” he says, noting that, because of its source, the compound is extremely safe.

“The BRC Knowledge Translation Grants are so important—they remove roadblocks and give researchers the opportunity to pursue real-world applications for their research.”

—Dr. George S. Robertson
Brain Repair Centre Commercialization Learning Sessions

In 2014, the Brain Repair Centre began offering learning sessions, to equip members with information and insight to aid them in their efforts to translate their research findings into real-world innovations.

The first two learning sessions, held in March 2014, provided participants with an overview of two fundamental aspects of commercializing research: assessing market risk and potential, and protecting intellectual property.

Protecting Medical Inventions: What Every Researcher Should Know

Participants learned the ins and outs of intellectual-property protection from a leading expert in the field, Dr. Jennifer Raoul, a partner and registered patent agent in the Ottawa office of Borden Ladner Gervais, LLP. Dr. Raoul shared her experience in drafting and prosecuting patent applications, and providing IP-related strategic advice and legal opinions to a variety of clients, including universities, research organizations, start-ups and global organizations.

Reduce Market Risk in Neuroscience Ventures

At this session, participants learned how to accurately assess and maximize the true market potential of their ideas. At the same time, they learned how to assess, anticipate and mitigate risks they could encounter in the marketplace as they take steps to commercialize their innovations. Joseph Galatowitsch, president and managing partner of Dymedex Consulting, led the session, sharing wisdom gained through more than 25 years of experience in medical business management, marketing and market development.

One-on-One Market Development Consultation

The BRC also provided its members with the opportunity to book one-on-one in-depth consultation sessions with Joseph Galatowitsch. Numerous members preparing to launch new products and devices took advantage of this unique chance to explore strategies for achieving success with one of North America’s leading medical business consultants.
Involving and Recognizing Students

The Brain Repair Centre and its investigator members find many opportunities to involve students and postdocs in activities that will develop their abilities as scientists, communicators and leaders. Trainees actively participate in BRC learning, networking and poster sessions and, with support from the BRC, have established the Undergraduate Neuroscience Journal Club to expand their awareness of the latest findings in the scientific literature and build their presentation skills.

Displaying Students’ Research

Researchers often share the results of their research via posters at scientific events. The BRC encouraged neuroscience graduate students to present posters at the 2014 Parkinson Disease Education and Awareness Conference and the 2013 BRC Research and Poster Day. The BRC offered cash prizes to the top two student posters at its poster day, as selected by secret ballot:

- First place went to Kaitlyn Holman, a graduate student in the labs of Dr. Kevin Duffy (Psychology & Neuroscience) and Dr. Bill Baldridge (Medical Neuroscience). Her poster showed results of her recent study of the role of sensory experience in neural development and plasticity.

- Second place went to Jessica Taylor, a graduate student in the lab of Dr. Ian Weaver (Psychology & Neuroscience), who studies the effects of in-utero and early-life stress on brain development.

As a research institute of Dalhousie University, one of the Brain Repair Centre’s roles is to foster the next generation of neuroscientists. BRC investigator members collectively supervise as many as 200 trainees. Their reputations and the stature of the BRC helps attract top graduate students and postdoctoral fellows from across Canada and around the world to pursue research studies in Halifax. Talented young people like these are the backbone of Nova Scotia’s neuroscience community and new knowledge economy.
The Brain Repair Centre has been a key funding partner of the Summer Institute in Neurotechnology, Innovation and Commercialization (NICE) since its inception in 2012. This annual 12-day intensive training program welcomes neuroscience trainees and researchers with a self-starting mindset who are motivated to transform neuroscience discoveries into viable solutions to real-world problems.

The NICE Summer Institute provides a thorough grounding in such vital topics as:

- finding and analyzing needs
- product design and prototyping
- protecting and licensing intellectual property
- financing, starting and running a business

More than 40 participants—mostly from Canada but also from the United States, Norway and Poland—had completed the course as of fall 2014. Participants reported high satisfaction with the calibre of the presenters and the scope and usefulness of the course contents.

