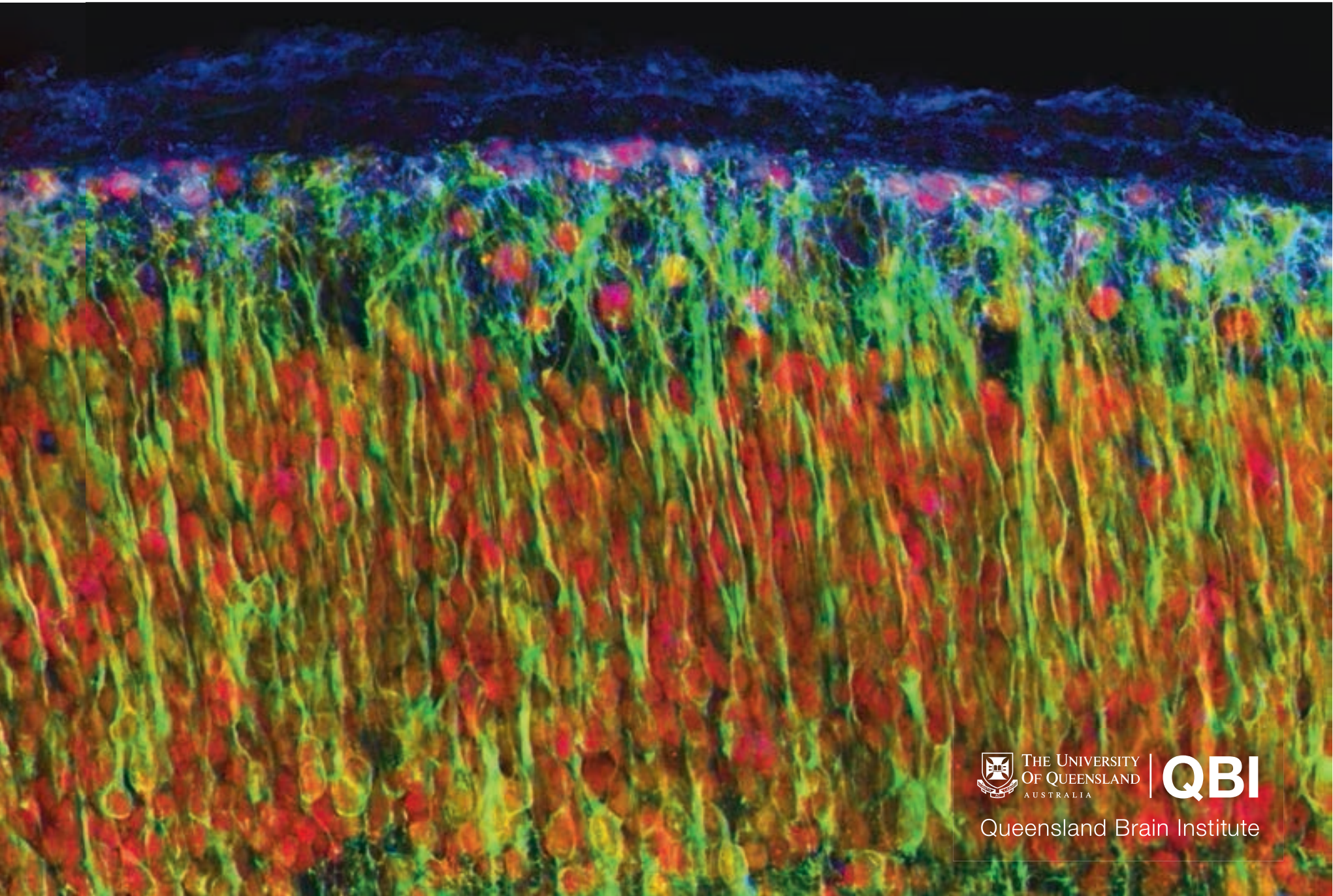
Queensland Brain Institute **2014 Annual Report**



The University Of Queensland
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Queensland Brain Institute

Cover Image: *Garden of Neurons* by **Gonzalo Almarza**

We are studying different populations of neurons in the cortex. In this image, subplate neurons (green) extend their processes towards the pial surface during early cortical development. These neurons project through the emerging cortical plate (in red), arborising in the marginal zone (in blue).

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Table of Contents

UQ Vice-Chancellor and President's Report

I am delighted to share with you a selection of the many successes achieved at the Queensland Brain Institute (QBI) in 2014.

Under the strong leadership of founding Director, Professor Perry Bartlett, QBI has progressively augmented an exemplary record built on collaborations, beginning with robust research partnerships at UQ, and extending to global research consortiums, philanthropists and companies.

The continued growth of the Clem Jones Centre for Ageing and Dementia Research (CJCADR), led by Professor Jürgen Götz, is testament to the power of collaboration. In 2014, CJCADR joined with the Chinese Academy of Sciences' Institute of Biophysics to create an Australia-China centre focussed on dementia research.

Further enhancing this work, the Stafford Fox Medical Research Foundation gifted $2.5 million for an international fellowship to study stroke-induced dementia—the cause of around 40 per cent of dementias. Also thanks to philanthropic support, German postdoctoral researcher and recipient of the prestigious Peter Hilton Research Fellowship in Ageing Dementia Dr Liviu-Gabriel Bodea joined CJCADR. Dr Bodea's expertise in neuroimmunology adds significant traction to QBI's dementia program.

QBI has continued its strong commitment to young scientists, and in 2014 two early career researchers, Dr Ramesh Narayanan and Dr Roger Marek, received The University of Queensland's Dean's Award for Research Higher Degree Excellence, for theses submitted in 2013. Dr Narayanan's winning work advanced knowledge of the mechanisms behind motor neuron disease; Dr Marek's thesis focussed on the neuronal circuit that is involved in the acquisition and extinction of fear memory. Both researchers reflect the extreme dedication to research outcomes exhibited across QBI's faculty.

QBI also hosted 24 Chinese students from Fudan University and Wenzhou Medical College as part of a six-week engagement at UQ to tighten ties between the institutions. Their positive experiences will produce benefits well into the future for people of both countries and for the global community.

Meanwhile, QBI continued to invest in coming generations of Australian knowledge leaders, and welcomed teenagers from more than 60 high schools for the 2014 Queensland Final of the Australian Brain Bee Challenge. Queensland has produced two of the last three champions of the International Brain Bee—and the Australian component owes its existence to QBI's Professor Linda Richards, who founded the competition here in 2006.

Before finishing, I wish to congratulate Professor Perry Bartlett for being awarded the prestigious Distinguished Achievement Award by the Australian Neuroscience Society. Perry is a lion of neuroscience, who during a 40-year career has been responsible for a series of ground-breaking discoveries that will have perpetual positive impact. His global reputation and unflagging commitment to excellence and outcomes have helped attract outstanding staff, students and partners to the QBI. You will see overviews of some of their work in the pages that follow. I congratulate and thank each and every one. The best news, perhaps, is that the best is yet to come!

Professor Peter Høj
Vice-Chancellor and President
The University of Queensland

QBI Director's Report

At a time when research funding is becoming increasingly more competitive, I am delighted with the success of our scientists in obtaining fellowships and grants totalling more than $26.5 million in 2014. In addition, we have received commitment for three new research multi-year fellowships to commence at QBI in 2015, supported entirely by the philanthropy of our wonderful supporters.

In our eleventh year, I reflect with satisfaction on the growth of QBI's publications in high impact scientific journals, from the very first paper published in *Nature Neuroscience* in 2002, to this year's output of seven in *Nature*, one in *Science*, two in *Neuron* and 15 in other named *Nature* journals among the 277 papers published in frontline journals.

We have featured a selection of these discoveries in this year's Annual Report, including Professors Bryan Mowry, Naomi Wray and Peter Visscher's work in revealing dozens of sites across the human genome that are strongly associated with genetic predisposition to schizophrenia.

In the world's largest molecular genetic study into a psychiatric disorder, using DNA samples from 36,989 schizophrenia patients, researchers used a genome-wide association study to find genetic variations between the patients and 113,075 control samples. The study uncovered 108 sites, 83 of which were previously unidentified, that form the genetic underpinnings of schizophrenia, which is an incredible result.

Following this, I was delighted to announce the appointment of Professor Peter Visscher and Professor Naomi Wray as Co-Directors of the new Centre for Neurogenetics and Statistical Genomics (CNSG), here at QBI. The Centre aims to understand the genetic basis of a range of brain diseases and to develop new statistical methodologies and computational tools to aid analysis of the human genome.

In this year's Annual Report you will also find featured the work of QBI Deputy Director (Research) Professor Pankaj Sah on how the brain plans movement. In collaboration with neurologist Professor Peter Silburn and neurosurgeon Associate Professor Terry Coyne from the UQ Centre for Clinical Research, Professor Sah examined the brains of 10 patients with Parkinson's disease while the patients were awake during deep brain stimulation surgery. They found more than one part of the brain is responsible for planning movement. This improved understanding of how the brain plans movement could lead to more targeted treatments for people with Parkinson's.

Professor Sah should also be commended for his appointment as Director of the Science of Learning Research Centre (SLRC), a Special Research Initiative of the Australian Research Council. Professor Sah is internationally renowned for his work in understanding the role of the amygdala—the area of the brain involved in emotional processing—in learning.

In addition to this recognition of high achievement, our scientists received many awards during 2014.

HRH Prince Philip, The Duke of Edinburgh presented the Royal Institute of Navigation's highest honour, the Harold Spencer-Jones Gold Medal, to Professor Mandyam Srinivasan. Professor Srinivasan studies insects and birds to understand how animals with small brains navigate complex environments. He applies that research in the field of robotics to help unmanned aerial vehicles avoid collisions and safely navigate their environments. In 2014, Professor Srinivasan was also named an inaugural Queensland Government Science Champion and elected into the Australian Academy of Science Council.

QBI laboratory head Professor Peter Visscher was identified on the prestigious 2014 Thomson Reuters Highly Cited Researchers list. The list identifies researchers ranked in the top one per cent by citation rate during 2002–2012, with Professor Visscher appearing in the category of Molecular Biology & Genetics.

Professor Justin Marshall was awarded the ARC's most prestigious fellowship, the Laureate Fellowship, one of only 16 awarded across Australia. This was in recognition of his pioneering work in discovering the neuroscientific basis of vision in marine animals, which is deepening on our understanding of human vision and being used to develop innovative devices to record visual information.

I was deeply honoured to receive the Australasian Neuroscience Society (ANS) Distinguished Achievement Award, granted "in honour of an outstanding contribution by an individual to neuroscience in Australia". This was especially pleasing because it recognises the achievements of the many students and postdoctoral fellows who I have been fortunate to have worked with over the past 40 years. In addition, I was greatly honoured to join the small group of distinguished scientists who have previously received this award: David Curtis (2009), Elspeth McLachlan (2006), John Furness (2003), Max Bennett (2001), Stephen Redman (2000) and Lawrie Austin (1993).

I wish to thank my many colleagues and friends who directly contributed to the Award and who have continued to be indispensable to the growth and success of QBI. In particular, I wish to acknowledge the support delivered by Professor Pankaj Sah and his team of Ms Rowan Tweedale and Dr Sylvie Pichelin, along with the administrative support provided by Deputy Director (Operations), Mr John Kelly, and Institute Manager, Mrs Helen Weir.

I also wish to recognise the role of the QBI Advisory Board, chaired by Dr Sallyanne Atkinson AO ,in guiding the Institute, and the QBI Development Board, chaired by Mr Jeff Maclean. Your support and generosity has enabled QBI to maintain its leading position as a hub for neuroscience discovery and translation, and I look forward to your continued support and friendship in 2015.

I extend my personal gratitude to our many donors and supporters, as this support is paramount to the success of the Institute.

Finally, my warmest thanks to Vice-Chancellor and President Professor Peter Høj, and Provost and Senior Vice-President Max Lu for their guidance and support.

Thank you again for your support,

Professor Perry Bartlett FAA
Director, Queensland Brain Institute

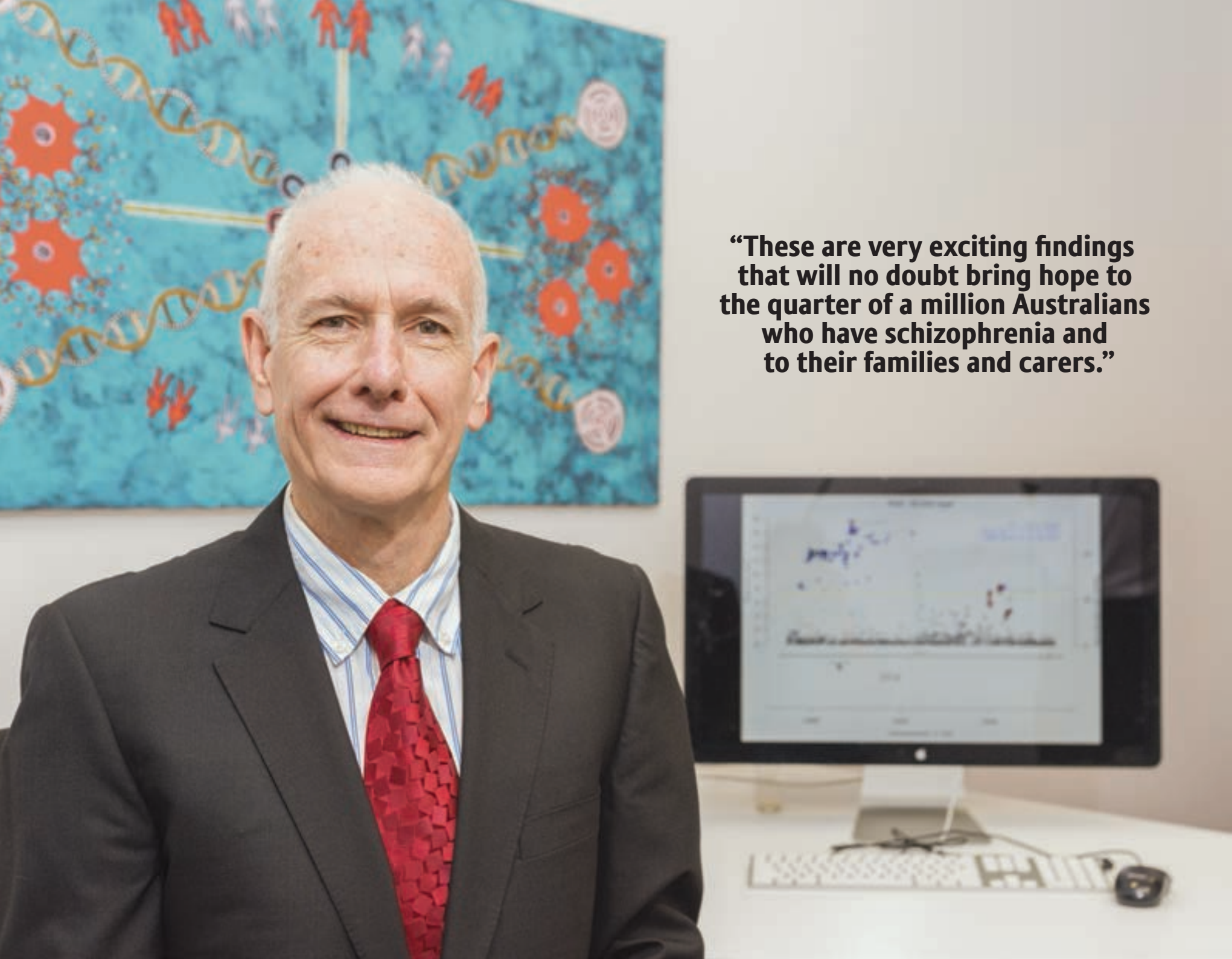
Discovery

The Queensland Brain Institute has rapidly positioned itself as one of the world's leading neuroscience research facilities.

QBI fosters an environment of discovery that will ultimately lead to the development of much-needed therapeutic treatments to combat diseases in which brain function has failed or is compromised.

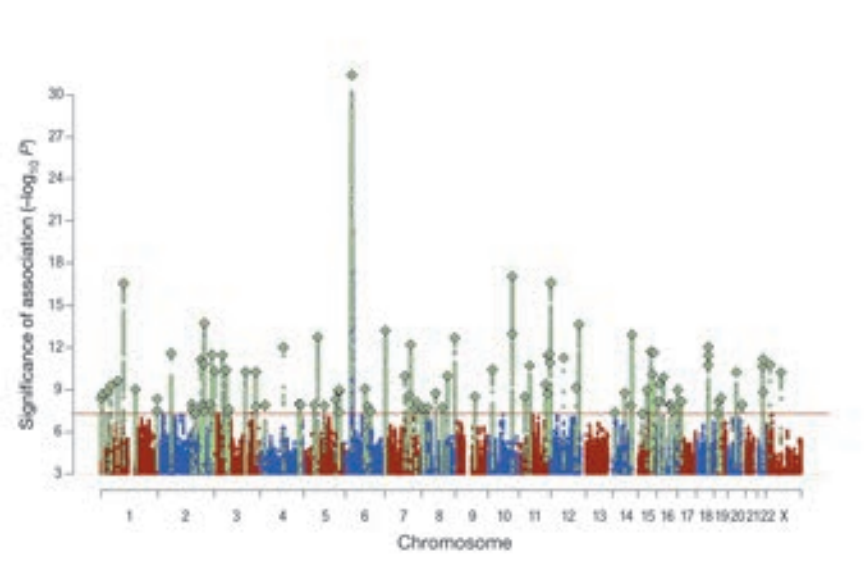
Here, we celebrate some of QBI's fundamental breakthroughs in 2014.

Nadia Cummins, Götz Laboratory.



“These are very exciting findings that will no doubt bring hope to the quarter of a million Australians who have schizophrenia and to their families and carers.”

Genome analysis reveals schizophrenia's secrets



Effective treatments for schizophrenia are closer after dozens of new sites across the human genome strongly associated with genetic predisposition to schizophrenia were uncovered.

The study, published in *Nature*, involved Professor Bryan Mowry, who said it was the world's largest molecular genetic study into a psychiatric disorder.

Professor Mowry said the study found 108 sites, 83 of which were previously unidentified, that formed the genetic underpinnings of schizophrenia.

"This provides the potential for understanding the causes of the illness and for discovering new treatments," he said.

These locations were not randomly distributed across the genome but converged upon genes that were expressed in certain tissues, particularly the brain and in tissues with important immune functions.

"These are very exciting findings that will no doubt bring hope to the quarter of a million Australians who have schizophrenia and to their families and carers," Professor Mowry said.

"This study constitutes a rapid advance in our understanding of the genetic architecture of schizophrenia, opening the door to expanding our understanding of its underlying biology."

Schizophrenia is a highly inheritable, debilitating psychiatric disorder that affects about one in every 100 people worldwide, and is characterised by hallucinations, disturbed beliefs and a breakdown of thought processes.

It is ranked ninth in the global burden of illness and is estimated to cost Australian society $5 billion a year.

Despite the huge cost to individuals and to society, only in the past five years has substantial progress been made.

"Interestingly, by far the strongest genetic finding links schizophrenia to a region previously identified in autoimmune diseases, implying the possibility of an autoimmune pathology in the disease, and is one that warrants further investigation."

Using DNA samples from 36,989 schizophrenia patients, researchers used a genome-wide association study to find genetic variations between the patients and 113,075 control samples.

"By screening the DNA of people with schizophrenia and those without it at millions of DNA markers across the human genome, we were able to determine which markers were statistically significantly associated with this disorder," Professor Mowry said.

"The next steps will involve determining the functional basis of these genetic signals and how they interact together to cause illness, and then develop new therapeutic interventions."

UQ partnered with more than 200 organisations in the Schizophrenia Working Group of the Psychiatric Genomics Consortium, including researchers from QBI, QCMHR and the Royal Brisbane and Women's Hospital Department of Psychiatry.

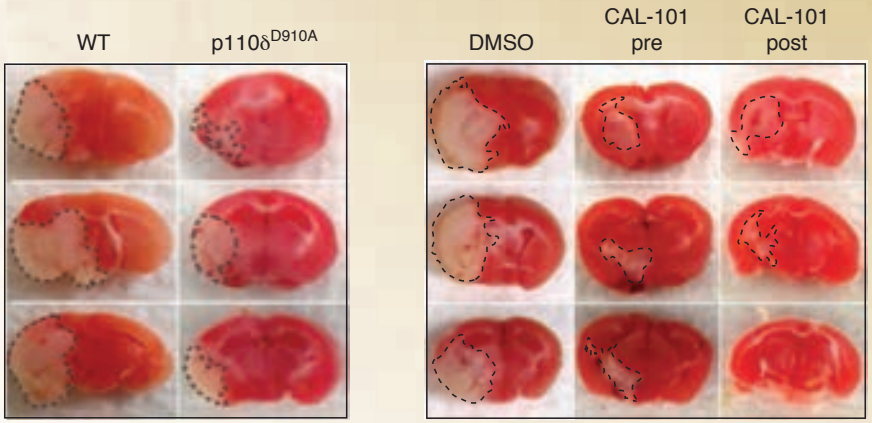
QBI's Professor Naomi Wray, Professor Peter Visscher, and Dr Sang Hong Lee also contributed to the analyses of the dataset.

Above left: A 'Manhattan plot' showing the sites across the human genome that are associated with a genetic predisposition to schizophrenia.

Far left: Professor Bryan Mowry.

“We’ve found that a molecule called CAL-101 could selectively prevent excess neuroinflammation.”

Halting the damaging effects of stroke



Professor Fred Meunier led an international team to discover a new avenue for the treatment of the debilitating effects of ischaemic stroke on patients.

The team discovered that the molecule CAL-101 can be used to stop inflammation of the brain.

Professor Meunier said that current stroke treatments—primarily aspirin or tissue plasminogen activator—clear clots caused by stroke, but often result in extra trauma as blood rushes back into highly delicate areas already damaged in the brain.

"Whenever you have a clot, you have inflammation, and when this happens in the brain it is very bad news," Professor Meunier said.

"Therefore it's critical to stop inflammation following clotting in the brain, and we've found that a molecule called CAL-101 would selectively prevent excess neuroinflammation."

The team found that mice treated with CAL-101, a selective phosphoinositide-3 kinase delta (PI3Kδ) inhibitor, received up to three hours of protection against the excessive secretion of tumour necrosis factor (TNF) that causes inflammation.

Results showed that there is a window of opportunity for treatment before further damage is caused, and this method would be an ideal first response treatment administered in conjunction with current treatments.

The findings of this highly promising therapeutic strategy coincide with current public health messages to identify the signs of stroke, and seek immediate medical treatment for a stroke victim.

The estimated economic burden in Australia is $49.3 billion.

CAL-101 was named molecule of the year by the FDA in America for the treatment of Hodgkin lymphoma, leaving the researchers hopeful that use of the molecule as a stroke treatment could be fast-tracked.

Though stroke is known to be a major cause of disability, with one Australian suffering a stroke every 10 minutes, fewer people understand the longer-term consequences.

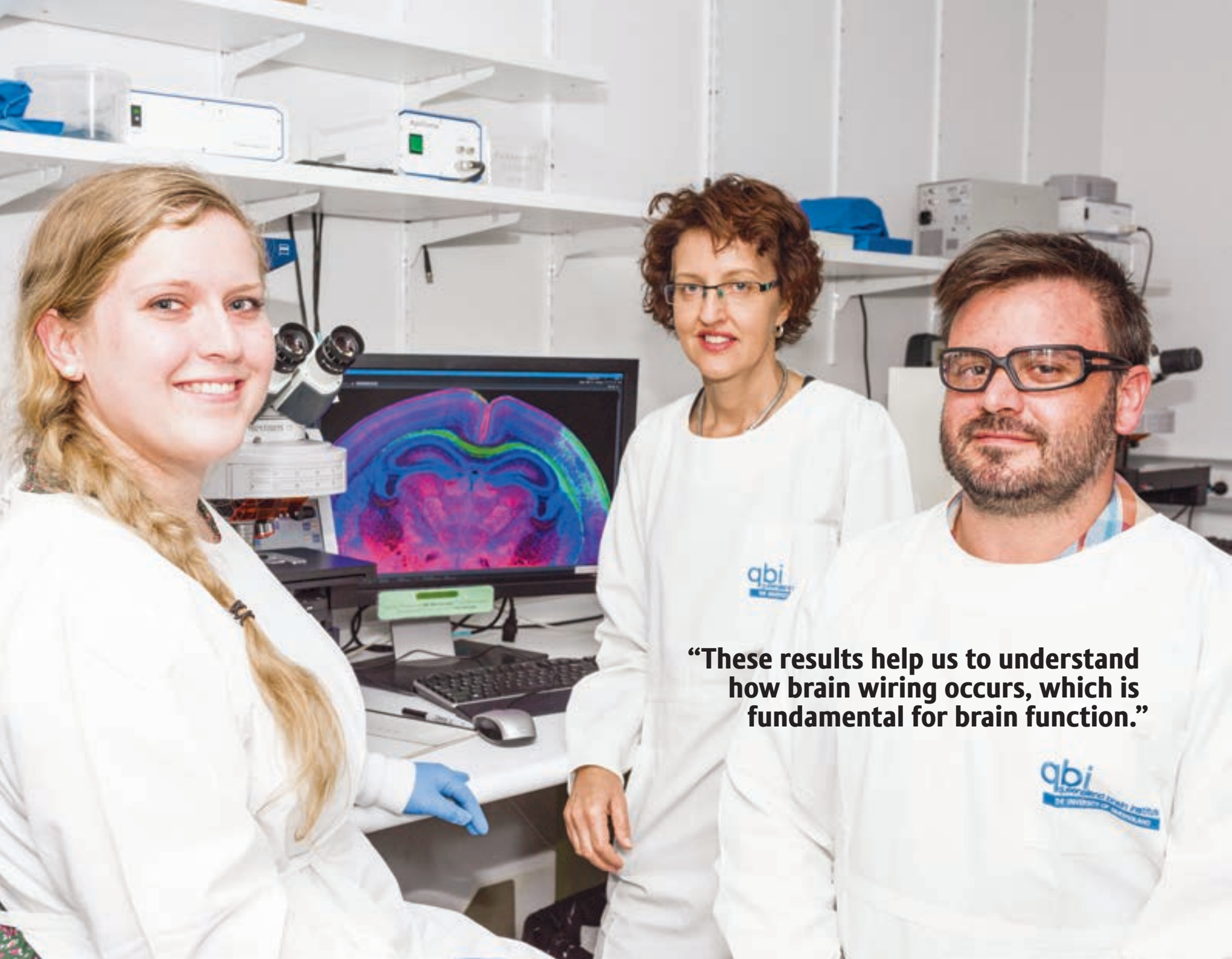
Additionally, stroke is the cause for around 40 per cent of dementias, highlighting the impact that the condition can have 'down-stream' for longer-term consequences beyond the initial event.

QBI worked together with UQ's School of Biomedical Sciences and Institute for Molecular Bioscience, as well with researchers from the University Medical Center Hamburg-Eppendorf, Germany; University College London, UK; and Monash University.

The study was published in *Nature Communications*.

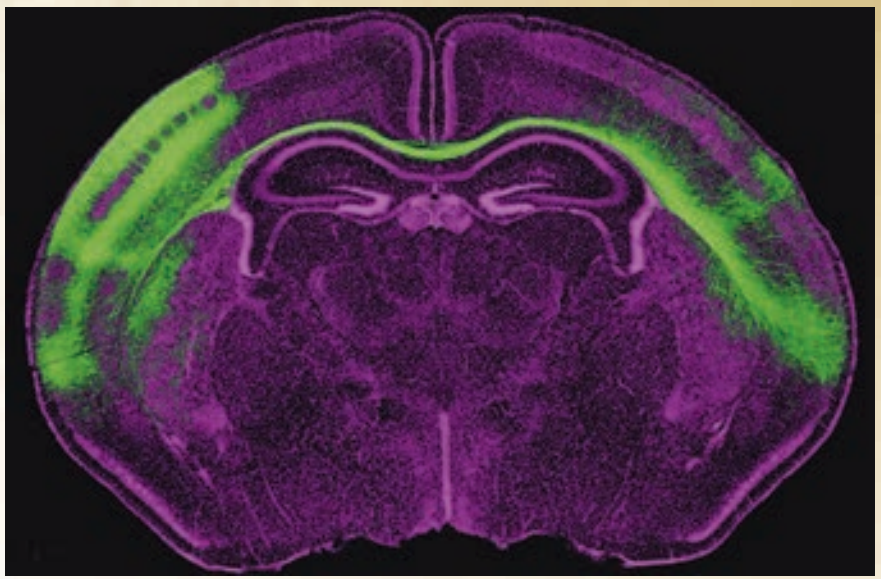
Above left: Decrease in infarct volume in p110δD910A mice (left) and mice treated with the p110δ inhibitor CAL-101 (right) and subjected to experimental ischaemic stroke.

Far left: Professor Frederic Meunier.



“These results help us to understand how brain wiring occurs, which is fundamental for brain function.”

Revealing the complexity of wiring the brain



A study discovered that early experience affects how the two sides of the brain are wired together after birth.

The study led by Professor Linda Richards found that balanced sensory input from both sides of the body is required for correct wiring to occur.

The connections that were highlighted in this study comprise a large fibre tract called the corpus callosum, which acts as a bridge between the two halves of the brain and plays a role in the development of social skills, language, touch, vision, hearing, and motor control.

These connections form during brain development and are shaped by both genes and experience.

Work in the Richards Laboratory showed that the developing corpus callosum requires balanced sensory input from both sides of the body in order to form the right connections between the two brain hemispheres.

"These results help us to understand how brain wiring occurs, and correct brain wiring is fundamental for brain function," Professor Richards said.

Malformations of the corpus callosum have an incidence of at least one in 3,000 people and result in a wide range of symptoms such as poor coordination, delayed childhood development milestones such as walking, and even lower perception of pain.

Corpus callosum malformations are also sometimes associated with psychiatric illnesses such as schizophrenia and autism.

The study was conducted in developing mice and found that when corpus callosum neurons were deprived of sensory or endogenous activity in one brain hemisphere they wired incorrectly.

This process could be rescued by manipulating activity in both hemispheres in a symmetric manner, demonstrating that not just overall activation, but balanced levels of neuronal activity between brain hemispheres are critical for precise wiring.

Dr Rodrigo Suárez and PhD candidate Ms Laura Fenlon were co-lead authors on the study.

"These results expand our understanding of how functional brain circuits form during development," Dr Suárez said.

"For example, not only sensory-evoked but also spontaneous activity is employed by these axons to accurately find their contralateral targets."

The research paper also showed that malformations of the corpus callosum can occur in subtle ways, as connections were disrupted only in their final stages of being established.

Small alterations of circuit connectivity during postnatal stages may have an impact on the development of psychiatric illnesses.

"The work advances our knowledge about how corpus callosum axons find their correct targets in the opposite hemisphere, which could have wide-reaching implications for numerous brain disorders involving altered brain connectivity," Ms Fenlon said.

The researchers now want to learn how the balanced activity influences the corpus callosum neurons to change their growth, and they are also looking for genes that might be involved in this process.

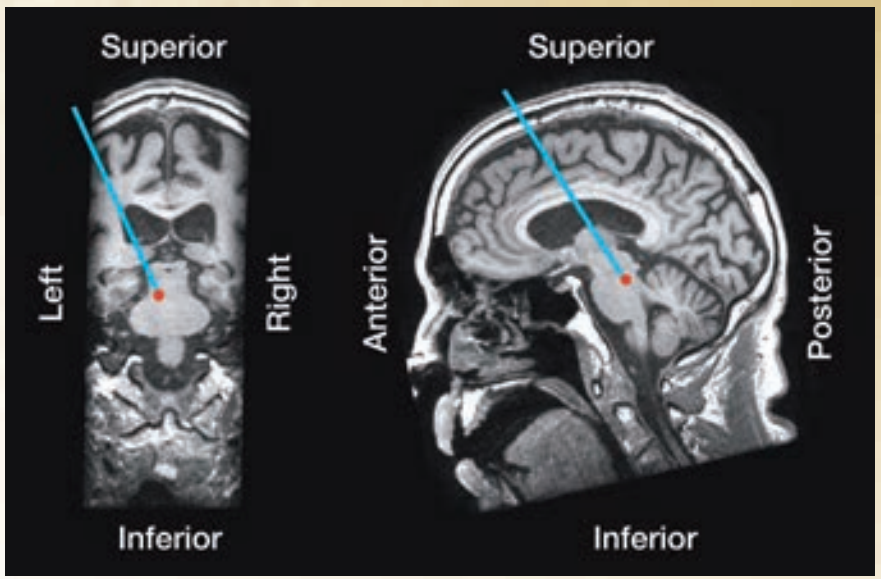
The study was published in the prestigious journal *Neuron*.

Above left: A green fluorescent protein was used to label neurons that project their axons across the mouse brain, from the left to the right side, via the corpus callosum.

Far left (L-R): PhD candidate Laura Fenlon, Professor Linda Richards and Dr Rodrigo Suárez.


"Improved understanding of how the brain plans movement could lead to more targeted treatments for people with Parkinson's."
genes VII
PRINCIPLES OF NEURAL SCIENCE

Redefining how we plan movement in the brain



A surprise discovery about how the brain plans movement that may lead to more targeted treatments for patients with Parkinson's disease.

A part of the brain that was thought to be only involved in controlling movement also plays a key role in planning movement.

The finding was made while recording the brain activity in patients with Parkinson's disease, during surgery to implant electrodes for deep brain stimulation to treat problems with gait.

Professor Pankaj Sah from QBI collaborated with neurologist Professor Peter Silburn and neurosurgeon Associate Professor Terry Coyne from the UQ Centre for Clinical Research.

"This study aimed to improve understanding of how different parts of the brain are involved in planning movement and controlling gait," Professor Sah said.

The team was particularly interested in a part of the brain stem known as the pedunculopontine nucleus (PPN), which lies in the brainstem, one of the deepest parts of the brain.

The PPN has previously been targeted as a treatment point for people with advanced Parkinson's disease who have difficulty in initiating movement or have 'freezing of gait'.

"To date, we have known that walking is generally controlled by the outer part of the brain known as the cortex," Professor Sah said.

"When you decide to walk, the cortex sends signals to your brain stem which in turn signals the spinal cord to initiate movement."

It had been known that neurons in the PPN are activated during limb movement; however, the study showed they were also activated when patients were simply thinking about walking.

"This is a complete surprise, because the general thinking has been that movement planning takes place in the cortex, but this study indicates it might be happening in the brain stem as well," Professor Sah said.

Parkinson's disease is the second most common neurodegenerative disorder after Alzheimer's disease, affecting more than six million people globally, and about one in 350 Australians.

Professor Sah said improved understanding of how the brain plans movement could lead to more targeted treatments for people with Parkinson's.

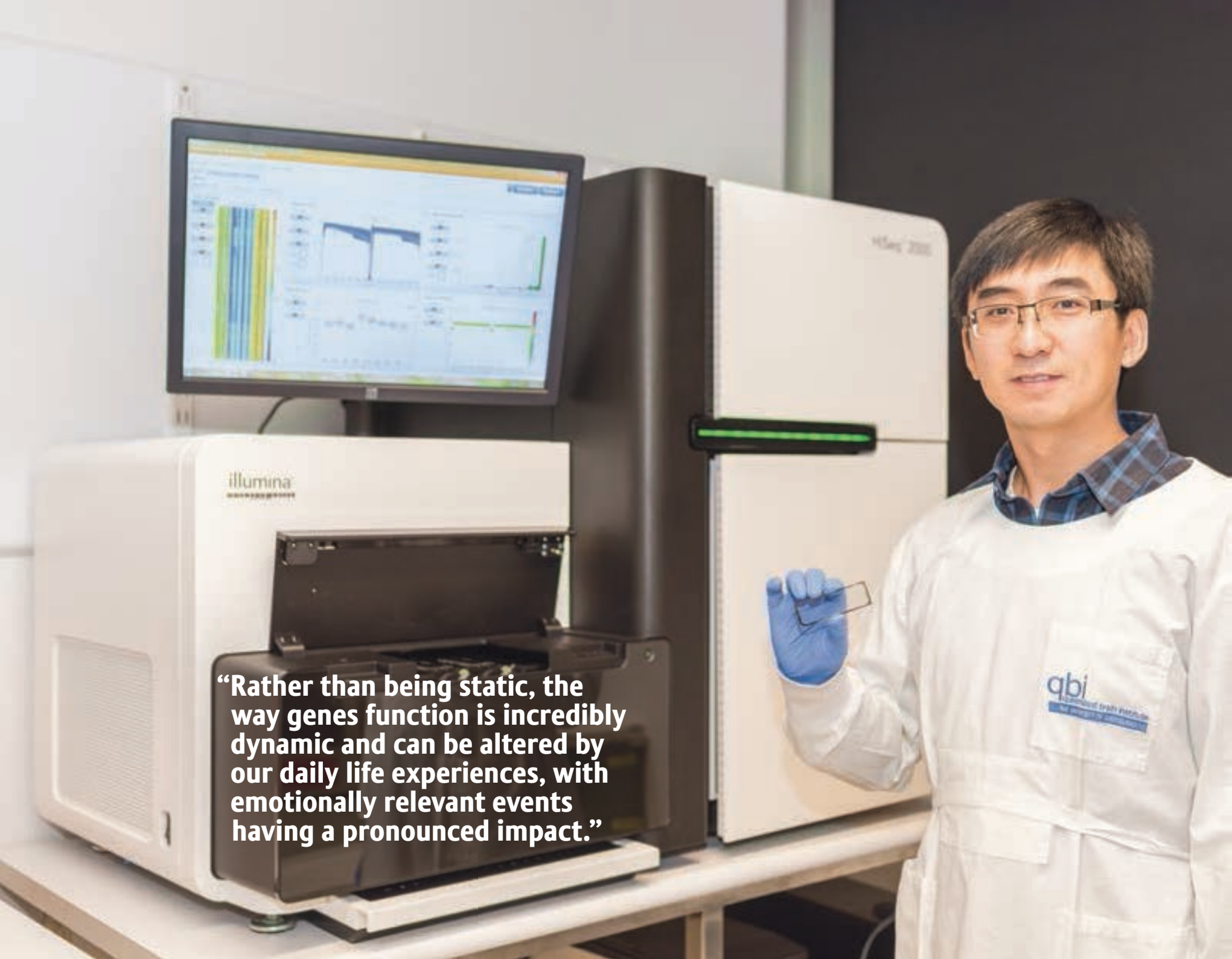
"The cells involved in these networks seem to be one type of cell, so when thinking about drug treatments for Parkinson's, maybe we should be targeting these cells," he said.

All the patients treated with deep brain stimulation during the study also recorded positive outcomes with improvements in gait, highlighting the importance of neuroscientists working with clinicians.

Findings of the research are published in the journal *Nature Neuroscience*.

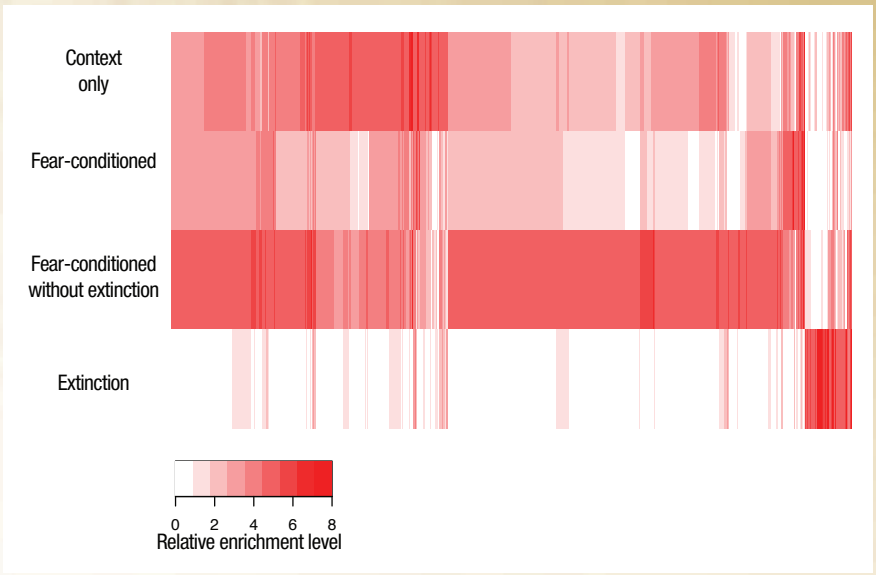
Above left: The trajectory of a deep brain stimulation electrode (blue) aimed at its target the pedunculopontine nucleus (red), are overlaid on a magnetic resonance image.

Far left: Professor Pankaj Sah.



“Rather than being static, the way genes function is incredibly dynamic and can be altered by our daily life experiences, with emotionally relevant events having a pronounced impact.”

Controlling fear may be possible by controlling DNA



Loosening the grip of fear-related memories, particularly those implicated in conditions such as phobia and post-traumatic stress disorder, may now be possible due to a new discovery.

QBI neuroscientists shed new light on the processes behind the mechanism, and may have found a way to silence the gene that feeds fear.

Senior research fellow Dr Timothy Bredy and his team have found a novel mechanism of gene regulation associated with fear extinction, an inhibitory learning process thought to be critical for controlling fear when the response was no longer required.

"Rather than being static, the way genes function is incredibly dynamic and can be altered by our daily life experiences, with emotionally relevant events having a pronounced impact," Dr Bredy said.

By understanding the fundamental relationship between the way in which DNA functions without a change in the underlying sequence, future targets for therapeutic intervention in fear-related anxiety disorders could be developed.

"This may be achieved through the selective enhancement of memory for fear extinction by targeting genes that are subject to this novel mode of epigenetic regulation," he said.

Mr Xiang Li, a PhD candidate and the study's lead author, said fear extinction was a clear example of rapid behavioural adaptation, and that impairments in this process were critically involved in the development of fear-related anxiety disorders.

"What is most exciting is that we have revealed an epigenetic state that appears to be quite specific for fear extinction," Mr Li said.

Dr Bredy said this was the first comprehensive analysis of how fear extinction was influenced by modifying DNA.

"It highlights the adaptive significance of experience-dependent changes in the chromatin landscape in the adult brain," he said.

Collaborative research into the field is continuing by a team from QBI, the University of California, Irvine, and Harvard University.

The study was published in *Proceedings of the National Academy of Sciences of the USA.*

Above left: Differences in experience-dependent 5-hydroxymethylcytosine enrichment in fear-conditioned mice, and those that had been trained to remove the fear-conditioning.

Far left: Dr Wei Wei from the Bredy Laboratory.

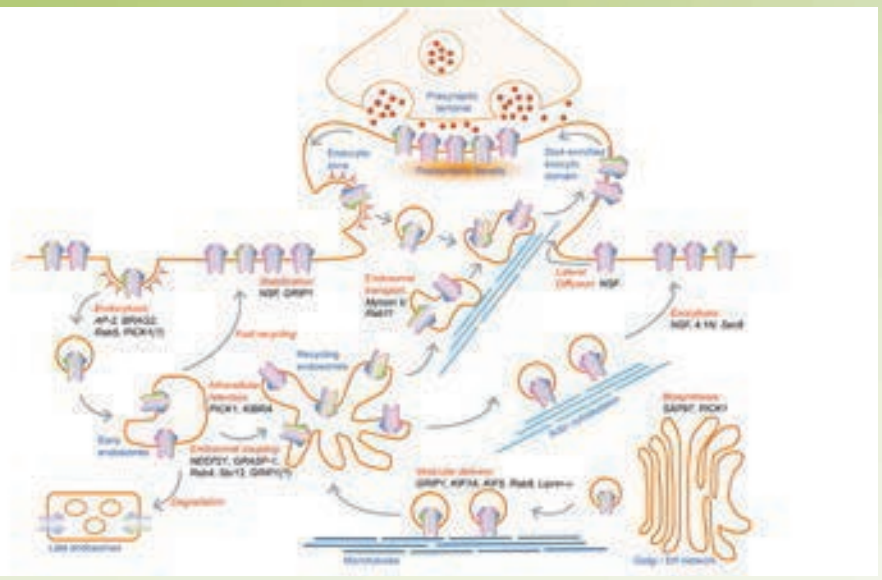
Research

QBI is a world-leading research facility whose staff are committed to discovering the fundamental mechanisms regulating brain function.

QBI's research provides the opportunity to address the overwhelming tide of neurological disease and mental ill health in the community.

Dr Jens Bunt, Richards Laboratory.

Laboratory Head **Dr Victor Anggono**



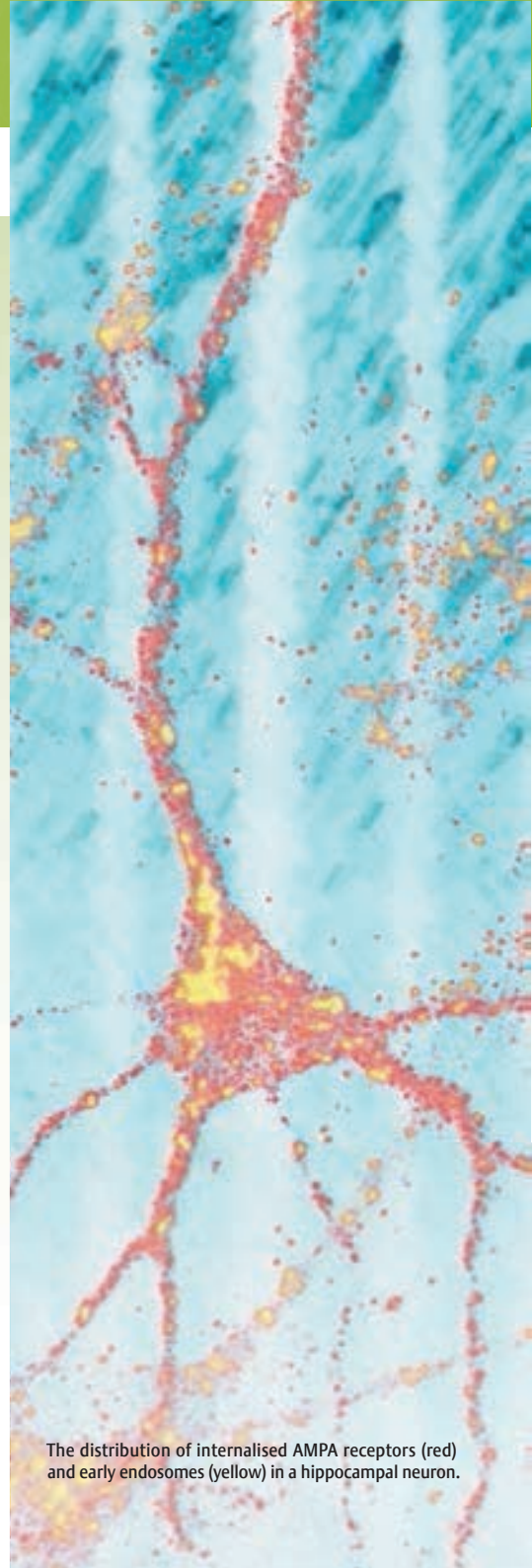
2014 Laboratory Members L–R/T–B: Victor Anggono, Ye Jin Chai, Yu Qian Chau, Se Eun (Joanne) Jang, Daniel Lim, Tong (Tina) Lin. *Not pictured*: Dirga Rachmad Aprianto, Kithmini Weerasinghe. **Image:** Dynamic regulation of AMPA receptor trafficking into and out of the postsynaptic membrane by various intracellular interacting proteins.

Molecular mechanisms of AMPA receptor trafficking

The AMPA-type neurotransmitter receptors mediate most of the fast synaptic transmissions in the brain. The ability of neurons to modulate the strength of their connections, termed synaptic plasticity, is determined in part by the number of these receptors at synapses. Dysregulation in AMPA receptor trafficking results in the imbalance in neuronal excitation and inhibition, which often results in memory impairment and cognitive deficit associated with various neurological disorders, such as Alzheimer's disease, schizophrenia, bipolar disorders and autism. The major aim of the Anggono group is to understand the detailed molecular mechanisms regulating AMPA receptor trafficking, synaptic plasticity, learning and memory.

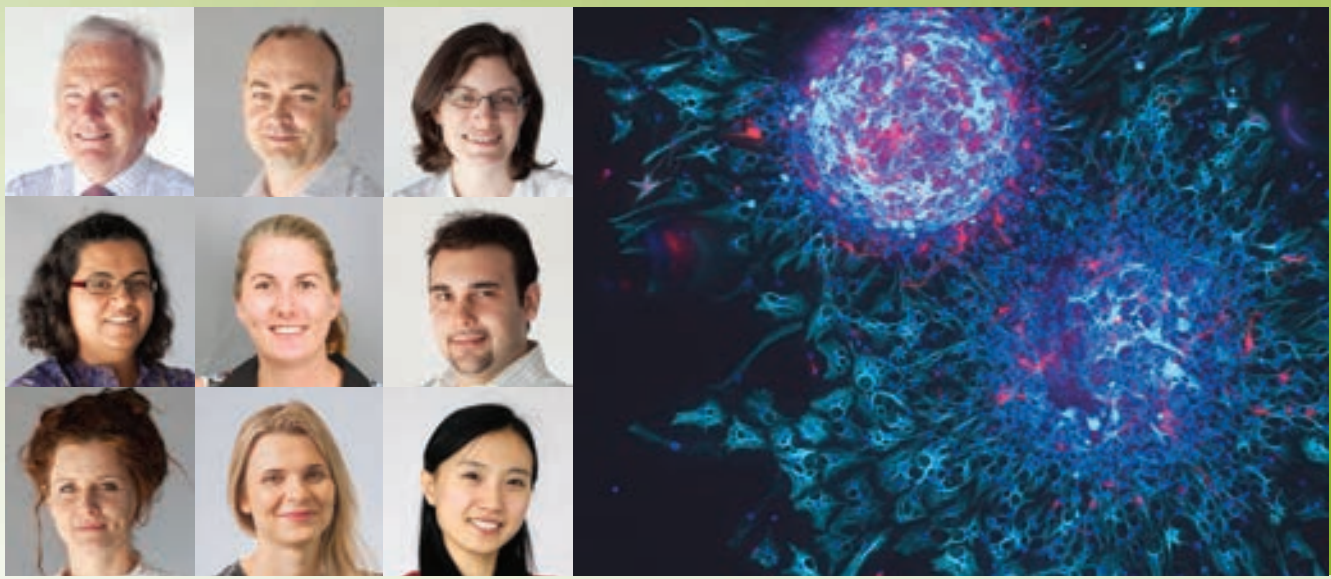
In collaboration with Professor Richard Huganir at The Johns Hopkins University School of Medicine, USA, the Anggono group identified an interaction between the AMPA receptor subunit and sorting nexin 27 (SNX27), a protein previously implicated in Down syndrome. The loss of SNX27 function impairs AMPA receptor trafficking towards the plasma membrane, resulting in impairment of long-term potentiation, a form of cellular memory. This study was published in the *Proceedings of the National Academy of Sciences of the United States of America* (2014). Together with Dr Brett Collins at the Institute for Molecular Bioscience, UQ, the group is currently extending the study to provide in-depth structure-function analysis of SNX27 in regulating AMPA receptor functions.

In addition, the Anggono group uncovered the roles of post-translational ubiquitination in regulating activity-dependent AMPA receptor intracellular trafficking, sorting and degradation. Part of this work was presented at the 44th Society for Neuroscience annual meeting in Washington, D.C., USA and the 7th Garvan Institute Signalling Symposium in Sydney. The laboratory also received the Alzheimer's Australia Dementia Research Foundation Project Grant to continue this research in 2015.

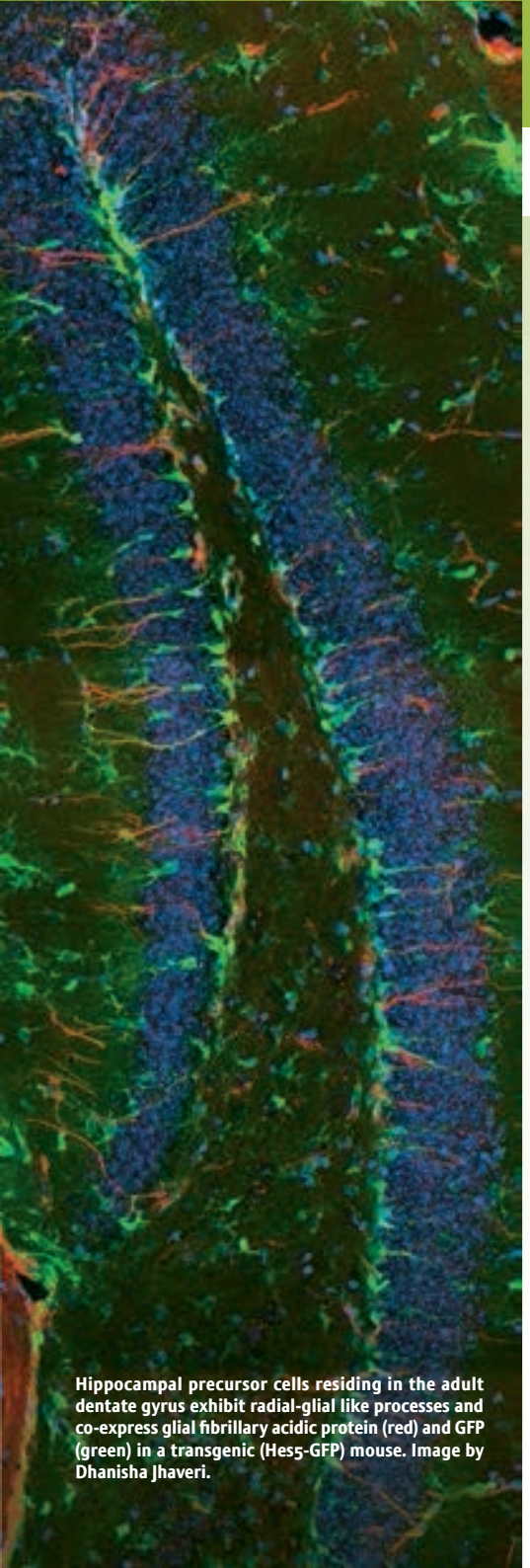


The distribution of internalised AMPA receptors (red) and early endosomes (yellow) in a hippocampal neuron.