The NICE Summer Institute is part of the NSERC-funded RADIANT CREATE Neurotechnology Innovation and Entrepreneurship program, a graduate certificate program that instills business knowledge and entrepreneurial thinking in young neuroscientists with a keen interest in pioneering new diagnostic and therapeutic technologies.

Jumping into entrepreneurship (above): His experience with the NICE Summer Institute inspired Dalhousie neuroscience PhD student Chris Cowper Smith (centre) to complete the Starting Lean entrepreneurship program, also at Dal. There he met the partners with whom he has since launched Spring Loaded Technology (www.springloadedtechnology.com). He’s now working with his PhD supervisor, BRC member Dr. David Westwood (right), to see how the company’s Levitation™ knee brace can be adapted to help people with neurologically based movement disorders. He has a particular interest in stroke.
Stroke and Parkinson’s disease can both impair a person’s ability to pay attention, hold multiple thoughts in mind, reason and solve problems. That’s why Dr. Gail Eskes, a clinical neuropsychologist at Capital Health and professor in the departments of Psychiatry and Psychology at Dalhousie University, has teamed up with Bedford, N.S.-based digital technology firm, REDspace, to develop the Cognitive Repair Kit.

The Cognitive Repair Kit includes a variety of video-game-based tools that help stroke survivors and Parkinson’s patients rebuild their working memory and ability to stay focused in their day-to-day lives. While REDspace fine tunes the games, Dr. Eskes and her team are testing their effectiveness in patients and healthy volunteers—including graduate students.

“Ultimately, we see a global market that goes beyond rehabilitation to encompass cognitive enhancement,” says Dr. Eskes, who has received $1.8 million from ACOA’s Atlantic Innovation Fund and matching funds from local partners to create and test the Cognitive Repair Kit.

Other tools in the works for the Cognitive Repair Kit include games to reduce a person’s distractibility and improve their ability to stay focused on a task—abilities that are also commonly affected by brain injury and disease.

Another problem that affects about half of the people who survive a stroke is called spatial neglect. “They literally cannot perceive the left-hand side of their environment, which is a huge safety issue,” explains Dr. Eskes. “We’ve developed a game to go with ‘prism’ goggles that shift one’s vision to the left, and have received funding from Springboard to adapt it to an iPad app.”
Researchers in the Biomedical Translational Imaging Centre (BIOTIC) at the IWK and Capital Health are pioneering the next generation of technologies for mapping and assessing the brain. One of their largest projects is with Scandinavian company, Elekta Neuro-mag, to develop non-invasive methods of mapping key brain functions prior to epilepsy surgery, using MEG (magnetoencephalography). Elekta is one of the world’s leading MEG manufacturers.

“Clinical teams must precisely locate the brain regions that control motor functions and language processing before going in to remove the area that’s generating seizures,” explains Dr. Steven Beyea, scientific lead of BIOTIC and associate professor in Dalhousie’s Department of Diagnostic Radiology. “We aim to replace risky current brain-mapping techniques, such as open-skull surgery to place electrodes on the brain and the Wada test, which injects an anesthetic drug into one half of brain.”

The BIOTIC researchers have launched a clinical research trial with collaborators in Finland to test their new MEG protocol for mapping language in the brain. They’re also working with Elekta to develop MEG techniques for assessing concussions, traumatic brain injuries and Alzheimer-related brain changes. ACOA’s Atlantic Innovation Fund is a key investor in the BIOTIC-Elekta partnership.

Among 15 companies it’s worked with over the past year, BIOTIC is facilitating a synergistic partnership between Winnipeg-based Cubresa Inc. and the Halifax-based diagnostic arm of Treventis Corporation, led by Dalhousie/QEII neurologist Dr. Sultan Darvesh. This effort will help Cubresa develop new applications for its SPECT technology, while validating Dr. Darvesh’s new method for diagnosing Alzheimer’s disease in its early stages (see page 13).