Laboratory Head **Professor Perry Bartlett**



2014 Laboratory Members L–R/T–B: Perry Bartlett, Daniel Blackmore, Lavinia Codd, Dhanisha Jhaveri, Imogen O'Keeffe, Gregory Robinson, Chanel Taylor, Jana Vukovic, Jing Zhao. *Not pictured*: James Cleland, Odette Leiter, Weichuan Mo (based in China), Xiaoqing (Alice) Zhou. **Image:** Two differentiated neurospheres grow beside each other, however upon contact one will begin to unravel as astrocytes (turquoise) pour out of the disintegrating sphere, and the neurons (red) struggle to stay in place. Image by Chanel Taylor.



Hippocampal precursor cells residing in the adult dentate gyrus exhibit radial-glial like processes and co-express glial fibrillary acidic protein (red) and GFP (green) in a transgenic (Hes5-GFP) mouse. Image by Dhanisha Jhaveri.

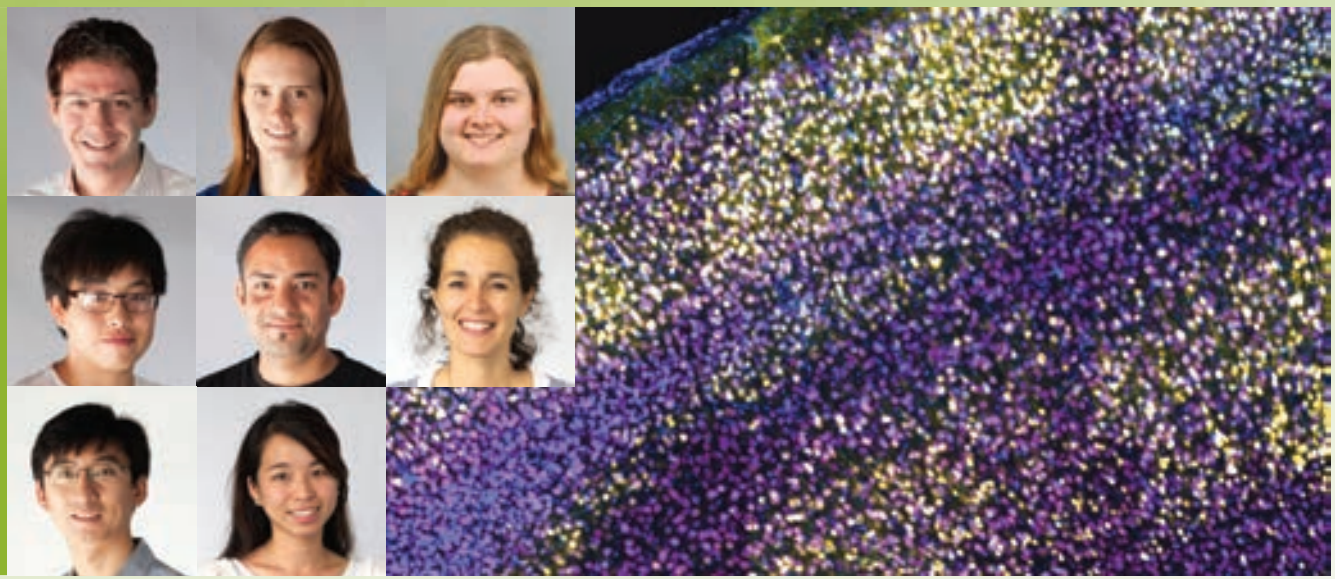
Understanding the mechanisms driving hippocampal neurogenesis

Professor Perry Bartlett's laboratory is dedicated to understanding the mechanisms that drive the continuous production of new neurons from the resident pool of neural stem cells in a region of the adult brain known as the hippocampus. This process, called neurogenesis, slows as we age, and this loss of neurons has been associated with a loss of cognitive function. The group is now focussed on identifying the factors that can trigger activation of stem cells to enhance production of these newborn neurons.

Hippocampal-dependent functions, such as learning, memory and mood, are regulated by the neurotransmitter norepinephrine, which exerts its effects by binding to adrenergic receptors. The Bartlett laboratory, with collaborators from the Tata Institute of Fundamental Research in India, demonstrated the importance of the balance between α_2- and β-adrenergic receptor activity (Jhaveri *et al.*, *PLOS One*, 2014). The study shows that, when stimulated, α_2-adrenergic receptors inhibit whereas β-adrenergic receptors enhance precursor cell activation and neurogenesis in the hippocampus. This study provides a potential mechanism by which norepinephrine-promoting drugs could enhance adult neurogenesis. The group also published work showing that blockade of microglial K_{ATP} channels abrogates the suppression of precursor cell activity by inflammatory cytokines (Ortega *et al.*, *Glia*, 2014). This finding adds to our understanding of the role of microglia in regulating neurogenesis, as previous work has shown that K_{ATP} channel blockade promotes neurogenesis after stroke.

The Bartlett laboratory also conducts research into the treatment of spinal cord injury. They have shown that blocking the activity of the EphA4 receptor results in significantly improved recovery of motor function after spinal cord injury. In 2014, Professor Bartlett, with Associate Professor Martin Lackmann and Professor Andrew Boyd, published a review (in the journal *Nature Reviews Drug Discovery*) on the rapidly evolving area that is therapeutic targeting of Eph receptors and their ligands.

Laboratory Head **Dr Timothy Bredy**



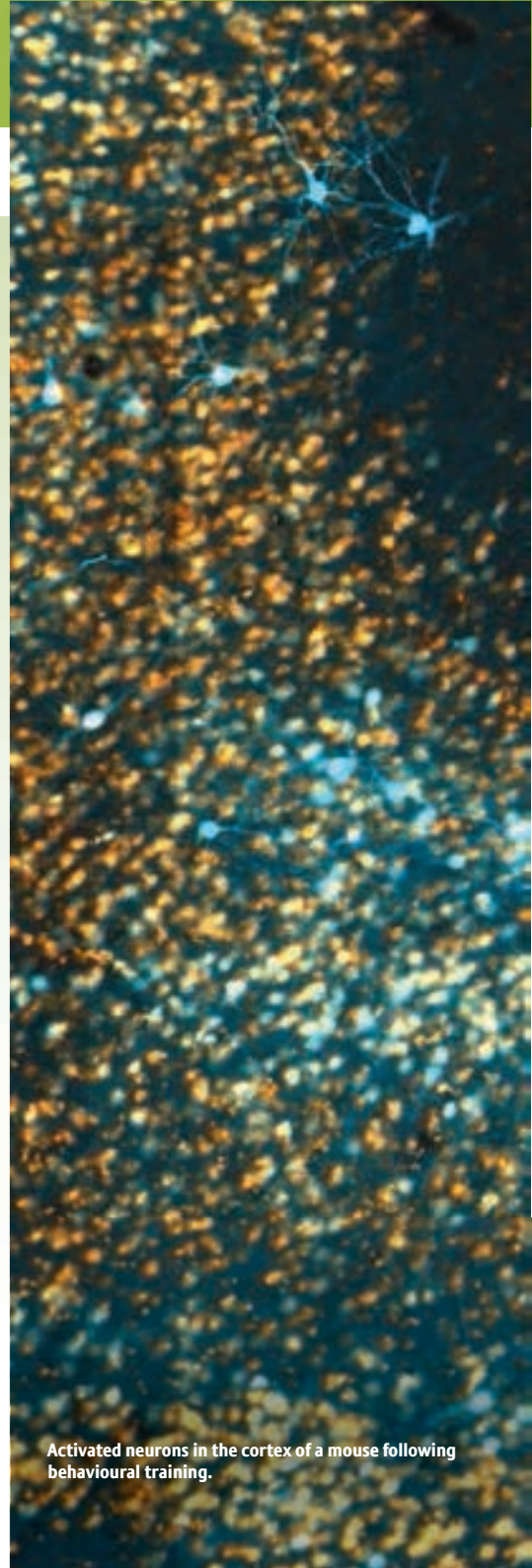
2014 Laboratory Members L–R/T–B: Timothy Bredy, Danay Baker-Andresen, Laura Leighton, Xiang Li, Vikram Ratnu, Paola Spadaro, Wei Wei, Jocelyn Widagdo. **Image**: Activated neurons in the cortex of a mouse following behavioural training.

Epigenetic mechanisms regulating memory

The extinction of conditioned fear—the reduction in respondse to a feared cue when the cue is repeatedly presented without any adverse consequence—is an important model for the treatment of anxiety disorders. Like other forms of learning, long-lasting memory for fear extinction depends on coordinated gene expression and the synthesis of new synaptic proteins. This process involves a tightly controlled interplay between transcriptional machinery and enzymes that regulate chromatin structure, a relatively recent field of research referred to as *epigenetics*.

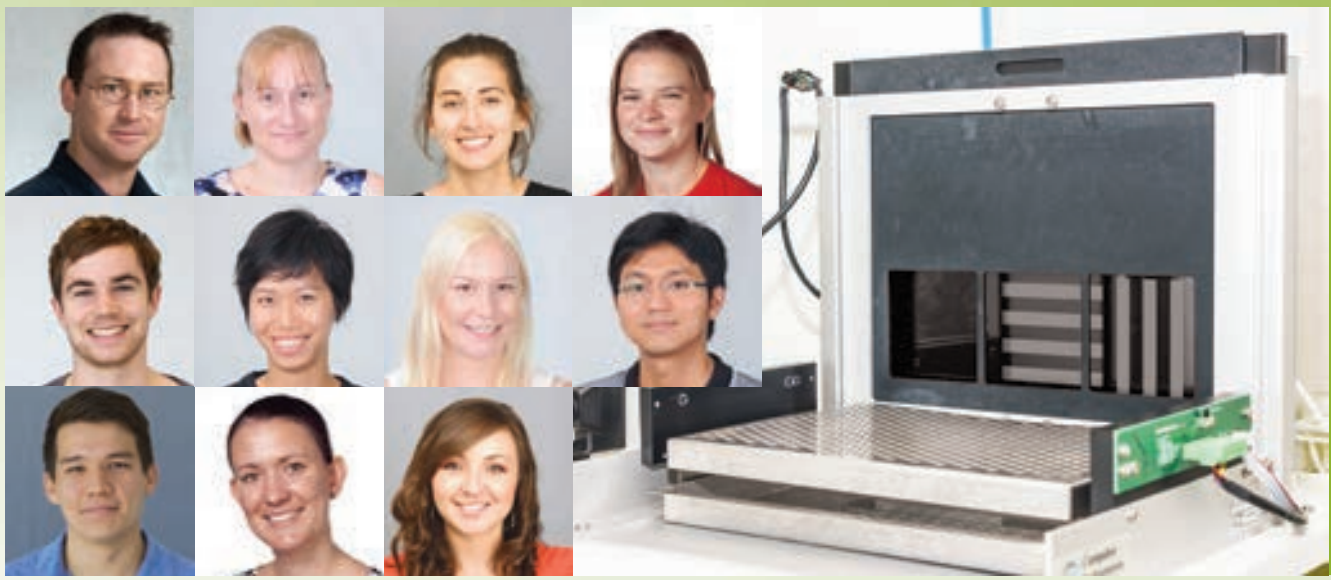
Research in the Bredy laboratory is elucidating how the genome is connected to the environment through epigenetic modifications, and how this relationship shapes behaviour across the lifespan. The group is particularly interested in how epigenetic mechanisms, including DNA methylation, histone modifications and the activity of non-coding RNAs, regulate the formation and maintenance of memory.

2014 was a productive year for the laboratory, which published new studies on the role of DNA methylation and neural plasticity in the journals *Proceedings of the National Academy of Sciences of the USA; Genes, Brain and Behavior*, and the *European Journal of Neuroscience*. In other work, which appeared in the journal *Molecular Psychiatry*, together with collaborators the group demonstrated that the long non-coding RNA Gomafu is both activity-dependent and associated with schizophrenia. The work received significant exposure in 2014 with invited talks at several international meetings, including those for the Molecular and Cellular Cognition Society, the Federation of European Neuroscience Society in Italy, the Canadian Association for Neuroscience in Montreal, and the 5th ERTC Conference in Shanghai, China.



Activated neurons in the cortex of a mouse following behavioural training.

Laboratory Head **Associate Professor Thomas Burne**



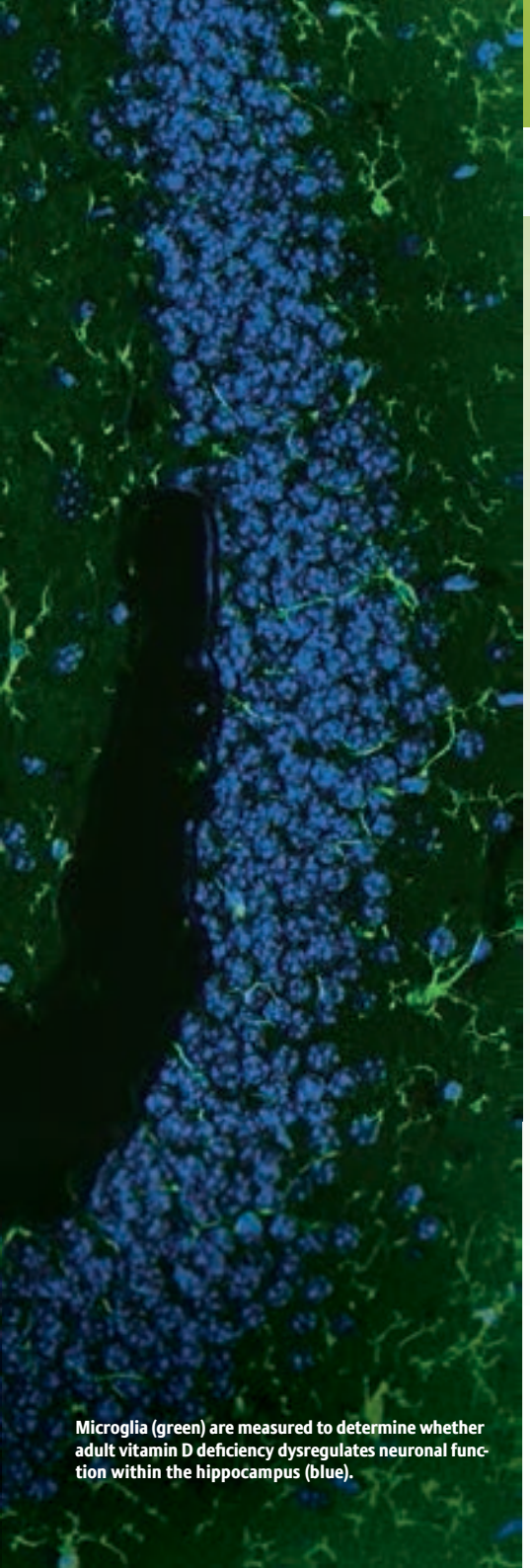
2014 Laboratory Members L–R/T–B: Thomas Burne, Suzy Alexander, Kyna-Anne Conn, Natalie Groves, Lachlan Harris, Pauline Ko, Emilia Lefevre, Aung Aung Moe, Chris Simpson, Karly Turner, Michelle Sanchez Vega. *Not pictured*: James Peak. **Image:** Touchscreen technology allows us to investigate cognitive performance in rodents using tasks that are similar to human tasks. In this paradigm the mouse learns to touch either horizontal or vertical white stripes to receive a sweet reward.

Translation of cognitive tasks for animal models of neuropsychiatric disorders

Associate Professor Thomas Burne's group studies brain development and behaviour in animal models. The group is focussed on investigating the underlying biological basis for schizophrenia, with the goal of finding public health interventions that will alleviate the burden of this disease. The group has been exploring the impact of developmental vitamin D deficiency on brain development, the impact of adult vitamin D deficiency on brain function and behaviour and, more recently, has been establishing novel ways to assess cognitive behaviour in rodents.

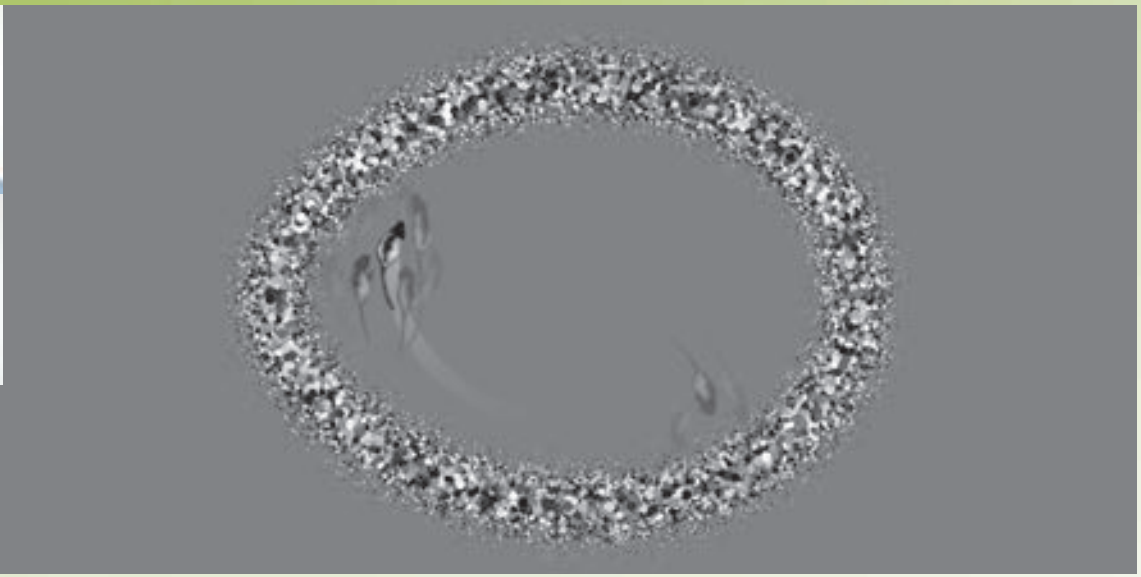
In 2014, the Burne group built on previous research on low prenatal vitamin D (the 'sunshine hormone') to show that adult vitamin D deficiency is also associated with alterations in behaviour, brain neurochemistry and receptor profiles. They have discovered that low vitamin D levels during adulthood affect the balance of excitatory and inhibitory neurotransmitters in the brain, as well as altering cognitive behaviour in rodents. These results provide the first evidence in mice to show that adult vitamin D deficiency impacts on neurotransmitter systems that are affected in a number of neuropsychiatric conditions, including autism, schizophrenia and depression. Ongoing National Health and Medical Research Council funding allows the group to dissect the exact neural pathways involved in cognitive impairments of attentional processing in vitamin D deficient animals to model the cognitive symptoms of schizophrenia.

The team has also created and validated a unique cognitive task for rodents that mirrors the continuous performance task in humans. The group's goal is to provide a novel tool for cognitive research in rodents and to uncover more about the pathophysiology and drug treatment of cognitive symptoms in schizophrenia.



Microglia (green) are measured to determine whether adult vitamin D deficiency dysregulates neuronal function within the hippocampus (blue).

Laboratory Head **Dr Allen Cheung**



2014 Laboratory Members T–B: Allen Cheung, Ashvin Srinivasan. *Not pictured*: Rebecca Chan, Vinay Chandragiri, Zoltán Kósci. **Image:** A simulated rat uses a population of hypotheses to determine its location by combining noisy information with a 'mental map'.

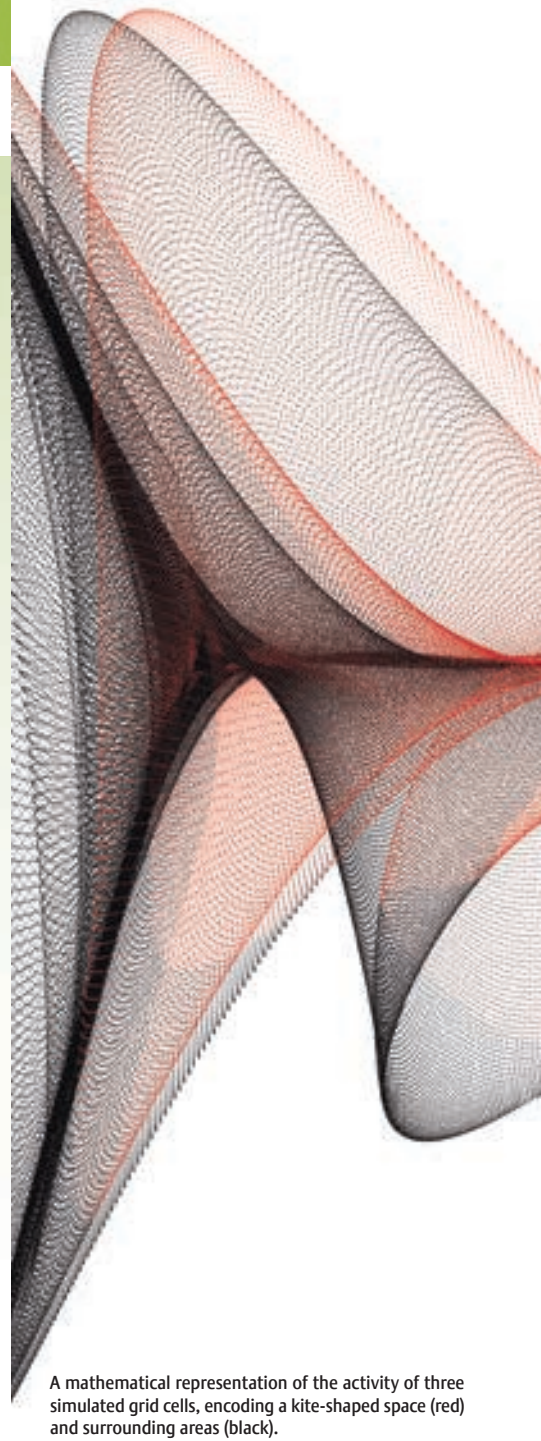
Computational theory of space and the brain

The core research of Dr Cheung's laboratory is aimed at understanding the fundamental brain computations required for spatial navigation. Spatial navigation is one of the oldest and most widespread brain functions in the animal kingdom. The cells, circuits and computations required for animals to search for resources, return home, and go back to those resources later are subjects of intense research worldwide.

Path integration is one strategy used by vertebrates and invertebrates alike, and may be the common 'scaffold' required for spatial navigation. It is the process whereby estimated self-motion is integrated over time to yield an approximate vector between the starting location and current location. This form of navigation is prone to noise, which leads to errors in navigation. It has long been assumed that animals must use external cues to correct for such errors. Surprisingly, the Cheung laboratory recently found that external cues are not always necessary. In fact, in a wide range of bounded environments, an animal can theoretically combine a 'mental map' with noisy self-motion cues to accurately track its location, without sight, sound, touch, smell or any other external sensory input. This applies to any space with one-fold rotational symmetry, such as a kite-shaped or egg-shaped arena.

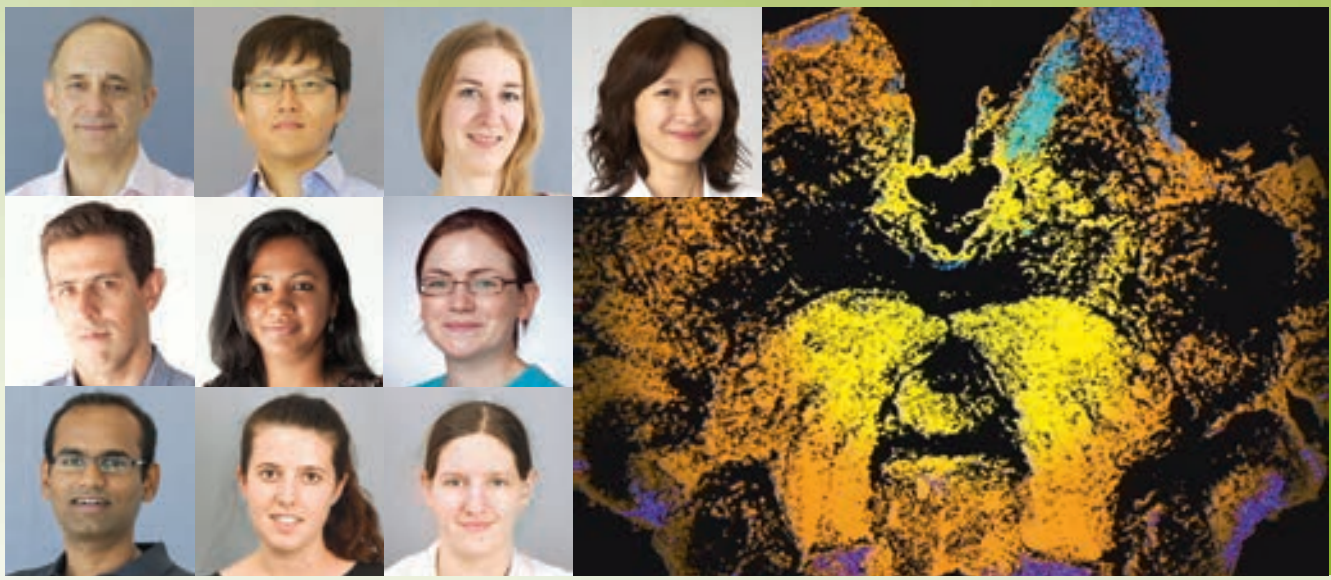
These unexpected results highlight the importance of mental maps for navigation, the need for great care in interpreting experimental results obtained inside any arena, and opens up new avenues to study the mammalian spatial memory system. Collaborative projects are being planned at QBI to test novel and important theoretical predictions arising from this work, in both humans and rats.

Research from the Cheung laboratory was published in the *Proceedings of the National Academy of Sciences of the USA*, *PLOS Computational Biology*, and *Journal of Theoretical Biology* in 2014.



A mathematical representation of the activity of three simulated grid cells, encoding a kite-shaped space (red) and surrounding areas (black).

Laboratory Head **Professor Charles Claudianos**



2014 Laboratory Members L–R/T–B: Charles Claudianos, Joon-Yong An, Stephanie Biergans, Ming-Yu Chen, Alexandre Cristino, Nivetha Gunasekaran, Aoife Larkin, Ramesh Narayanan, Michelle Watts, Sarah Williams. **Image:** Immunostaining of neuroligin 2 (orange/yellow) and overlapping RNA expression of embedded miR-932, associated with learning and memory integration regions (mushroom bodies) of the bee brain. DNA staining of cell bodies is shown in blue/purple.

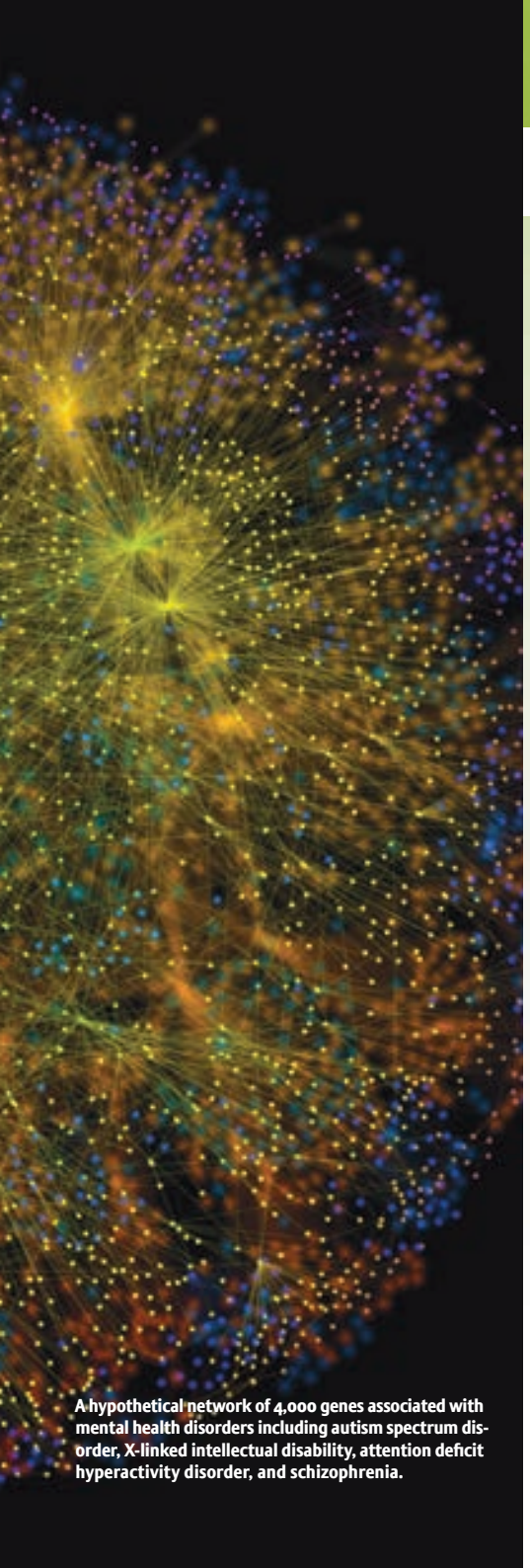
Senses and synapses

The development of the nervous system occurs in two ways: that which is determined by our genetic program, helping to direct cells to replicate and differentiate, producing neurons that can project to and connect with other neurons and innervate muscle and tissues typical of a developing fetus; and that which requires the same genetic program to respond to environmental stimuli, learn, acquire and recall memory and is subject to constant cellular/neuronal remodeling throughout life. Within this framework the Claudianos group works to understand the biological basis of neurodevelopmental disorders such as autism.

Current work involves genome sequencing of families affected by autism spectrum disorder (ASD) to identify risk genes that are often involved with nerve cell interaction. These molecules are being characterised using human neuronal cells, and aberrant cellular functions including changes in nerve cell connections (affecting neuronal projections and synapses) are helping to measure the impact of human DNA variations. The laboratory also examines the biological relevance of genes and gene regulation, including epigenetic mechanisms such as methylation and microRNA, on brain plasticity. Due to its range of sophisticated behaviours and documented brain plasticity, the honeybee is used by the Claudianos laboratory as a neurobiological model.

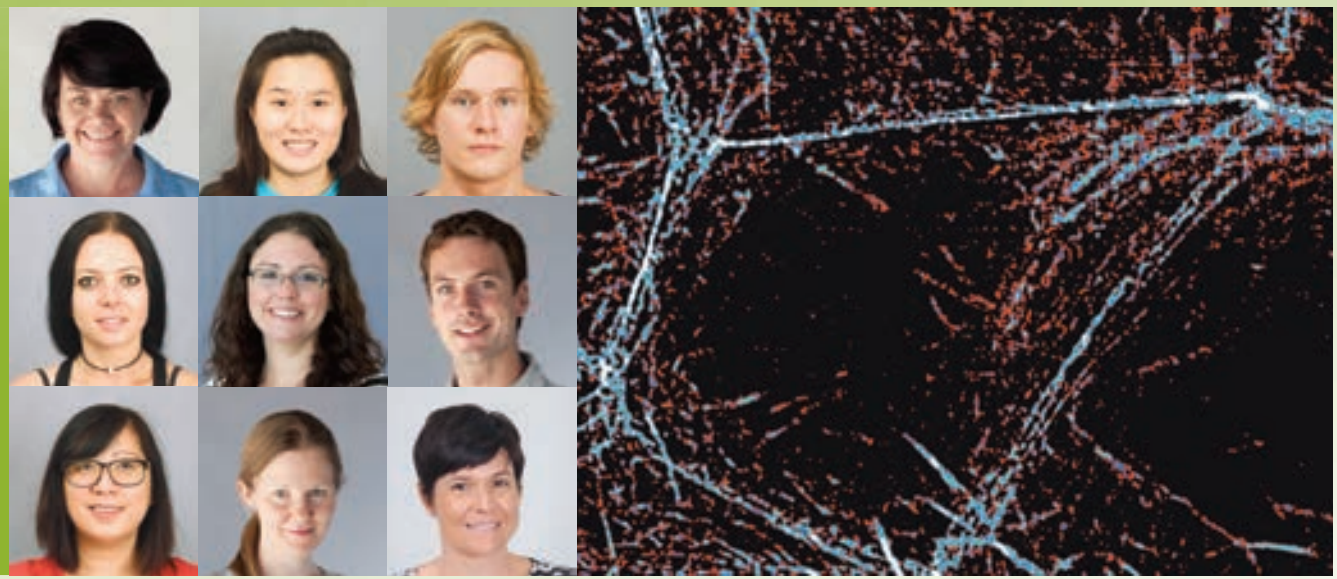
Key research findings:

- First to show that the sense of smell (olfactory receptor expression) is regulated by long-term memory formation (Claudianos *et al.* 2014, *European Journal of Neuroscience;* Faculty 1000 publication).
- Whole genome (exome) sequencing of Australian families with ASD confirms the AXAS™ model (Cristino *et al.* 2014, *Molecular Psychiatry*) can be used to predict genetic risk of autism.
- First to show that DNA variants inherited from parents with a broader autism phenotype (BAP) have a significant association with ASD (An *et al.* 2014, *Translational Psychiatry*).
- First to show that non-coding RNAs (neuroligin-associated miR-932) target the key development molecule actin and affect learning and memory (Cristino *et al.* 2014, *Nature Communications*).



A hypothetical network of 4,000 genes associated with mental health disorders including autism spectrum disorder, X-linked intellectual disability, attention deficit hyperactivity disorder, and schizophrenia.

Laboratory Head **Associate Professor Helen Cooper**



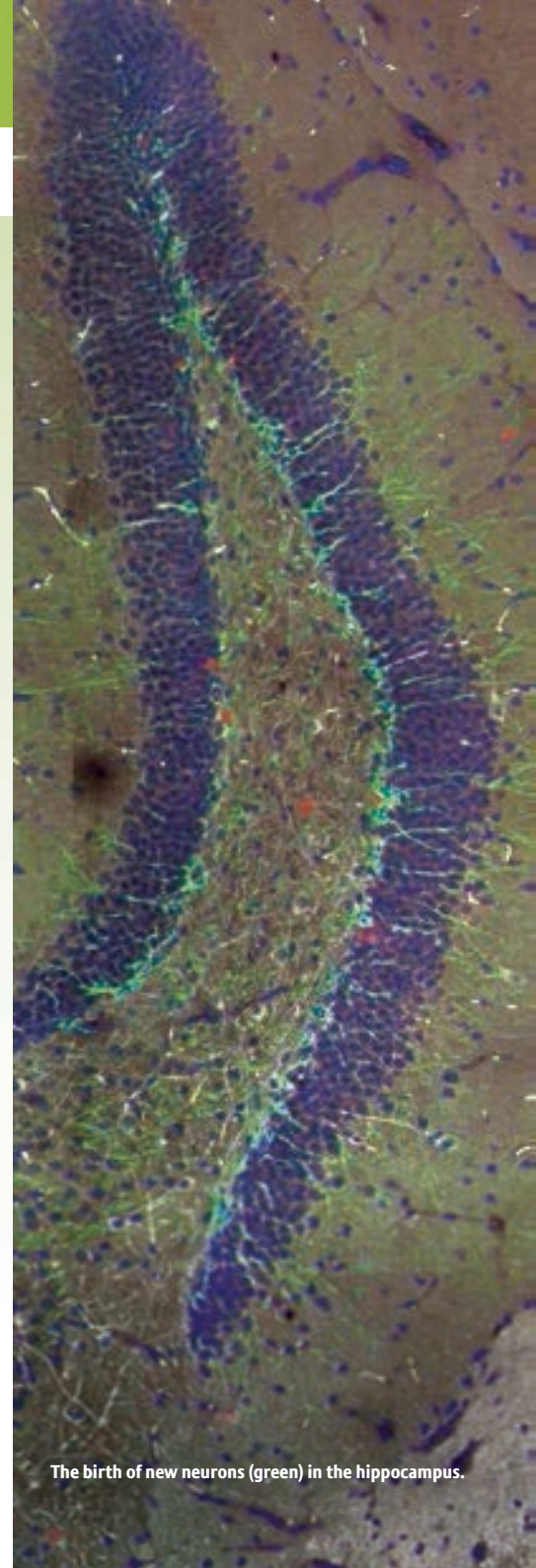
2014 Laboratory Members L–R/T–B: Helen Cooper, Ka Wai Foc, Michael Langford, Vanessa Lanoue, Natalie Lee, Conor O'Leary, Loc duyen Pham, Amanda White, Nicole Wilson.
Image: Representative image of the actin cytoskeleton at the site of junctions in polarised epithelial cells, acquired using super-resolution structured illumination microscopy (SIM). Image by Natalie Lee.

Molecular mechanisms that regulate new neurons in the brain

The goal of the Cooper laboratory is to understand the fundamental molecular and cellular biological processes within the neural stem cell niche that govern the development of the neocortex. In the embryonic cortex, neural stem cells undergo self-renewing divisions or switch to asymmetric divisions to generate new neurons. Understanding this critical decision-making process is of major importance as an imbalance between stem cell and neuron production is causative for cortical malformations and has also been linked to autism, intellectual disability and schizophrenia.

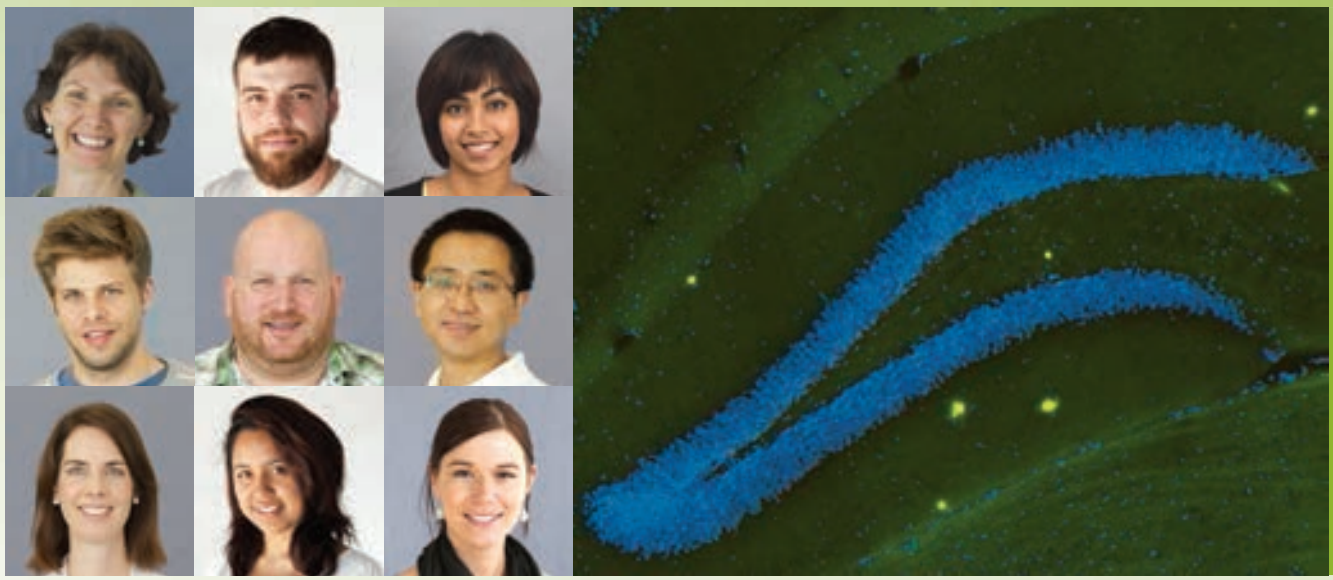
The Cooper group has discovered that the stem cell receptor neogenin is essential for maintaining the integrity of the cortical stem cell niche. They found that neogenin is a key regulator of neural stem cell division as it closes down the cell cycle and encourages neuronal differentiation. Shutting down neogenin signalling in the embryonic mouse leads to disruption of cortical development. Strikingly, these phenotypes closely parallel those seen in humans, thereby implicating neogenin in the aetiology of cortical malformations.

The six layers of the adult cortex are comprised of distinct pyramidal neuron subtypes that work together in complex neural networks to shape cognitive and behavioural outcomes. This raises the intriguing question of how different subpopulations adopt their unique identities. Members of the Cooper laboratory have identified a new signalling pathway activated by the Ryk receptor, which promotes the acquisition of certain layer-specific identities while suppressing other subtype identities. Ryk mutations lead to an imbalance in neuronal subtypes, suggesting a link to intellectual disability.

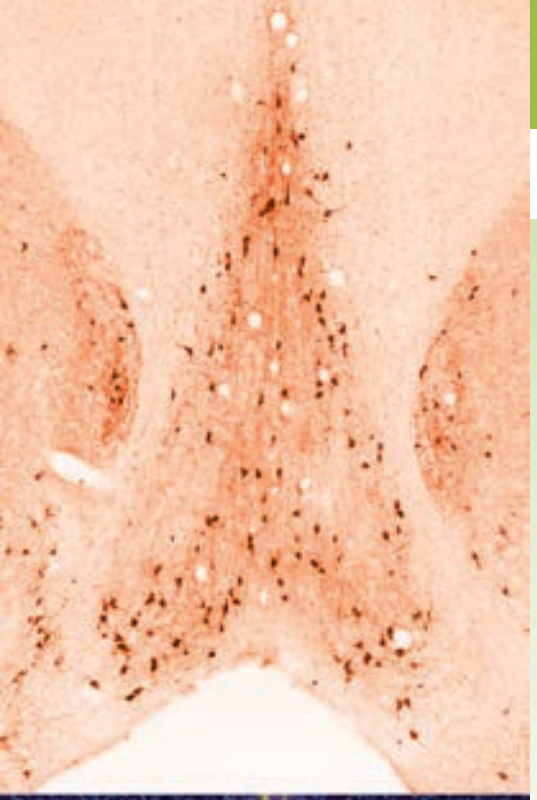


The birth of new neurons (green) in the hippocampus.

Laboratory Head **Associate Professor Elizabeth Coulson**



2014 Laboratory Members L–R/T–B: Elizabeth Coulson, Zoran Boskovic, Marie Camara, Georg Kerbler, Dusan Matusica, Lei Qian, Bree Rumballe, Aanchal Sharma, Toni Turnbull. *Not pictured:* Mirela Wagner. **Image:** The hippocampus of a mouse model of Alzheimer's disease showing accumulations of the amyloid-β protein, known as amyloid plaques (green puncta).



Cholinergic neurons in a mouse basal forebrain labelled with a histological stain (top) and immunofluorescence (bottom).

Understanding the aetiology of Alzheimer's disease

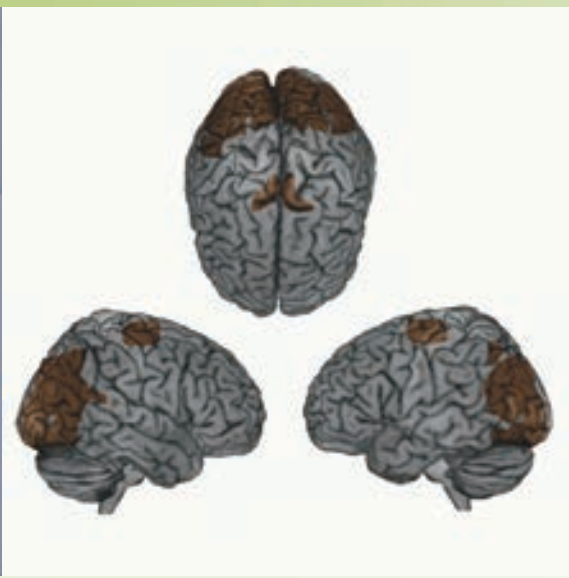
The Coulson laboratory is investigating why certain neurons die in Alzheimer's disease (AD) and how that affects cognition. Their work focusses on the p75 neurotrophin receptor and its role in neuronal loss, particularly nerve cell degeneration that occurs in the basal forebrain.

Basal forebrain neurons are important for learning and memory, and post-mortem studies show they can be selectively lost in AD. The current treatment for AD patients targets the function of basal forebrain neurons. However, significant loss of these neurons has already occurred in the majority of AD patients prior to treatment. Because these drugs are only efficacious while the neurons are alive, it is not surprising the treatment is of limited value to most patients.

The Coulson group, in collaboration with scientists from the CSIRO, has developed a method to measure basal forebrain loss in humans using magnetic resonance imaging (MRI). In a population of more than 200 elderly subjects, they found that basal forebrain atrophy occurs early in AD and is correlated with cognitive impairment. They are now testing whether the MRI method can be used to predict which AD patients are most likely to get benefit from the currently available AD drugs.

In addition, they found that basal forebrain loss is correlated with the development of another AD hallmark—amyloid-β plaque deposition (measured using positron emission tomography; PET imaging). This correlation occurred even in a group of people without cognitive impairment but who are considered susceptible to developing dementia. Indeed, by assessing the entire group longitudinally they found subjects with basal forebrain atrophy were more likely to undergo cognitive decline over the subsequent 18 months. Importantly parallel, studies ongoing in the Coulson laboratory using mouse models of AD indicate that basal forebrain loss might induce increased amyloid-β production, and therefore degeneration of these neurons may be a very early aetiological factor in the development of the disease.

Laboratory Head **Associate Professor Ross Cunnington**



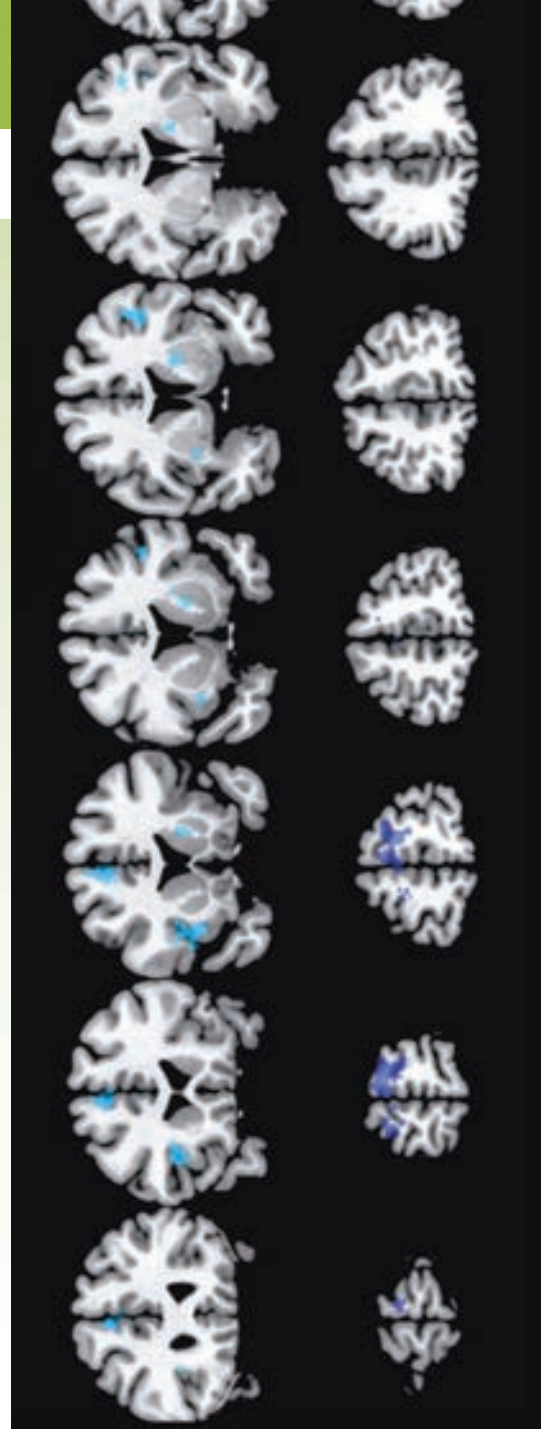
2014 Laboratory Members L–R/T–B: Ross Cunnington, Jeff Bednark, Megan Campbell, Yuan Cao, Veronika Halász, Jessica McFadyen, Vinh Nguyen, Kelsey Palghat, Simmy Poonian, Natalie Rens, Thomas Shaw, Chase Sherwell. **Image:** Mirroring activity in the visual and motor areas of the brain as people observe and imitate hand actions.

Brain processes for action, mirroring, and empathy

The Cunnington laboratory focusses on the brain processes involved in planning and preparing for our own voluntary actions, as well as neural 'mirroring' processes that are important for our ability to perceive and understand others' actions, intentions, and emotional states.

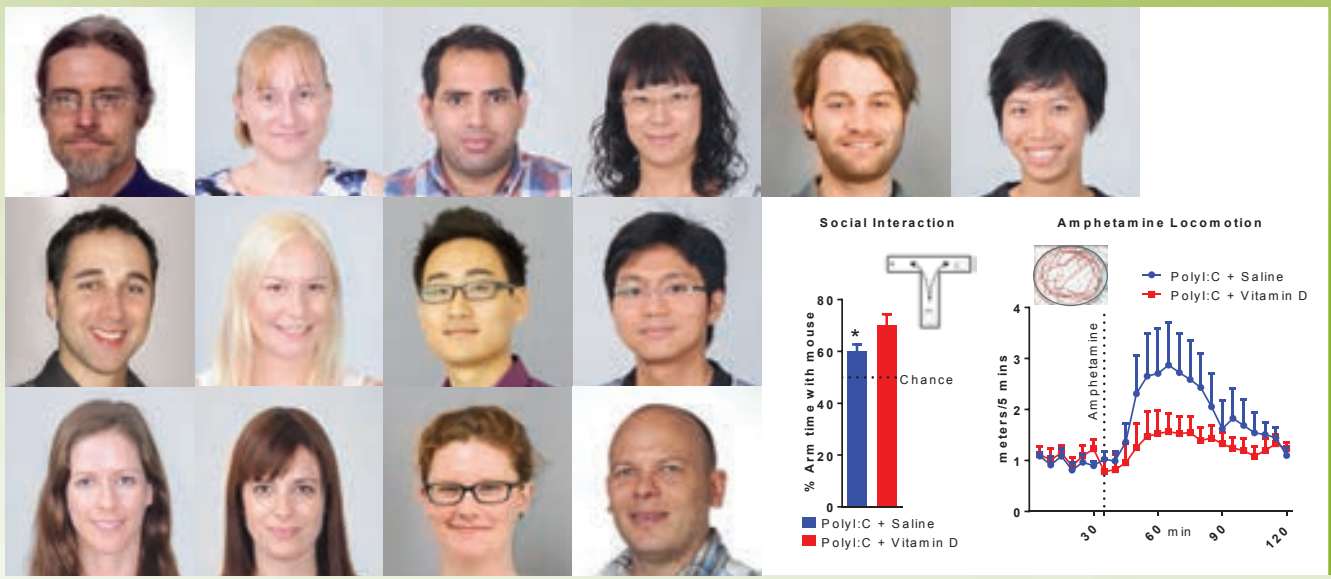
Research from the group is examining brain processes important for the planning and co-ordination of voluntary movement before its initiation. Using the new 7 Tesla MRI scanner at UQ, the group is examining the function of the fine circuitry of deep regions of the brain, known as the basal ganglia, which are crucial for higher-order planning and control of voluntary movement. The group is also combining MRI brain imaging with concurrent measurement of brain activity using electroencephalography (EEG). This work has revealed the crucial role of brain areas known as the supplementary motor area (SMA) and cingulate cortex in movement planning processes occurring over 1–2 seconds prior to movement initiation.

Other research in the group examines mirroring processes in the brain, whereby brain activity normally associated with first-hand experience of actions, sensations, and emotions appears to be mirrored in our brain when we observe the same actions or states in others. Through the new Australian Research Council Science of Learning Research Centre, the group is examining the mirroring or synchrony of biological markers of brain states between children in school classrooms, examining how shared engagement between children, down to the level of their mirrored neurological or brain states, may contribute to learning in group co-operative activities. Other research of the group is examining neural mirroring and brain processes important for empathy and the neural factors that might lead us to empathise more strongly with some people over others.



Brain areas important for timing and anticipation in the prefrontal cortex and basal ganglia.