Revenues flow to BIOTIC from diverse sources, including the Government of Nova Scotia, academic departments and individual researchers at Dalhousie University, as well as from grants and industry partners. Its goal is to become self-sustaining.
Vision researchers at Dalhousie Medical School and the QEII are working with the world’s leading maker of clinical eye-imaging devices, Heidelberg Engineering, to develop breakthrough technologies for seeing inside the living human eye. Their goal is to invent technologies that reveal the structure and function of individual neurons and groups of neurons in the retina.

Vision scientist Dr. Balwantray Chauhan has been working with Germany-based Heidelberg Engineering for more than 20 years, helping the company develop technologies that are used in ophthalmology clinics around the world. With funding from ACOA’s Atlantic Innovation Fund, he and his collaborators, including Dalhousie neuroscientist Dr. Bill Baldridge, are working with Heidelberg Engineering to pioneer the next generation of eye-imaging devices.

“The new technology we’re developing will reveal a level of detail we never thought we’d be able to see. It’s like the difference between binoculars and the Hubble telescope—it will enable us to precisely track changes in the eye as neurons die in glaucoma, diabetic retinopathy, and other blinding diseases.”

Vision researchers at Dalhousie Medical School and the QEII are working with the world’s leading maker of clinical eye-imaging devices, Heidelberg Engineering, to develop breakthrough technologies for seeing inside the living human eye. Their goal is to invent technologies that reveal the structure and function of individual neurons and groups of neurons in the retina.

The researchers are taking advantage of a series of new developments that open the door to previously impossible advances. “We want to combine new methods of labelling living cells with new techniques for safely injecting the human eye, and new 2-photon imaging, to create a technology that will allow us to assess the function of individual neurons in a living person’s eye,” says Dr. Baldridge, who heads the Department of Medical Neuroscience. “This would be a truly revolutionary step forward in vision research and eye care.”
In February 2014, Nova Scotians were called to action with an urgent plea from the Nova Scotia Commission on Building Our New Economy. The commission galvanized many in the province with its report, *Nova Scotia Now or Never*—or, simply, The Ivany Report, in honour of the commission’s chair, Ray Ivany.

The Ivany Report detailed an array of challenges—from youth outmigration and our disproportionately aging population, to industrial failures and dwindling federal-government support—that could lead to a severe economic slump, *if* people across all sectors, political parties and communities do not come together in a concerted, cooperative effort to build a better, stronger province.

The Brain Repair Centre and its academic health-sciences partners are poised to play a pivotal role in this critical province-building effort. In fact, the local health research community is already working on a collective vision to build a vibrant economic sector on our strong foundation of health research, infrastructure and partnerships. Now, we want to expand that partnership to include the broader community.

This community has already proven it can accomplish a lot in the realm of brain repair—together, we’ve built a world-class research facility (the Life Sciences Research Institute) and a highly collaborative, productive and innovative neuroscience research community that’s making an impact on the prevention, diagnosis and treatment of brain-related diseases.

The results of this research will become increasingly crucial as Nova Scotia’s population ages and faces ever-rising rates of neurodegenerative disease. We have the potential in this community to tackle a looming problem that will cripple our health care system unless we mobilize the resources to support ongoing neuroscience research. If we can obtain the necessary research dollars, we will be able to create the diagnostic, preventive and treatment strategies of the future, while creating jobs and attracting talent to Halifax from all over the world.

It’s a powerful win-win scenario that requires sustained commitment and investment.

Visit www.brainrepair.ca, or call (902) 494-3502, to make a contribution to research at the Brain Repair Centre, through Dalhousie Medical Research Foundation. 100% of every donation will go directly to support neuroscience research in Nova Scotia.

Donations to support local neuroscience research can also be made through the QEII Foundation by calling (902) 473-7932.

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