Laboratory Head **Associate Professor Darryl Eyles**



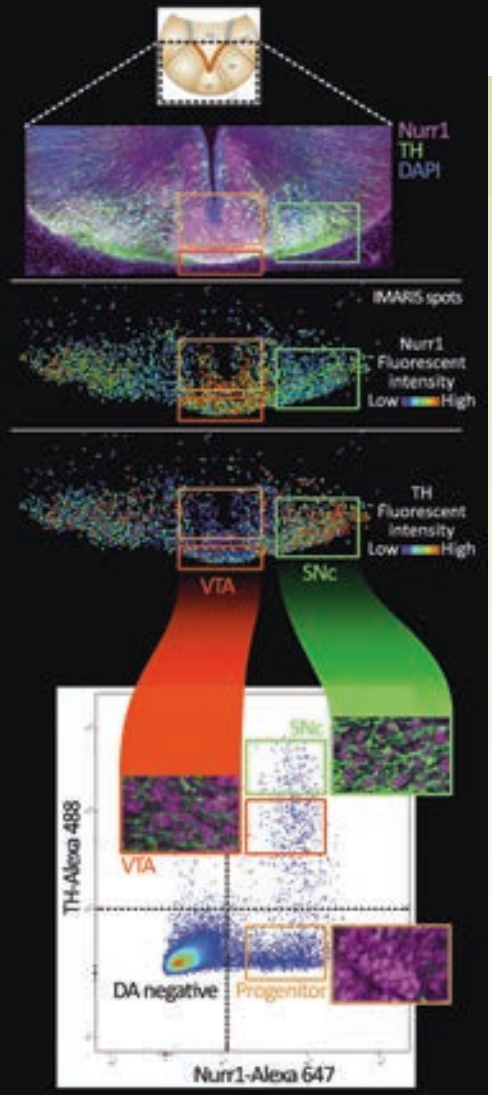
2014 Laboratory Members L–R/T–B: Darryl Eyles, Suzy Alexander, Asad Ali, Xiaoying Cui, Lachlan Ferguson, Pauline Ko, David Kvaskoff, Emilia Lefevre, Leon Luan, Aung Aung Moe, Kathie Overeem, Renata Pertile, Alice Petty, Henry Simila. *Not pictured*: Stephenie Vuillermot. **Image:** Vitamin D reverses social interaction deficits and blocks hyperlocomotion in response to amphetamine in a Maternal Immune Activation animal model of schizophrenia.

Vitamin D deficiency, autism and schizophrenia

The Eyles laboratory focusses on how risk factors for schizophrenia, such as developmental vitamin D (DVD) deficiency and maternal immune activation, change the way the brain develops. The group has developed an extremely sensitive LC/MS/MS assay for vitamin D species in blood spot cards. This assay allowed the 2010 landmark study implicating low maternal levels of vitamin D as a risk factor for schizophrenia to be conducted. The group is now examining the relationship between DVD deficiency and autism with five international collaborations, aiming to develop new ways to measure other important vitamin D metabolites in blood and brain.

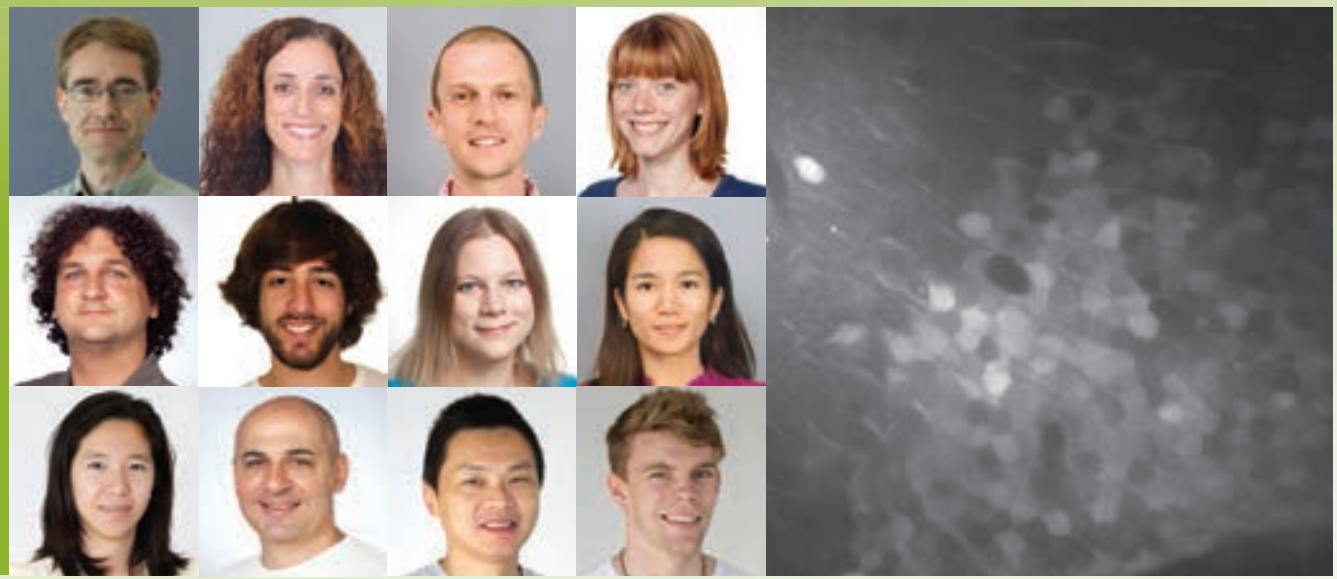
Schizophrenia is closely associated with abnormalities in dopamine transmission. The group's work in DVD deficient animals confirms there are early abnormalities in dopamine development and turnover, and its work in 2014 using human cell systems describes for the first time the direct control vitamin D exerts over dopamine production via the vitamin D receptor. The group's work represents a synthesis of the two major theories of schizophrenia, the 'dopamine hypothesis' and the 'neurodevelopmental hypothesis', into the 'dopamine ontogeny hypothesis of schizophrenia'.

For 15 years the Eyles group has explored the role of vitamin D in the developing brain and how DVD deficiency may affect brain function and behaviour in adult offspring. With continual National Health and Medical Research Council and now National Institutes of Health funding success in 2014, the group intends to expand the scope of its existing animal model in two critical ways. Firstly, the group will examine the effect of varying the duration and level of DVD deficiency on brain development and function. Secondly, the group will examine whether abnormalities in the ontogeny of dopamine systems observed in DVD deficient animals are shared by other prominent animal models of this disease. Promising initial data indicates that the active vitamin D hormone can suppress many schizophrenia-relevant phenotypes in other animal models.



Based on the intensity of tyrosine hydroxylase (TH) expression we have isolated dopamine neurons from the developing Substantia Nigra (SN) and Ventral Tegmental Area (VTA). This will now allow us to examine the ontogeny of gene–expression in animal models of abnormal dopamine neuron development.

Laboratory Head **Professor Geoffrey Goodhill**



2014 Laboratory Members L–R/T–B: Geoffrey Goodhill, Lilach Avitan, Brendan Bicknell, Kelsey Chalmers, Richard Faville, Nicholas Hughes, Elizabeth Kita, Margaret Maallo, Huyen Nguyen, Zac Pujic, Biao Sun, Daniel Sutherland. *Not pictured:* Philip Dyer. **Image:** Cells in the zebrafish brain labelled with a fluorescent calcium indicator.

Computational, systems and developmental neuroscience

Professor Goodhill's laboratory is interested in how brains process information, particularly during development. This includes how growing nerve fibres (axons) use molecular cues to make guidance decisions, how map-like representations of visual inputs form in the optic tectum and visual cortex, and how these maps code sensory information. The laboratory is using a combination of experimental, mathematical and computational techniques.

One area of focus is how nerve fibres are guided by molecular gradients to find appropriate targets in the developing nervous system. The laboratory recently investigated the shape of growth cones, the structures at the tip of developing axons. This morphology is complex and highly dynamic but the significance of these changes for either the sensory or motor roles of growth cones is mostly unknown. Sophisticated mathematical techniques for characterising shape in general have been adapted to develop a more quantitative understanding of the role growth cone shape plays in effective axon guidance. In 2014 the laboratory was awarded a National Health and Medical Research Council Project grant to continue this work.

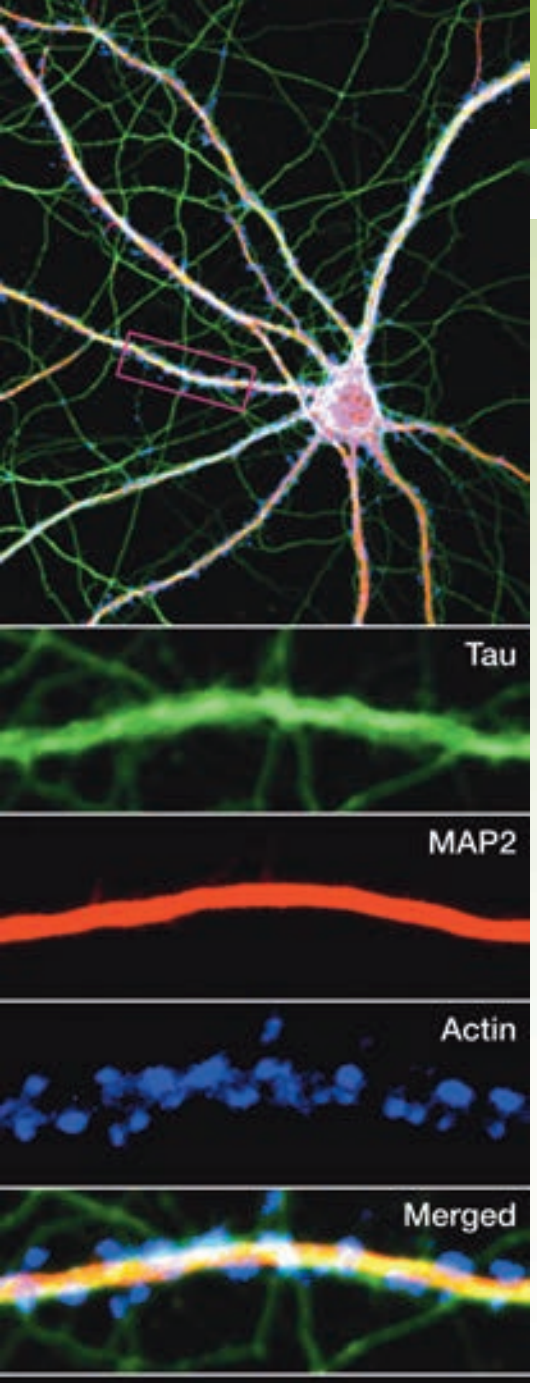
Once nerve fibres have reached their targets, connections are refined by neural activity. The laboratory recently developed new statistical methods based on Gaussian process regression to discover new ways in which the pattern of visual stimulation early in life influences brain structure.

The group is also using fluorescent labelling techniques to visualise the simultaneous activity of many neurons in the developing zebrafish brain in response to simple visual stimuli. By using mathematical techniques from statistics and information theory, it is then possible to predict how the zebrafish could optimally decode these patterns of activity in order to determine what visual stimulus was actually present. A better understanding of neural decoding is important for optimising the design of brain–computer interfaces. In 2014 the laboratory was awarded an Australian Research Council Discovery grant to continue this work.

Cultured neurons growing in a novel microfluidics chamber.

Laboratory Head **Professor Jürgen Götz**

2014 Laboratory Members L–R/T–B: Jürgen Götz, Siân Baker, J Bertran-Gonzales, Liviu Bodea, Nadia Cummins, Linda Cumner, Xia Di, Harrison Evans, Jasmin Galper, Robert Hatch, Gerhard Leinenga, Jing Lu, Miriam Matamales, Rebecca Nisbet, Tishila Palliyaguru, Zala Skrbis. *Not pictured*: Chuanzhou (Joe) Li, Chang (Sydney) Liu, Juan-Carlos Polanco. **Image:** Newly synthesised proteins fluorescently labelled with click chemistry in transgenic mouse fibroblasts (Ullrich *et al.*, *Nature Protocols,* 2014).



The top image shows a neuron in culture. The boxed area represents a dendritic branch with the enlarged images revealing staining for cytoskeletal and cyoskeleton-associated proteins.

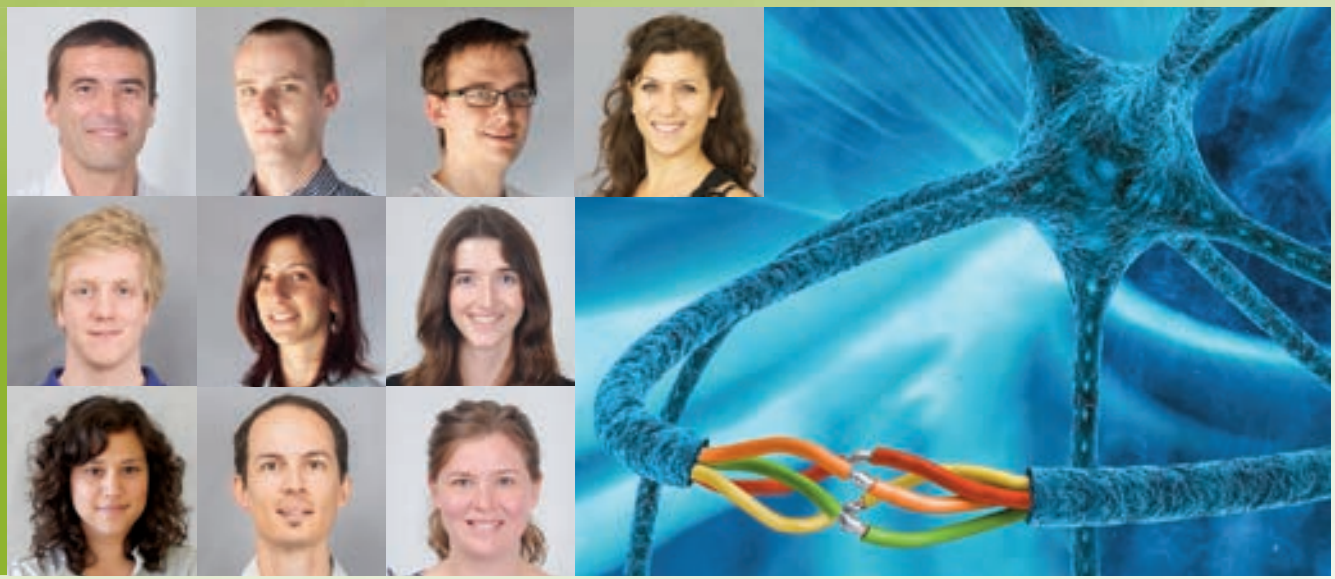
Alzheimer's disease—from basic mechanisms to a therapy

With an increasing life expectancy, the number of Australians suffering from Alzheimer's disease (AD) and related dementias including frontotemporal dementia (FTD) is dramatically increasing, from 320,000 currently to almost one million by 2050. In the Götz laboratory, which forms part of the Clem Jones Centre for Ageing Dementia Research (CJCADR), there are three major streams of research: (i) understanding disease initiation and progression at a molecular and cellular level using cellular and animal models, (ii) understanding the role that proteins implicated in dementia have in physiological processes, and (iii) the development of novel therapies.

2014 has seen significant funding from the State and Federal Government and ongoing funding from the Australian Research Council and the National Health and Medical Research Council (including a Program Grant on FTD and motor neuron disease). Strategic decisions were the recruitment of the electrophysiologist Robert Hatch from a leading epilepsy laboratory, and Liviu Bodea (Peter Hilton Research Fellow) from an overseas laboratory working on the role glial cells have in neurodegeneration. Research highlights include the discovery of what dictates the localisation of tau (which forms clumps in AD brains) in dendritic spines, and the role the kinase Fyn has in this process. Tau-based immunisation was revealed as a therapy for AD and FTD, with ongoing efforts focusing on so-called single-chain antibodies. Collaborative work with Hannah Nicholas (The University of Sydney) in the roundworm *C. elegans* addressed the role of a tau homologue in neuronal integrity and life-span, and established a novel click chemistry method to visualise and identify newly synthesised proteins in ageing and under conditions of stress.

We have further established QBI's first TALEN-based edited mouse genome in order to understand the trafficking of tau into dendritic spines. Also, excitingly, we have established a novel ultrasound-based therapy that in the coming year will be combined with the delivery of antibodies.

Laboratory Head **Associate Professor Massimo A. Hilliard**



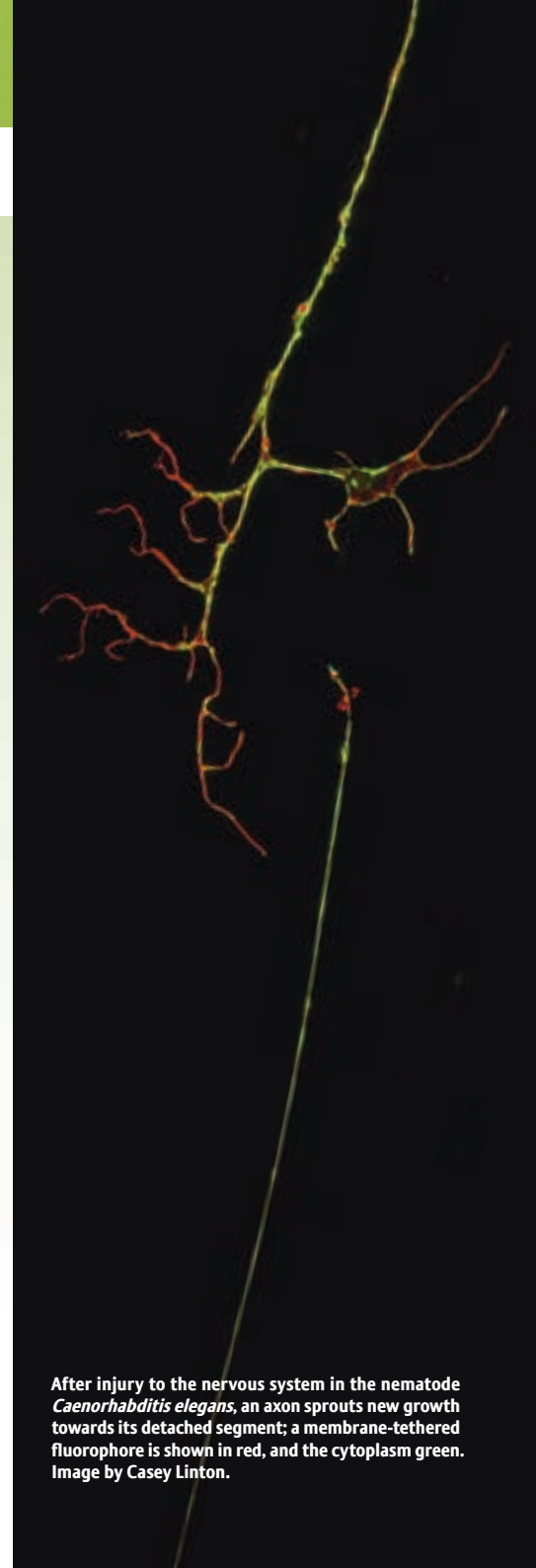
2014 Laboratory Members L–R/T–B: Massimo Hilliard, Justin Chaplin, Sean Coakley, Alessandra Donato, Sam Geraghty, Rosina Giordano-Santini, Casey Linton, Ellen Meelkop, Brent Neumann, Fiona Ritchie. **Image:** Injured axons of the nematode *Caenorhabditis elegans* and other invertebrate species are able to rejoin with their separated segments (shown here as fused electrical wires), preventing degeneration and restoring the original axonal tract.

Axonal development, regeneration, and degeneration: molecules & mechanism

The Hilliard laboratory is interested in understanding how axons (nerve fibres conducting impulses from the neuron) develop and are guided to their targets. The group also investigates how the axonal structure is maintained over time and how it can be reconstituted after injury. Neurons are highly polarised cells, with neurites, dendrites and an axon forming distinct morphological and functional domains. How a neuron decides on the number of neurites to extend is not well understood. Using *C. elegans* mechanosensory neurons as a model system, the Hilliard group has discovered MEC-7/β-tubulin, a component of microtubules, to have a critical role in this process. In contrast to the idea that microtubules are simple building blocks or cargo-tracks of the cytoskeleton, these *in vivo* results are consistent with emerging evidence *in vitro* that microtubules can provide critical signals for axon formation.

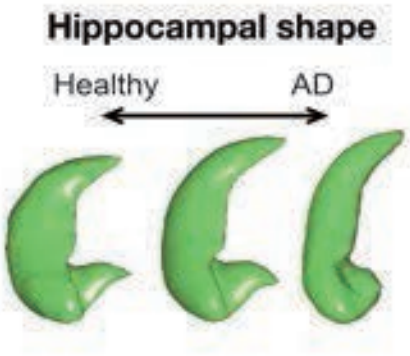
The axon is the neuron's longest process, but the mechanisms that allow it to maintain its structural integrity, or facilitate repair following injury, remain poorly understood. Reactive oxygen species (ROS) are major neuronal damaging components generated in a number of neurodegenerative conditions. In a collaborative project, the Hilliard group has developed an approach to generate ROS in selective classes of neurons, which makes it possible to determine, with a genetic approach, the molecular mechanisms responsible for the ROS-mediated degeneration. The team has also uncovered an axonal protective function for MEC-17, an α-tubulin acetyltransferase, which stabilises the cytoskeleton to allow proper transport of molecules and organelles throughout the axon (*Cell Reports*, 2014).

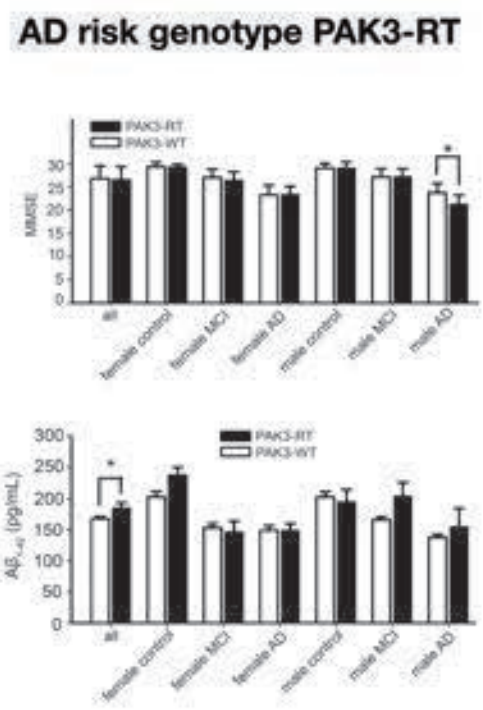
Using laser-based technology to axotomise single neurons in *C. elegans*, the Hilliard group has characterised neuronal regeneration in different classes of sensory neurons. In earlier work they demonstrated that axonal regeneration can occur as a result of axonal fusion, when two separated axonal fragments re-attach and restore the original axonal tract.



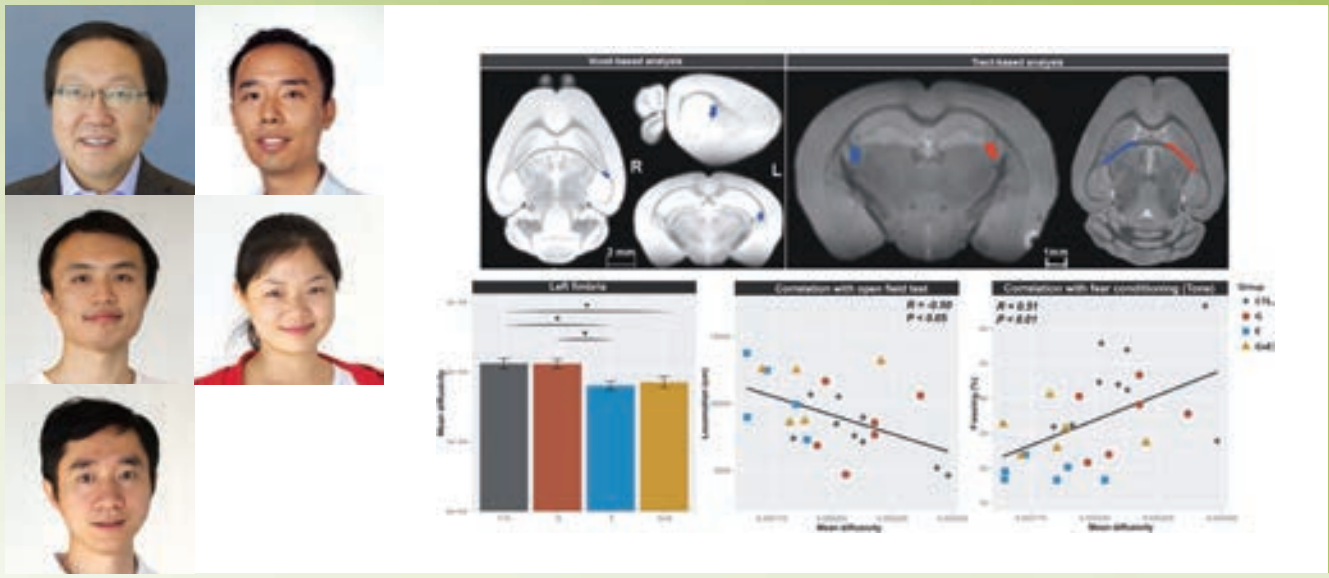
After injury to the nervous system in the nematode *Caenorhabditis elegans*, an axon sprouts new growth towards its detached segment; a membrane-tethered fluorophore is shown in red, and the cytoplasm green. Image by Casey Linton.

Laboratory Head **Professor Tianzi Jiang**





Top: The elongated hippocampal shape phenotype associated with Alzheimer's disease (AD) risk. Bottom: The effects of the AD risk genotype PAK3-RT on memory (using the mini mental state examination) and amyloid-β (Aβ) levels.



2014 Laboratory Members L–R/T–B: Tianzi Jiang, Yonghui Li, Cirong Liu, Tong Wu, Xianfeng Yang. **Image:** Abnormal mean diffusivity within the fimbria found by tractography based on diffusion magnetic resonance (dMRI) and correlated with behavioural performance of mice.

Mapping human and animal brain networks with neuroimaging

Convergent evidence has shown that brain functions can manifest at different scales within brain networks, and that the malfunctions associated with most psychiatric disorders are the result of faulty brain networks. The Brainnetome (www.brainnetome.org) provides a foundation for integrating the multi-level network features obtained with various functional and anatomical brain imaging technologies. The Jiang laboratory is studying basic theory, methodologies and algorithms underpinning the Brainnetome platform, and their applications in neurological and psychiatric diseases.

In 2014, one study on the mouse Brainnetome focussed on the Disrupted-In-Schizophrenia-1 (*DISC1*) gene. Despite the fact that *DISC1* is a promising risk gene for many mental illnesses associated with white matter abnormities and disconnection syndromes, the roles of *DISC1* in white matter development, oligodendrocyte differentiation and myelination are unclear. By performing behavioural, high resolution *ex vivo* diffusion magnetic resonance (dMRI) and histological examinations on the same animal, the Jiang laboratory identified significant dMRI-based abnormalities in the hippocampus and fimbria of DISC1 mice that underwent adolescent isolation, an effect that correlated significantly with specific behavioural and histological phenotypes. This suggests a gene–environment interaction may underlie a variety of neuropsychiatric disorders such as schizophrenia.

In addition to findings in animal models, the laboratory also made significant progress in human studies, particularly in the identification of Alzheimer's disease (AD) risk genes using neuroimaging markers. Using a novel hippocampal shape phenotype derived from a computational neuroanatomy approach, the Jiang laboratory identified 18 *PAK3* low frequency variants that have significant effects on β-amyloid production and the severity of AD symptoms via haplotypes, and have large effects on late onset AD risk, particularly for males or the non-APOE ε4 population. This finding provides new insight into the mechanism of AD development, and has clinical significance due to the enrichment of these variants in AD patients.

Laboratory Head **Professor Joe Lynch**

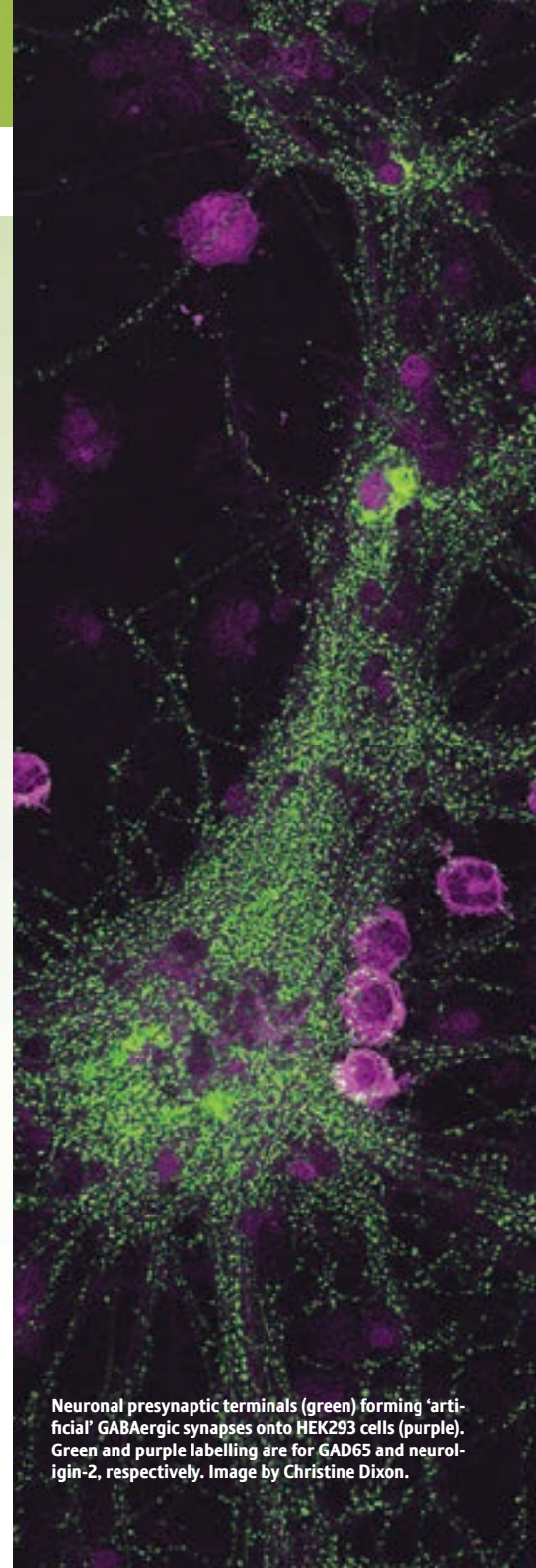
2014 Laboratory Members L–R/T–B: Joe Lynch, Christine Dixon, Argel Estrada, Justine Haddrill, Sharifun Islam, Robi Islam, Angelo Keramidas, Suzanne Scott, Ming Shiuan Soh, Sahil Talwar, Yan Zhang. *Not pictured*: Kristin Sung. **Image:** Docked pose of 2,4,5-trimehtoxyamphetamine (TMA-2) binding to the GlyR. TMA-2 is a novel high affinity modulator of GlyRs. Image by Talwar Sahil.

Discovering new drugs for inhibitory neurotransmitter receptors

The Lynch laboratory's major research interest concerns the molecular structure and function of the glycine and $GABA_A$ receptor ($GABA_AR$) chloride channels that mediate inhibitory neurotransmission in the brain. The $GABA_AR$ is an important therapeutic target for sedative and anxiolytic drugs and the glycine receptor (GlyR) has recently emerged as a therapeutic target for pain, spasticity, epilepsy and tinnitus. The Lynch laboratory is discovering new drugs active at these receptors and the molecular mechanisms by which their structures and functions are disrupted in hereditary neurological disorders.

Chronic inflammatory pain is caused by prostaglandins modulating α3 GlyRs that are specifically found in pain sensory neurons in the spinal cord. These 'pain-modulated' receptors represent a promising therapeutic target for chronic pain, but the problem has always been to prevent the drugs from affecting other GlyRs elsewhere in the brain. Following years of collaboration with a natural product chemist (Rob Capon, from the Institute for Molecular Bioscience, UQ) to develop new α3 GlyR-specific drugs, the group has succeeded in developing a drug with exquisite sensitivity and specificity for α3 GlyRs, which exerts potent analgesia in animal pain models.

As synaptic $GABA_ARs$ and GlyRs are formed from a wide variety of subunits, many isoforms are possible *in vivo*. Each isoform exhibits unique pharmacological and physiological properties, and has a unique role in brain function. Until now, it has not been possible to investigate a particular isoform in isolation in neurons due to the huge range of isoforms that are expressed simultaneously. The group has now developed techniques for reliably generating 'artificial' inhibitory synapses that incorporate the defined GlyR or $GABA_AR$ subunits of interest. This enables investigation of the effects of drugs on synaptic currents mediated by defined $GABA_AR$ or GlyR isoforms, and the effect that disease mutations have on the formation and function of both types of synapses.



Neuronal presynaptic terminals (green) forming 'artificial' GABAergic synapses onto HEK293 cells (purple). Green and purple labelling are for GAD65 and neuroligin-2, respectively. Image by Christine Dixon.

Laboratory Head **Dr Marie Mangelsdorf**

2014 Laboratory Members L–R/T–B: Marie Mangelsdorf, John Baisden, Tim Butler, Sarah Furlong, Jing Zhao. *Not pictured:* He Ji, Damien Rank. **Image:** The TARDBP gene encodes the protein TDP-43, which displays abnormal pathology in most patients with motor neuron disease (MND). A mutation in TARRDBP is revealed using whole exome sequencing, comparing an unaffect person (top) to a patient with MND who carriers a mutated green 'A' nucleotide in their DNA (bottom).

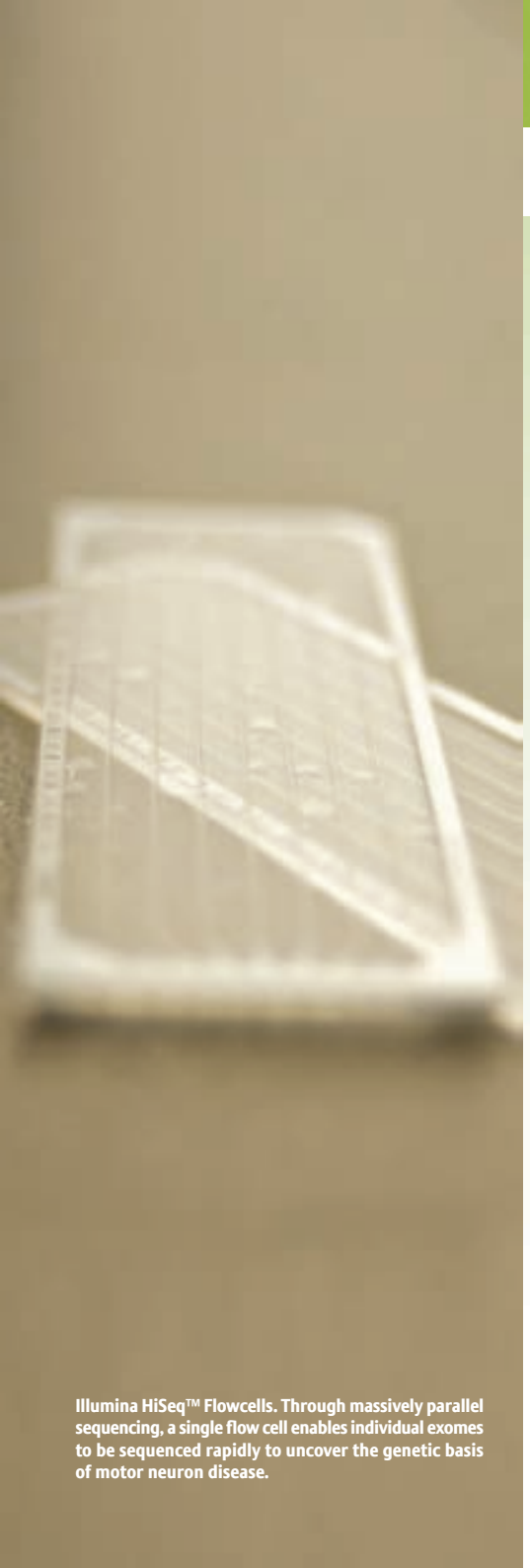
Understanding the mechanisms of motor neuron disease using molecular genetics

Dr Mangelsdorf is head of the Peter Goodenough and Wantoks Research Laboratory, dedicated to understanding the causes of motor neuron disease (MND). MND is a neurodegenerative disease that occurs when motor neurons that control muscles degenerate. There is no cure and a person diagnosed with MND has a life expectancy of only three years.

A genetic basis for MND is suggested by families in which multiple people are affected, and several genes that play a significant role in MND have been identified. However the cause of ALS in ~35 per cent of familial cases, and ~80 per cent of cases with no family history, remains unclear.

The Mangelsdorf group has been using next generation sequencing to generate data from MND patients and controls. In collaboration with others from QBI (Professors Bartlett, Visscher and Wray), as well as Professors Matt Brown (TRI), Huji Xu (Shanghai) and Dongsheng Fan (Beijing), sequencing data from more than 600 cases from China has been completed. In addition, the Mangelsdorf laboratory is sequencing DNA from more than 100 patients who have donated samples at the MND clinic at the Royal Brisbane and Women's Hospital (funded by the Motor Neurone Disease Research Institute of Australia). Analysis of this data is underway and will help to uncover novel genetic contributions to the disease.

The group is also investigating the role of the RNA binding protein TDP-43 in MND. Most patients with MND have abnormal TDP-43 in their neurons. The Mangelsdorf group is testing a new mouse model of TDP-43 with the aim of revealing the effect of TDP-43 mutation on the RNAs it regulates. Based on information previously generated by the group from mouse models, the Hilliard group at QBI is studying TDP-43 mediated RNA transport in *C. elegans* neurons to determine the role of this cellular process in MND pathology. In collaboration with Associate Professor Peter Noakes (QBI affiliate), who has collected muscle samples from MND patients, the Mangelsdorf laboratory will also be investigating the RNAs regulated by TDP-43 in human samples using next generation sequencing.



Illumina HiSeq™ Flowcells. Through massively parallel sequencing, a single flow cell enables individual exomes to be sequenced rapidly to uncover the genetic basis of motor neuron disease.

Laboratory Head **Professor Justin Marshall**

2014 Laboratory Members L–R/T–B: Justin Marshall, Karen Cheney, Wen-Sung Chung, Fabio Cortesi, Yakir Gagnon, Alan Goldizen, Kyra Hay, Diana Kleine, Yi-Hsin Lee, Martin Luehrmann, Genevieve Phillips, Qamar Schuyler, Sara Stieb, Rachel Templin, Hanne Thoen. *Not pictured*: Santi Krisantini, Melody Puckridge, Anne Winters. **Image:** Golgi stain of a newly discovered amacrine cell in the visual pathway of stomatopod crustaceans.

Visual ecology—neuroscience in the real world

A systems approach to sensory neuroscience is the aim of the Marshall laboratory. Working from the outside in, visual ecology examines the biology and physics of an organism's habitat, how light is guided through the eye's optics to the retina, the retinal molecules and design components that absorb light, neural conduction of this information to the brain, processing and behavioural outcomes driven by the brain and finally the different types of behaviour such as sexual, territorial or defensive.

The laboratory's mostly marine model animals are extracted from the field and include crustaceans, fish and cephalopods. In 2014 this comparative drive delivered many discoveries in colour and polarisation vision. Some core questions include interpreting the new language of polarisation communication, use of colours and unconventional colour vision systems and molecular mechanisms behind colour vision in marine organisms. With colleagues in the USA and UK, these areas are now delivering bio-inspired solutions for imaging neural activity and the detection of cancer.

Our comparative systems approach saw more than 20 articles and five books published in 2014, including work appearing in *Science, Current Biology, Proceedings of the National Academy of Sciences of the USA* and *Proceedings of the Institute of Electrical and Electronics Engineers. Visual Ecology*, a much needed field update book, was a highlight along with four edited volumes through the *Springer Series in Vision Research*, a new cornerstone reference in visual neuroscience with Professor Marshall as senior editor and co-series founder with colleague Professor Shaun Collin of The University of Western Australia. Communicating science to the public is important to the group and collaborations with local TV and radio, the BBC, Sir David Attenborough and Atlantic Productions gathered momentum, seeing the group central to several documentary series due out in 2016. CoralWatch (the group's environmental section) continues to grow as one of Australia's leading citizen science groups, exploring new methods of science outreach and participation in more than 80 countries.

Colourblind reef squids enhance their eyesight using polarisation vision to increase image contrast, and a range-finding mechanism to enable their fast strike.

Laboratory Head **Professor Jason Mattingley**

2014 Laboratory Members L–R/T–B: Jason Mattingley, Oliver Baumann, Nicholas Bland, Luca Cocchi, Daina Dickins, Eve Dupierrix, Hannah Filmer, Marta Garrido, Michelle Hall, Luke Hearne, Oscar Jacoby, Marc Kamke, David Lloyd, Natasha Matthews, Claire Naughtin, Abbey Nydam, David Painter, Amanda Robinson, Martin Sale, Cooper Smout, Susan Travis, Lisa Wittenhagen. *Not pictured*: Amy Taylor, James Teng. **Image:** Large-scale brain network involved in cognitive problem-solving. Coloured disks represent different brain regions and arrows show the functional links between them.

Understanding human brain function in health and disease

Researchers in the Mattingley laboratory investigate how the human brain gives rise to perception, cognition and the control of movement, in health and disease. They are inspired by a desire to understand how people use attention to prioritise information, whether from the sensory world or from internal thought processes. They also investigate learning, with the aim of harnessing new discoveries from the field of neuroscience to enhance learning outcomes across the lifespan. A particularly important part of the research involves understanding how perceptual and cognitive processes can be impaired in brain disorders such as stroke. They employ a range of approaches to investigate these questions, including behavioural tests, imaging and brain stimulation methods.

In 2014, researchers in the Mattingley laboratory made several important discoveries. Graduate student Amanda Robinson published a paper in the *Journal of Cognitive Neuroscience* showing that inhaled odours can modify how visual areas of the human brain respond to familiar objects. This work has improved our understanding of how the various sensory areas of the brain integrate their activity. In other work, postdoctoral fellow Luca Cocchi published a paper in *Cerebral Cortex* showing how frontal regions of the brain establish functional connections with other areas during complex problem-solving tasks. And postdoctoral fellow Hannah Filmer published a review in *Trends in Neurosciences* on a new method for non-invasive brain stimulation.

2014 also saw a number of important milestones in the Mattingley laboratory. David Painter and Amanda Robinson were awarded their PhDs and took up prestigious postdoctoral fellowships in overseas laboratories. Postdoctoral fellow Martin Sale was awarded a National Health and Medical Research Council Project grant to examine whether slow-wave neural oscillations can enhance brain plasticity, and Jason Mattingley and Marta Garrido were part of a successful bid to the Australian Research Council to establish a new $20 million Centre for Integrative Brain Function.

Transcranial electrical stimulation of the brain. Current travelling between electrode pads (blue) changes the likelihood of neurons firing (gold).

Laboratory Head **Professor John McGrath**

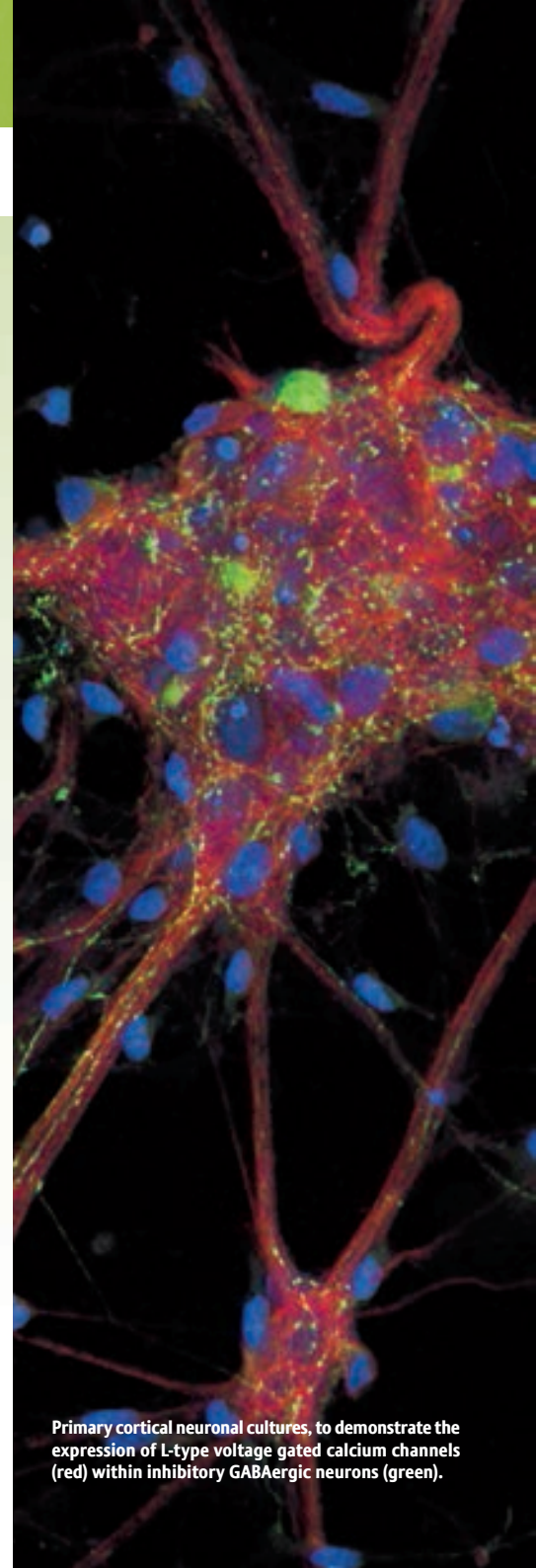
2014 Laboratory Members L–R/T–B: John McGrath, Helen Gooch, Amy Heffernan, Henry Simila, Anna Vinkhuyzen. *Not pictured*: Peter Josh. **Image**: 'Faces' by Francesca Roberts. Crayon and pencil on paper, from the Queensland Centre for Mental Health Research Art Collection.

The prevention and treatment of schizophrenia

The aim of the McGrath laboratory is to explore risk factors that are linked to schizophrenia and other mental disorders. They focus on non-genetic factors that are potentially modifiable. In recent years the team has been examining the impact of low vitamin D (the 'sunshine hormone') during early brain development and on adult brain function. In collaboration with Associate Professors Darryl Eyles and Thomas Burne at QBI, they have developed animal models to examine the impact of low vitamin D during gestation on brain development. The group has established a new research program with Professor Pankaj Sah and Dr Helen Gooch to explore links between vitamin D and voltage-gated calcium channels.

Previously in 2013, Professor McGrath was awarded a prestigious National Health and Medical Research Council John Cade Fellowship in Mental Health Research. These funds have allowed the group to explore a wider range of modifiable risk factors (e.g. infectious agents, stress, cannabis, vitamin D), a more diverse range of brain-related outcomes (e.g. prenatal and neonatal brain growth, childhood neurocognition, autism, schizophrenia, other mental disorders), and a wider range of epidemiological samples (in collaboration with national and international groups). New projects include an international study related to psychotic experiences in the general community (Harvard University and 19 other universities). The group has also been extending studies related to vitamin D in international datasets by exploring gene–environment interactions.

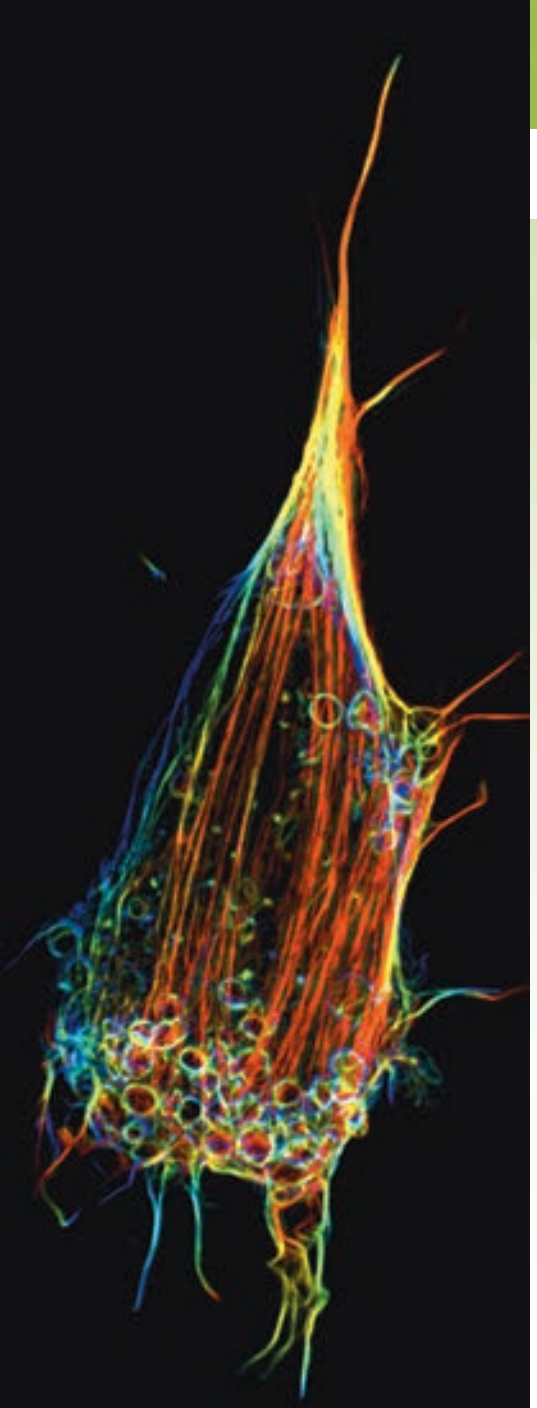
In collaboration with Associate Professor James Scott (UQ Centre for Clinical Research), the McGrath laboratory commenced a clinical trials program related to improving outcomes in people with Early Psychosis. In collaboration with hospitals and clinics in South-East Queensland, the team will examine new treatments using randomised controlled trials.



Primary cortical neuronal cultures, to demonstrate the expression of L-type voltage gated calcium channels (red) within inhibitory GABAergic neurons (green).

Laboratory Head **Professor Frederic Meunier**

2014 Laboratory Members L–R/T–B: Frederic Meunier, Adekunle Bademosi, Rachel Gormal, Callista Harper, Ravikiran Kasula, David Kvaskov, Regine Low, Sally Martin, Nika Mohannak, Vinod Narayana, Tam Hong Nguyen, Andreas Papadopulos, Vanesa Tomatis, Tong (Iris) Wang. **Image:** Secretory vesicles are entangled in a dense mesh of actin filaments underneath the cell membrane, ready to release their hormone or neurotransmitter content in response to stimulation.



The basal cortical actin network of a bovine chromaffin cell undergoes remodeling in preparation for bulk endocytosis. Acto-myosin II rings form around the neck of budding endosomes.

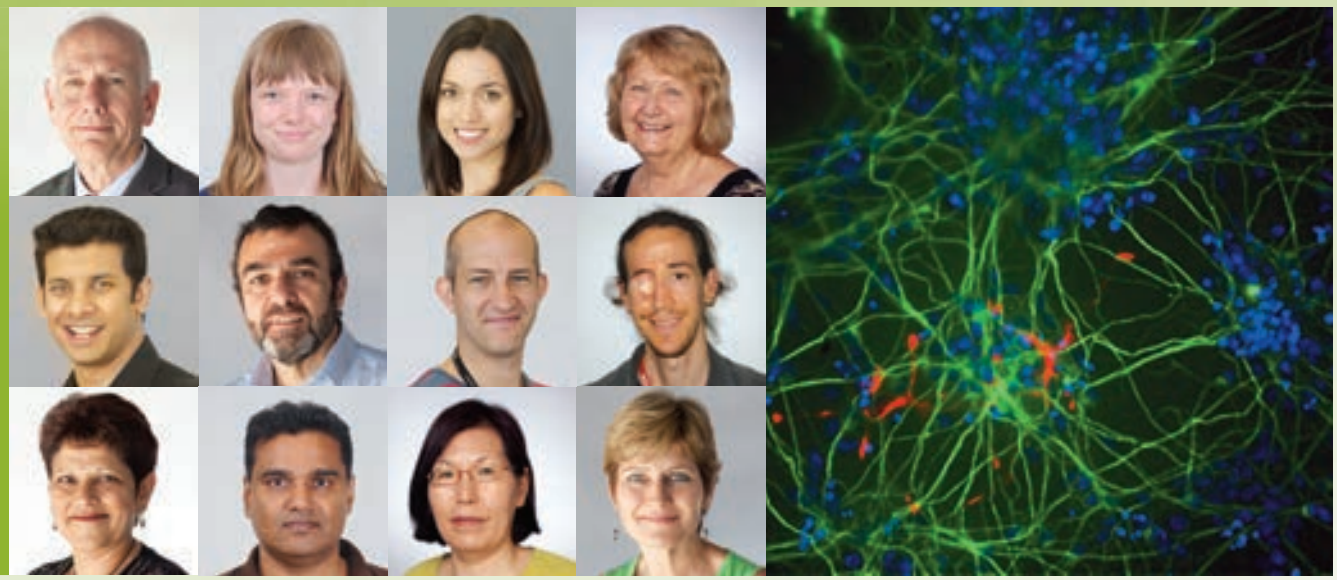
Unravelling neuronal communication and survival

2014 was a great year for the Meunier laboratory, including the award of an Australian Research Council Discovery Project grant and the publication of five peer-reviewed publications.

As part of the Clem Jones Centre for Ageing Dementia Research (CJCADR), the Meunier laboratory made a breakthrough in the fight against stroke. Claiming five million lives each year, it is the second biggest killer after ischaemic heart disease. The socio-economic burden is enormous, as those who survive stroke have to live with profound neurological deficits. Current treatments for ischaemic stroke are inefficient and solely rely on removing blood clots in the brain, which activate inflammation and lead to worsened outcomes. In a study published in *Nature Communications*, the laboratory, in collaboration with several others from London and Hamburg, showed that the PI3-kinase δ inhibitor CAL-101 provided a clear neuroprotective effect by controlling the release of the pro-inflammatory cytokine Tumor Necrosis Factor-α from microglia. CAL-101 was effective in improving post-stroke recovery in mice, and it was still effective up to three hours after the clot was removed and blood started flowing. This suggests that CAL-101 or similar drugs could be given in conjunction with currently used drugs such as tPA. The study had wide media and social media coverage including an article in *The Conversation*.

The team has continued to pursue its work into the mechanism of neuroexocytosis, discovering that a human mutation of the protein MUNC18-1, linked to early infantile epileptic encephalopathy, potently increased its ubiquitination and proteasomal degradation leading to a temperature-sensitive defect in exocytosis (*Cell Reports*). This paper was highlighted in *Prime F1000*. The group also unravelled a novel mechanism allowing neurosecretory vesicles to be directed towards the plasma membrane in an activity-dependent manner (*PLOS ONE*).

Laboratory Head **Professor Bryan Mowry**



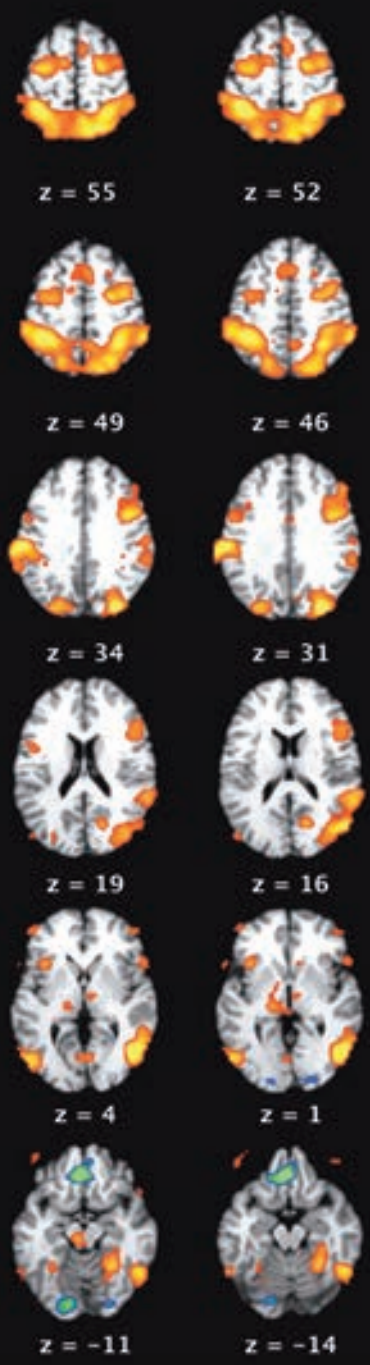
2014 Laboratory Members L–R/T–B: Bryan Mowry, Emma Byers, Ilvana Dzafic, Cheryl Filippich, Javed Fowdar, Bill Mantzioris, Andrew Martin, Samuel Nayler, Kalpana Patel, Sathish Periyasamy Chikako Ragan, Heather Smith. **Image:** Glial cells (red) are being studied to determine whether there are differences in schizophrenia (neurons are green).

Exploring latest genetic findings

The Mowry laboratory aims to identify and functionally characterise susceptibility genes for schizophrenia and related disorders. The group aims to achieve this by combining genome-wide association studies (GWAS), DNA sequencing and transcriptome profiling with neuropsychological testing and neuroimaging in people with schizophrenia.

Current studies include: (i) the recruitment of a large Indian case-control and family cohort in collaboration with Dr Rangaswamy Thara (Schizophrenia Research Foundation, Chennai); (ii) neuroimaging and neuropsychological phenotyping of schizophrenia patients with major copy number variations, and comparing patients with a matched sample of healthy individuals; (iii) GWAS in homogeneous Indian and Sarawak populations, and relating the results to the latest European study results; (iv) transcriptome-wide analysis of small non-coding RNAs in post-mortem brain samples from schizophrenia patients and unaffected individuals; (v) targeted resequencing of a previously identified schizophrenia linkage region on chromosome 1 in an Indian case-control sample, using QBI's next-generation sequencing facility; (vi) derivation of neuronal cells using induced pluripotent stem cell (iPSC) technology in a subset of schizophrenia patients and controls, in order to establish an *in vitro* model of disease.

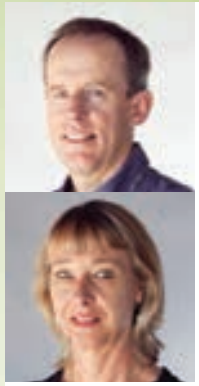
Highlights during the year included (i) National Health and Medical Research Council funding (2014–16) to conduct a whole exome sequencing study of families to identify *de novo* and inherited mutations contributing to disease; (ii) contributions to the latest Psychiatric Genomics Consortium schizophrenia GWAS, which has identified more than 100 genetic susceptibility loci (*Nature*, 2014). The group also published a review in *Schizophrenia Bulletin* on the role for iPSCs in schizophrenia research.

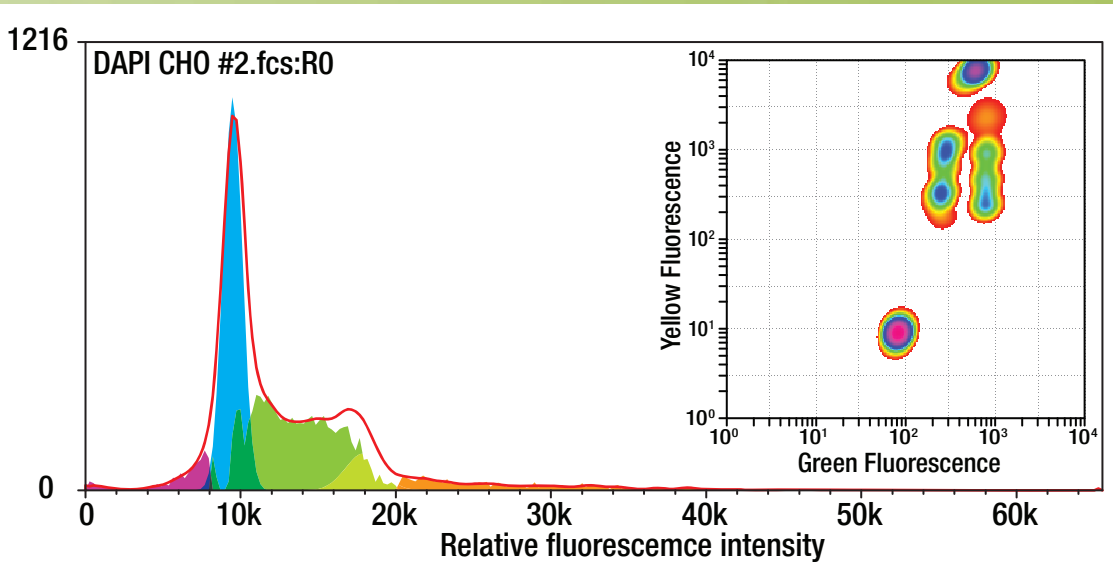


Functional magnetic resonance imaging (fMRI) activation differences across random (warm colours) and theory of mind (cool colours) animations in patients with schizophrenia and healthy controls.

Laboratory Head **Mr Geoffrey Osborne**

The gonometric nozzle assembly in a cell sorting flow cytometer. This feature allows to the use of low operating pressures that improves assay sensitivity and allows the generation of results such as those on the right.





2014 Laboratory Members T–B: Geoffrey Osborne, Virginia Nink. **Image**: The analysis of DNA and specific RNA's from sub-populations of cells is becoming increasingly important. The laboratory has been developing combined methods based on accurate sorting of cells from different phases of the cell cycle (main image: resting cell phase coloured blue for example) and then analysing expression levels of specific microRNA's using a fluorescent barcoded particle approach (inset: green and yellow fluorescence barcode population binding microRNA's) from different phases of the cell cycle.

Implementing novel approaches to solve fundamental problems

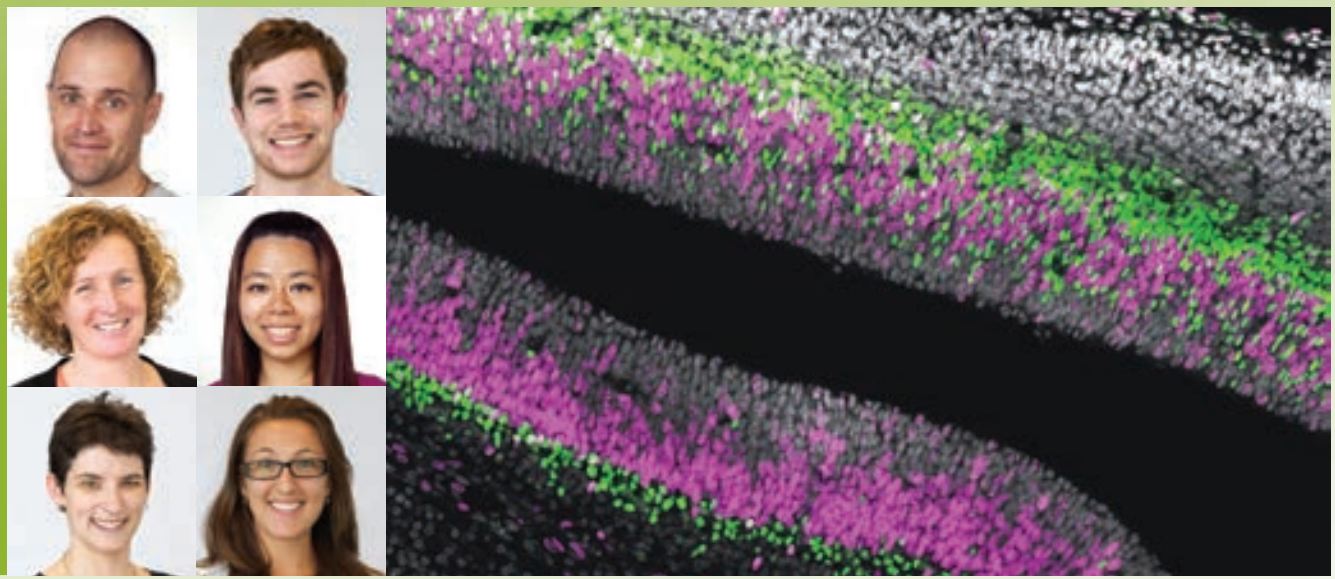
As Director of Flow Cytometry for both QBI and the Australian Institute for Bioengineering and Nanotechnology, Mr Geoffrey Osborne leads a team that provides crucial cell sorting and analysis services to researchers both within QBI and across the broader university. The laboratory specialises in the analysis and separation of cells derived from a variety of sources such as solid tissue, blood and cultured cell lines.

The wide diversity of scientific areas in which flow cytometry can be applied has resulted in a number of collaborative projects. One critical area that has been addressed in the past year is the defining of absolute cell counts by flow cytometry. To date, accurate determination of the number of cells with characteristics of interest by flow cytometry has not had widespread uptake in the research setting. The group published a paper showing that a simply volumetric method provides results that are comparable to those obtained using commercial counting beads, or those obtained using a 'gold standard' haematology analyser. The implication of this work is that now absolute counts of numbers of particular cells present in blood or tissue can be quantified and loss or gain related to disease, or in response to stimuli, can now be readily quantified.

The quantification of particular microRNAs using a novel flow cytometry assay is another area that the laboratory actively pursued in 2014. MicroRNAs have been shown to be critical regulators of cell growth and differentiation in glioblastoma, the aggressive form of brain tumour that has been a research focus of this laboratory for a number of years. Using a novel approach based on multiplexed nanorod probes, the laboratory has shown that it is possible to detect varying microRNA levels in human tumour samples.

Mr Geoffrey Osborne holds a joint appointment with the Australian Institute for Bioengineering and Nanotechnology.

Laboratory Head **Dr Michael Piper**



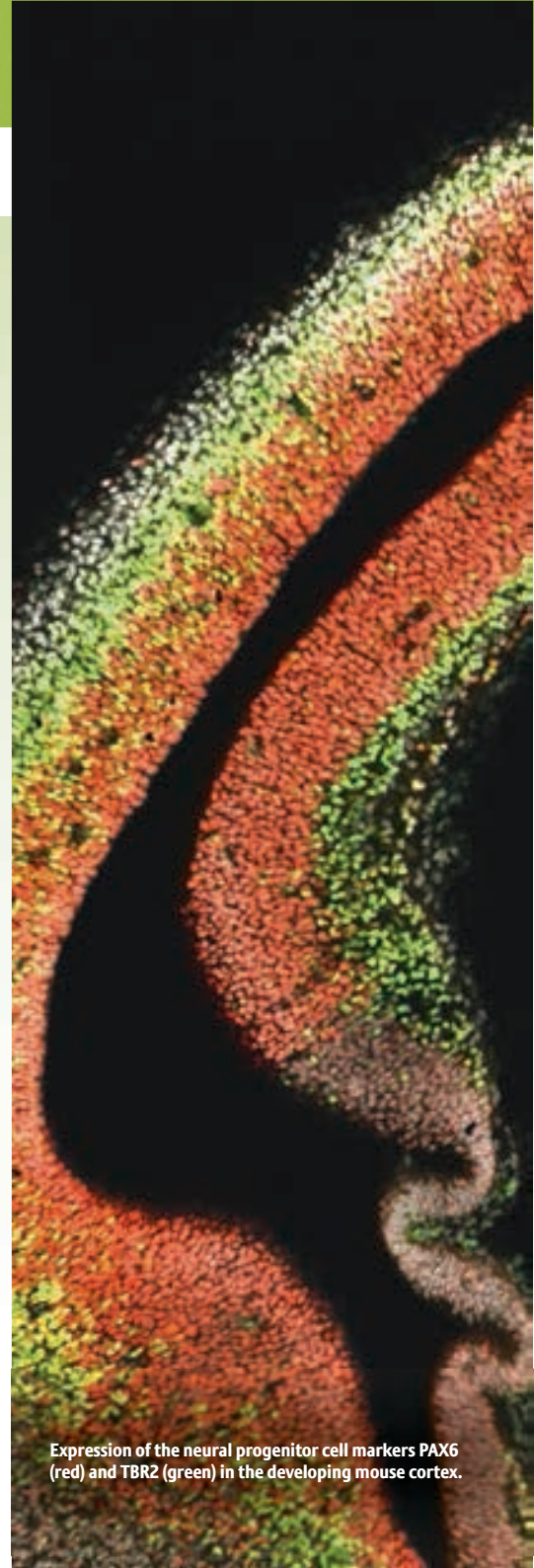
2014 Laboratory Members L–R/T–B: Michael Piper, Lachlan Harris, Tracey Harvey, Evelyn Heng, Chantelle Reid, Diana Vidovic. *Not pictured*: Elise Horne. **Image:** Study of the biology of proliferating neural stem cells within the cortex by determining where dividing neural progenitor cells are found (different progenitor cells are labelled here with purple and green fluorescent markers), and the genes that control their division.

Regulation of stem cell differentiation

Neural stem cells provide the building blocks from which the neurons and glia of the mature brain are generated. During development, the control of how these stem cells either self-renew or differentiate is crucial to the correct formation of the brain. Moreover, neural stem cells are also found in the adult brain, where they provide ongoing neurogenesis throughout life. Understanding how these neural stem cells are regulated is critical if we are to understand the normal trajectory of brain development, and can also provide insights into developmental disorders and disease.

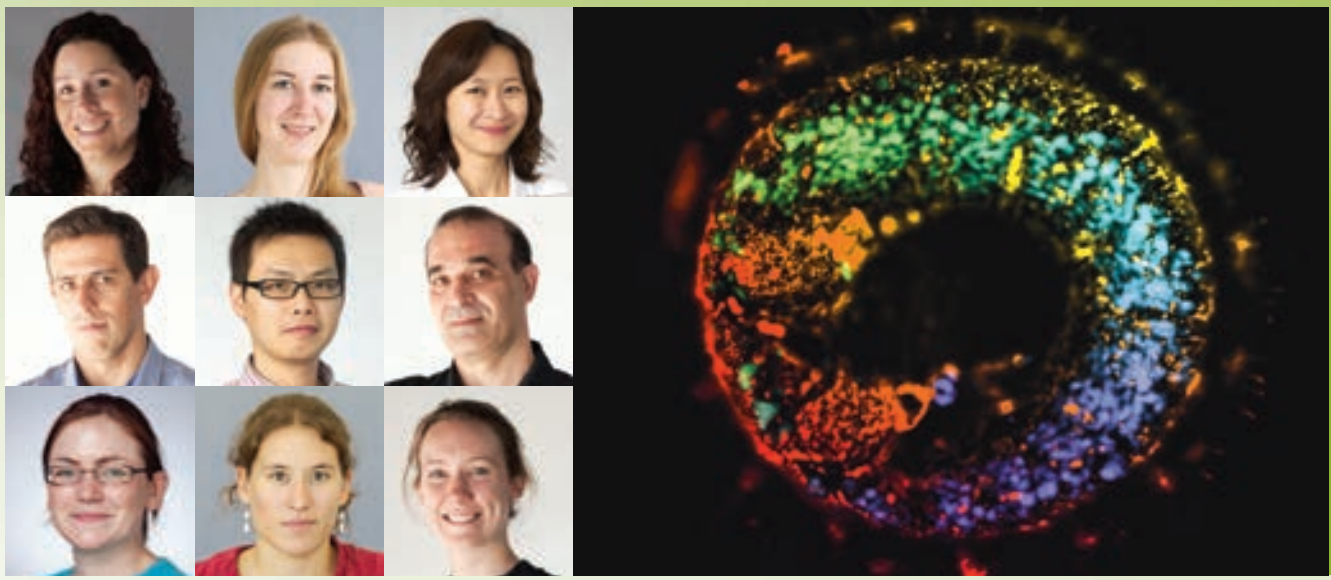
The Piper laboratory studies the genes that control neural stem cell differentiation in both the developing and adult brain. To do this it uses mouse model systems and *in vitro* cell culture paradigms to investigate the key processes behind the biology of neural progenitor cells, and to reveal the genetic hierarchy that controls neural progenitor cell differentiation. Moreover, the Piper laboratory is also applying these findings to investigate disorders such as glioma, which are characterised by unrestrained stem cell proliferation.

The group's recent findings reveal how neural stem cell development and differentiation within the embryonic and adult brain are regulated by a family of transcription factors known as the nuclear factor one family (NFI). They have shown that NFIB is critical for the formation of the hippocampus, a key site for learning and memory within the brain (Piper *et al.*, *Journal of Neuroscience*, 2014). Furthermore, the group has shown that another NFI family member, NFIX, is also required for the formation of the hippocampus (Heng *et al.*, *Cerebral Cortex*, 2014). Current work in the Piper laboratory is aimed at further elucidating the targets of NFI transcription factors, and how misregulation of this transcription factor family can culminate in brain cancer.



Expression of the neural progenitor cell markers PAX6 (red) and TBR2 (green) in the developing mouse cortex.

Laboratory Head **Dr Judith Reinhard**



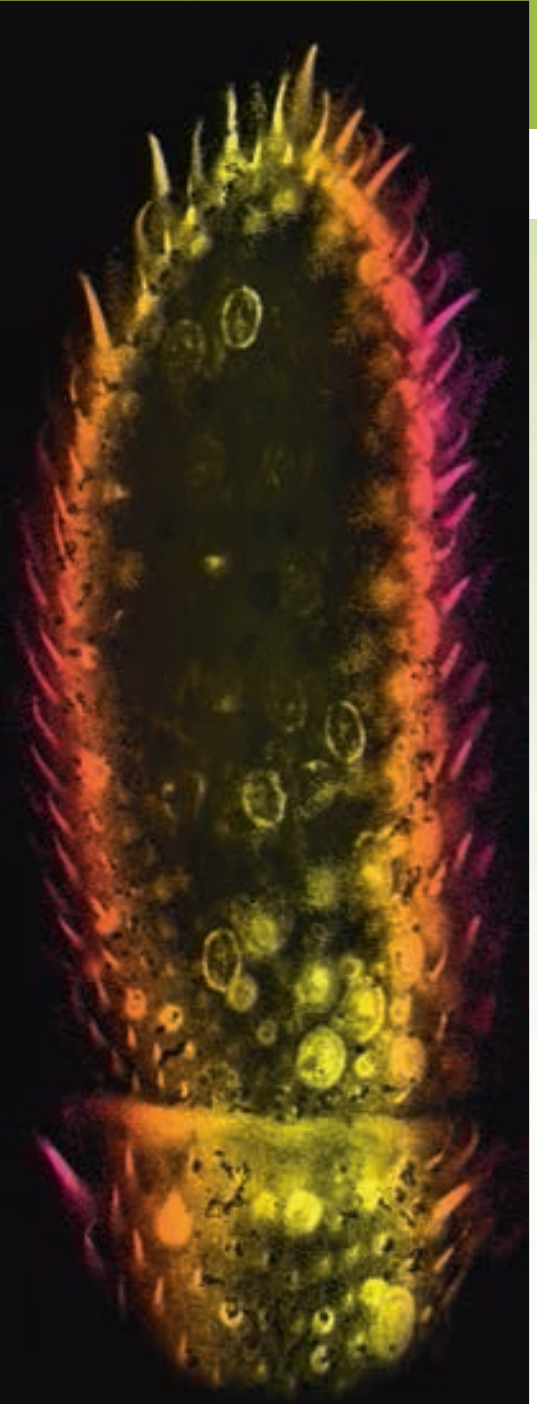
2014 Laboratory Members L–R/T–B: Judith Reinhard, Stephanie Biergans, Ming-Yu Chen, Alexandre Cristino, Shao-chang Huang, Homayoun Kheyri, Aoife Larkin, Morgane Nouvian, Amanda Robinson. **Image:** Cross-section of a honeybee antenna showing expression of olfactory receptor Or151 in neurons (red/orange/yellow).

Olfactory plasticity: how the brain makes sense of scents

Researchers in the Reinhard laboratory investigate how the brain processes sensory information and translates it into behavioural activity, thus linking brain function to behaviour. In particular, the group studies the mechanisms underlying learning of odours, and how olfactory experiences and memories modulate brain function. The laboratory uses insect model systems in combination with human studies and integrates behavioural approaches with physiological and molecular approaches.

Smell memories are some of the most salient that humans form in their lives, and a mere whiff of an odour can trigger recall of long-forgotten events. However, how we perceive different scents, aromas and flavours changes throughout our lives, which can affect our preferences for different foods or beverages. The Reinhard laboratory has led an international study that has boosted understanding of this process, by showing that olfactory memory formation plastically regulates olfactory receptor expression in the sensory periphery. Using an insect model with a superb capacity for learning odours, the honeybee, they showed that formation of a particular odour memory in the brain modulates expression of the respective receptor molecules in the sensory periphery, the bee's antennae.

This research demonstrates for the first time that the ability to smell different things is experience-dependent and modulated by scent conditioning. The findings may help explain the wide variability of smell perception in humans and the neurological mechanism underlying the common phenomenon of 'acquired taste', where repeated sensory experience with a flavour or aroma leads to perceptual changes. This knowledge will provide an enormous insight for understanding flavour and aroma perception, and how our sensory experiences shape our preferences. The study, which was published in the *European Journal of Neuroscience*, was recommended by the Faculty of 1000 and highlighted by Global Medical Discovery.



Segment of a honeybee antenna showing expression of olfactory receptor Or151 in neurons.

Laboratory Head **Professor Linda Richards**

2014 Laboratory Members L–R/T–B: Linda Richards, Gonzalo Almarza, Jens Bunt, Kok-Siong Chen, Tim Edwards, Sinead Eyre, Laura Fenlon, Ilan Gobius, Zelan Hu, Peter Kozulin, Jonathan Lim, Laura Morcom, Annalisa Paolino, Thomas Pollak, Rodrigo Suárez. *Not pictured:* Julie Webster. **Image:** Diffusion MRI of a platypus brain showing bilateral cortical connections crossing through the anterior commissure. Image by Rodrigo Suárez.

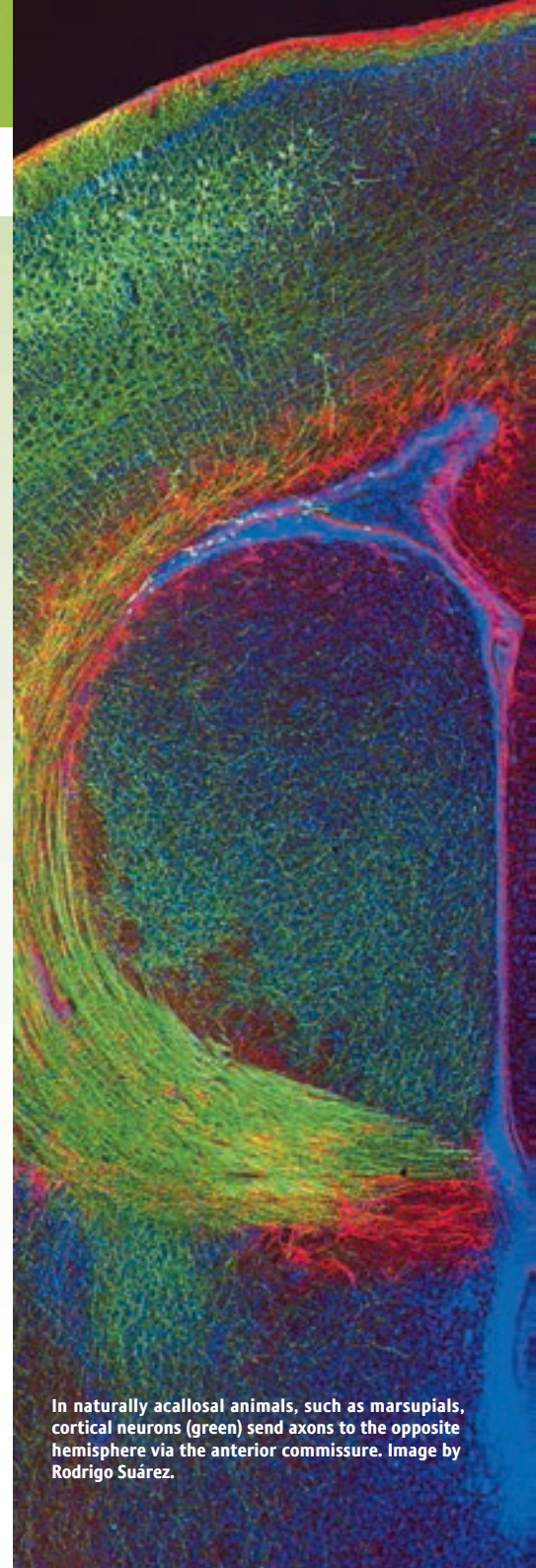
Mechanisms of brain development required for brain function

The laboratory is focussed on understanding early brain development and the mechanisms that lead to correct brain wiring. They are interested in how such mechanisms may be disrupted during development and how this affects the cognitive outcome of individuals.

2014 was a very productive year for the laboratory. One highlight was a paper showing that a balance of activity between the two hemispheres of the brain is important for its wiring (Suárez, Fenlon *et al., Neuron*, 2014). The group is now investigating what aspects of activity are important for brain wiring as this may provide insight into the causes of developmental disorders of brain wiring such as malformations of the corpus callosum. A number of collaborative projects also came to fruition with groups in the USA, China and Europe, which resulted in high impact publications on mechanisms underlying brain wiring in mouse models of human congenital malformations. A clinical review on the genetics and developmental mechanisms related to human malformations of the corpus callosum with specialist-physician colleagues in San Francisco was also published (Edwards *et al., Brain*, 2014).

The laboratory has employed a wide variety of sophisticated techniques, from genetics and gene manipulation in animal models to high resolution microscopy and multimodal magnetic resonance imaging.

Awards to laboratory members included the UQ Academic Medal to BSc(Hons) student Jonathan Lim. PhD student Laura Fenlon was awarded a competitive student presentation prize (second place in the QBI graduate student symposium) and the QBI prize for best student paper (co-first place), and two competitive travel scholarships. Dr Rodrigo Suarez was awarded two travel scholarships to attend a conference on brain evolution in Toledo, Spain from the International Brain Research Organisation (IBRO) and Contributing to Australian Science and Scholarship (CASS). Finally, Dr Jens Bunt received independent project funding from the Brain Foundation for his work on brain cancer.



In naturally acallosal animals, such as marsupials, cortical neurons (green) send axons to the opposite hemisphere via the anterior commissure. Image by Rodrigo Suárez.

Laboratory Head **Professor Pankaj Sah**

2014 Laboratory Members L–R/T–B: Pankaj Sah, Eleanora Autuori, Suzanne Campbell, Christine Dixon, Amu Faiz, Arezoo Fallah, Andrea Giorni , Helen Gooch, Sarah Hunt, Roger Marek, John Morris, Chris Nolan, Madhusoothanan Bhagavathi Perumal, Margreet Ridder, Petra Sedlak, Peter Stratton, Cornelia Strobel, Robert Sullivan, Yajie Sun, Fabrice Turpin, François Windels, Li Xu, Shanzhi Yan. **Image**: Neurons of the auditory cortex (AC, green) were genetically manipulated to express a light sensitive protein. This allows to control their activity using laser light with a very precise temporal and spatial resolution.

Neural circuits and mechanisms underpinning learning and memory

The Sah laboratory studies the physiological and molecular mechanisms that underlie behaviour, learning and memory formation. Using a combination of electrophysiology and molecular techniques, in conjunction with behavioural studies, the laboratory seeks to understand the neural circuitry that underpins learning and memory formation in animal models. These studies are complemented by electrophysiological recordings and behavioural analysis in humans. The laboratory focuses on the part of the brain called the amygdala. The group uses viruses to deliver optogenetic constructs to neurons in defined regions, and then records the electrical activity in acute brain slices to study the properties of the connections in these neural circuits. The group has mapped the circuits that provide auditory and noxious information to the amygdala, and studied the circuits that connect the amygdala with the prefrontal cortex and hippocampus.

In collaboration with Professor Joe Lynch at QBI, the group is exploring the molecular identity of receptors that are present at inhibitory connections in the amygdala. In the last year they have concentrated on the properties of synaptic γ-aminobutyric (GABA) receptors that contain γ1 subunits. These receptors are enriched in specific circuits in the amygdala and could be targets for the development of new anxiolytic drugs.

For the human studies, Professor Sah collaborates with Professor Peter Silburn and Dr Terry Coyne (UQ Centre for Clinical Research) to study neural activity in the human brain in patients undergoing neurosurgery for deep brain stimulation. These recordings are revealing the activity in the human brain in a range of movement disorders, such as Parkinson's disease, essential tremor and Tourette's syndrome. In 2015, the group will be involved in a clinical trial for the treatment of obsessive compulsive disorder.

The surgical implantation of a recording electrode is part of the procedure used for the the treatment of Parkinson's disease by deep brain stimulation.

Laboratory Head **Professor Mandyam Srinivasan**

2014 Laboratory Members L–R/T–B: Mandyam Srinivasan, Julia Groening, Michael Knight, Nikolai Liebsch, Ingo Schiffner, Dean Soccol, Reuben Strydom, Gavin Taylor, Saul Thurrowgood, Hong Vo, Michael Wilson. *Not pictured*: Peter Anderson, Aymeric Denuelle. **Image:** Quadrotor aircraft, designed and developed in the biorobotics laboratory, for implementing and testing biologically inspired strategies for aircraft navigation.

Visual guidance in bees, birds and flying machines

Birds and bees display remarkable navigational capacities, despite their diminutive brains. The Srinivasan laboratory is using honeybees and budgerigars as models to understand how animal vision guides flight and enables navigation, and to design biologically inspired systems for the guidance of aircraft.

The bee laboratory is examining how aggressive honeybees pursue and intercept moving targets. High-speed video cinematography is revealing a suite of behavioural strategies that comprise an initial 'orientation' phase, a subsequent tracking phase, and a final interception phase, which in combination orchestrate a stealthy and rapid arrival at the target.

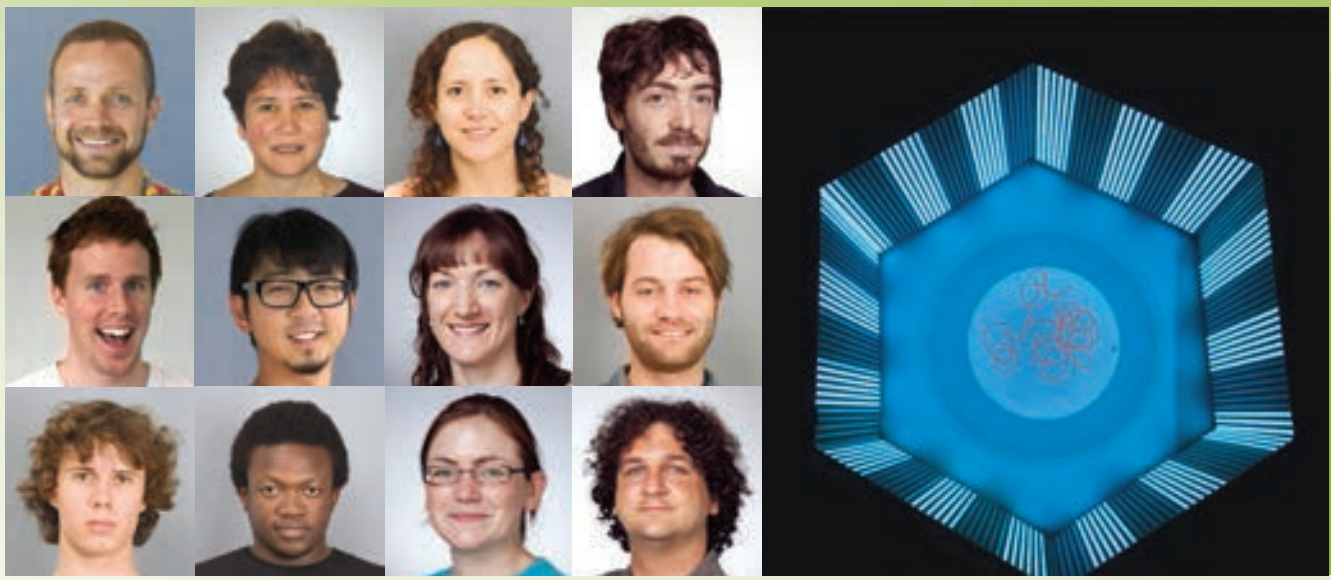
The bird laboratory is investigating the behaviour of budgerigars as they move through varying environments. Examination of their flight through tapered tunnels is revealing two distinct flight modes: (i) A high-speed, energy-efficient 'cruise' mode, when flying in open areas, and (ii) A low-speed 'manoeuvring' mode, when negotiating cluttered environments. The advantage of such a strategy is that, for each speed, the distances to obstacles can be directly calibrated in terms of the optic flow that they elicit.

The biorobotics laboratory has successfully tested a novel, biologically inspired vision system that guides an aircraft on a fully autonomous circuit—comprising takeoff, cruise and return—without the use of conventional navigational aids such as GPS.

This year has seen the commencement of research pertaining to three grants that were awarded to the laboratory: (i) An Australian Research Council (ARC) Discovery grant, in collaboration with QUT, to investigate the tracking of moving targets by aggressive bees, and design aircraft vision systems for automated target tracking; (ii) An ARC Linkage grant, in collaboration with QUT and Boeing, to investigate mid-air collision avoidance in birds, and to develop aircraft vision systems for collision avoidance; and (iii) An ARC Discovery Outstanding Researcher Award to study the perception of pain in invertebrates.

Illustration of a budgerigar (yellow) closing its wings momentarily as it flies through a narrow gap (purple).

Laboratory Head **Associate Professor Bruno van Swinderen**



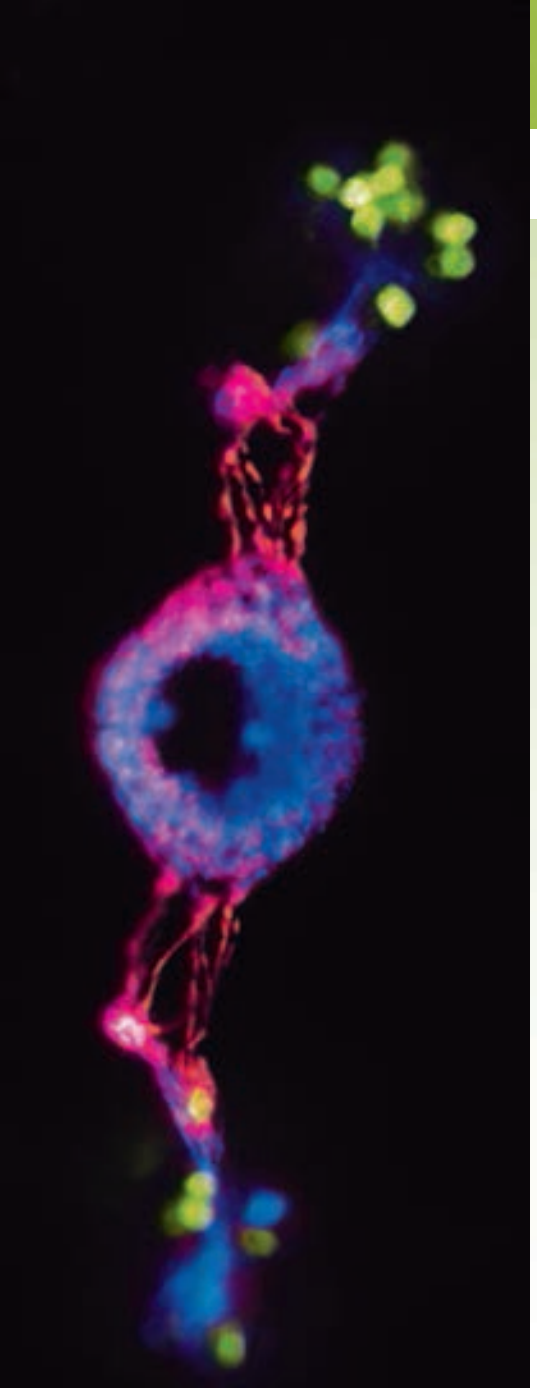
2014 Laboratory Members L–R/T–B: Bruno van Swinderen, Kathy Asmussen, Leonie Kirszenblat, Ben Kottler, Michael Troup, Melvyn Yap, Oressia Zalucki, Lachlan Ferguson, Matthew Van De Poll, Adekunle Bademosi, Aoife Larkin, Richard Faville. *Not pictured*: Kelly Munro, Esmi Zajaczkowski. **Image:** A fruit fly's attention is measured by how it responds to visual cues, in this case circularly moving stripes. Image by Leonie Kirszenblat.

Drosophila behaviour and cognition

The van Swinderen laboratory uses the fruit fly model *Drosophila melanogaster* to investigate perception and cognition. By combining powerful molecular genetic tools with high-throughput behavioural assays and electrophysiology, they are able to study the underpinnings of complex phenomena such as selective attention, memory, general anaesthesia, and sleep in the more simple fly brain. To pay attention, learn, and sleep, a brain must be able to suppress parts of the outside world effectively. Understanding how this suppression mechanism works is a central question of the laboratory, with a focus on visual systems.

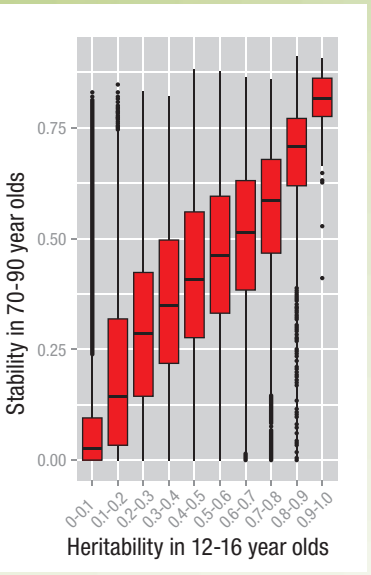
In collaboration with the Srinivasan group at QBI, the laboratory has created novel paradigms for tracking insect behaviour in virtual reality environments (*Journal of Neuroscience Methods*). Closed-loop walking paradigms for honeybees and fruit flies allow these insects to report their attention-like states in different experimental scenarios. Combined with multichannel electrophysiology techniques developed in the laboratory, these paradigms provide insight into how small brains pay attention to the world. For example, research in the laboratory found that attention-like signals in the honeybee optic lobes precede behavioural action selection (*Proceedings of the National Academy of Sciences of the USA*).

Pharmacological work in the laboratory is centred on testing a hypothesis for general anaesthesia, and suggests that this common procedure actually involves two distinct steps: first a sleep process is activated in the brain, and this is followed by a synaptic defect (*BioEssays*). The *Drosophila* model is ideally suited to testing this hypothesis, because both sleep pathways and synaptic mechanisms can be manipulated. In order to better measure sleep and general anaesthesia in flies, the laboratory has invented a sophisticated platform called DART, *Drosophila* ARousal Tracking (*Scientific Reports*).



This ring-like structure in the centre of the fly brain is thought to control spatial memory and attention. Image by Leonie Kirszenblat.

Laboratory Head **Professor Peter Visscher**



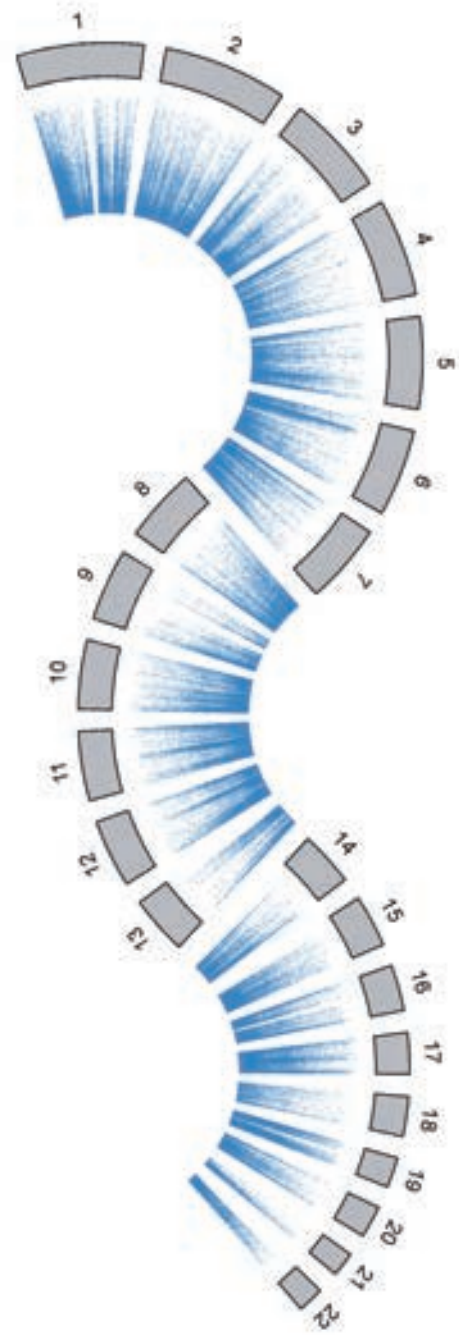
2014 Laboratory Members L–R/T–B: Peter Visscher, Beben Benyamin, Marie-Jo Brion, Guo-Bo Chen, Anita Goldinger, Alexander Holloway, Luke Lloyd-Jones, Allan McRae, Gerhard Moser, Joseph Powell, Matthew Robinson, Philip Robinson, Sonia Shah, Konstantin Shakhbazov, Peter Smartt. **Image:** Stability of epigenetic DNA modifications in old people (y-axis) is correlated with heritability in young people (x-axis).

Genomes, genes and common diseases

The Visscher laboratory specialises in quantitative and statistical genetics, population genetics, human genetics and bioinformatics, with the ultimate aim of trying to understand the genetic basis of differences in risk for disease and other phenotypes between individuals. Applications of the research include dissection of genetic variation underlying cognition and cognitive change, and quantification and deciphering of the genetic architecture of psychiatric disorders. The group uses theoretical derivations, simulation studies, development of new analytical methods and software tools, and the application of advanced statistical analysis methods to genetic and phenotypic data.

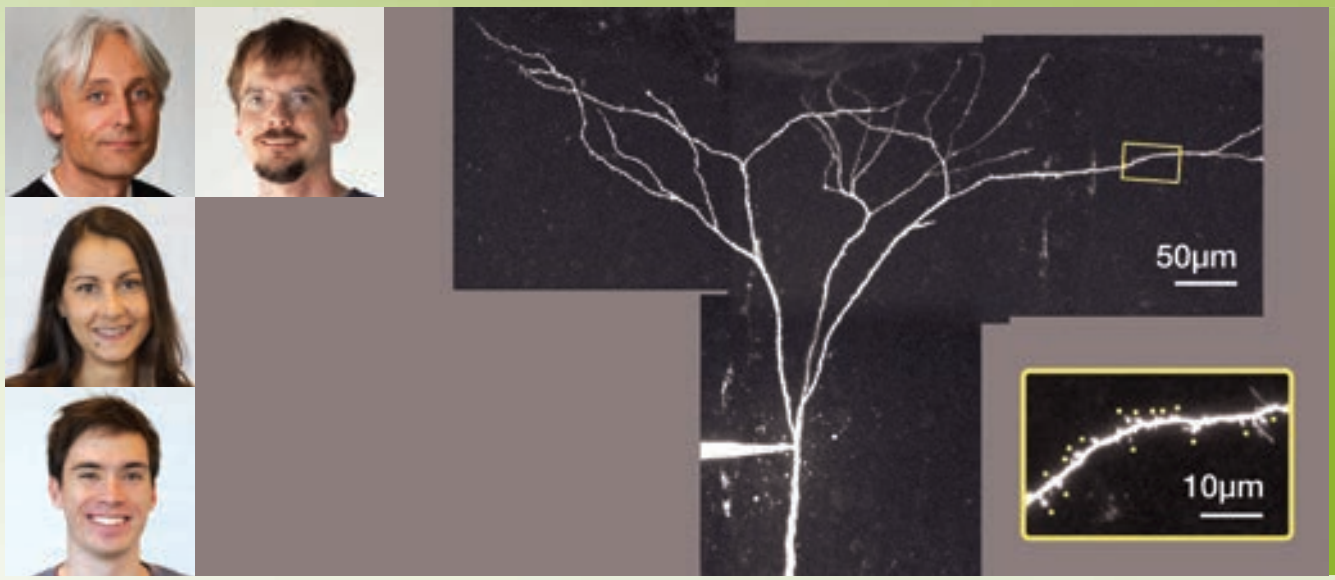
In 2014, using human height as a model trait, the group demonstrated, in collaboration with a large international research consortium, that individual differences in this complex trait are caused by the cumulative effect of thousands of genes, and new analytical methods were developed to find the responsible genes. The exact same analysis methodology can be used to detect genes underlying cognitive ageing and dementia. The group has also contributed analysis expertise to a large number of international research consortia that have found genes affecting schizophrenia, obesity and auto-immune diseases.

In collaboration with researchers from the QIMR Berghofer Medical Research Institute, Professor Visscher has established the Brisbane Systems Genetics Study, with the aim of understanding genetic variation in the expression of genes and its correlation with individual differences in complex traits. In addition to the Brisbane study, a long-standing collaboration with Professor Ian Deary (University of Edinburgh, UK) has been expanded through joint projects on the genomics underlying cognitive ageing. By combining these studies, the group has shown that epigenetic DNA changes—modifications that are not due to sequence differences between people—can be stable over the entire human life course.



Evidence for genetic heritability for epigenetic differences between people. All across the genomes there are DNA modifications that are shared between relatives because of their DNA sequence.

Laboratory Head **Professor Stephen Williams**

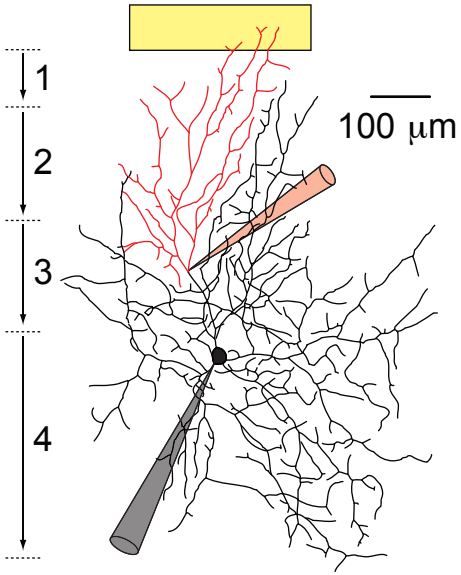


2014 Laboratory Members L–R/T–B: Stephen Williams, Arne Brombas, Florence Cotel, Lee Fletcher. *Not pictured:* Simon de Croft. **Image:** 2-photon image of the dendritic tuft of a neocortical output neuron.

Single neuron and neural circuit computation

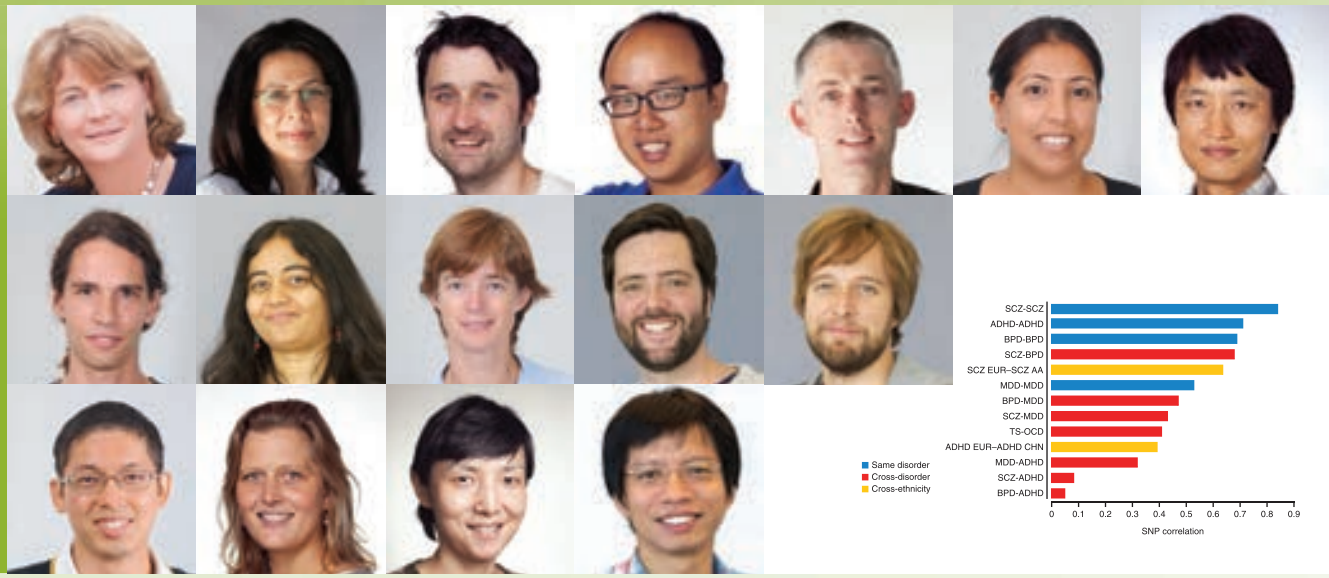
The brain is fundamentally a computational device in which nerve cells are arranged in intricate networks. Within these neuronal circuits computations are performed that underlie all aspects of behaviour. The Williams laboratory is investigating how nerve cells and neural circuits implement computations. They use advanced electrophysiological and optical techniques to investigate how neurons integrate input signals termed synaptic potentials, received throughout their dendritic tree, to produce an output signal. This work has shown that single neurons can operate as complex computational devices, acting to produce finely tuned output signals through the engagement of active dendritic synaptic integration, and highlights how the brain can operate in a fast and energy efficient manner. The laboratory seeks to understand the rules and mechanisms that form and control this rich neuronal integrative process and explore the relevance to the operation of neuronal networks in health and disease.

Over the last few years they have discovered that active dendritic integration is recruited by natural stimuli, implementing circuit-based computations in the neuronal networks of the neocortex and retina to underlie key aspects of perception and behaviour. Ongoing work is aimed at discovering the circuit elements that drive and control active dendritic integration. For example, their recent work has demonstrated that active dendritic integration in the output neurons of the neocortex is strongly modulated by the cholinergic system, providing a plausible candidate mechanism for attentional processing. Furthermore, in the retina they are dissecting the functional impact of the co-release of neurotransmitters from amacrine cells on the control of active dendritic integration in classes of ganglion cells, in order to better understand visual processing. This work will lead to a better understanding of how networks of neurons function, and ultimately how these processes are disturbed in disease.



Active dendritic integration engaged by light stimuli in the retina.

Laboratory Head **Professor Naomi Wray**



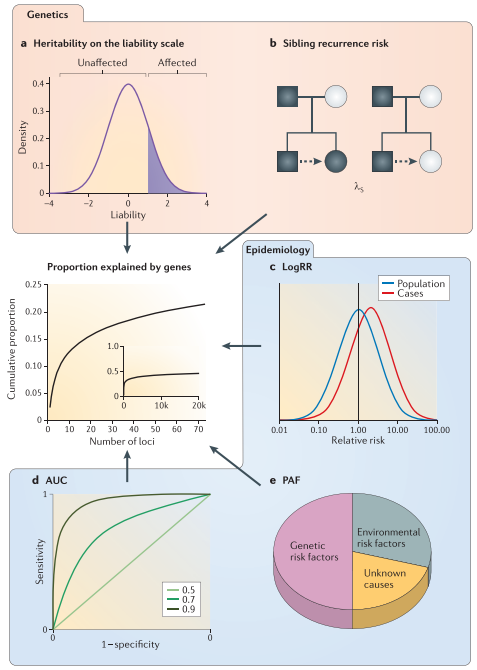
2014 Laboratory Members L–R/T–B: Naomi Wray, Earlene Ashton, Enda Byrne, Guo-Bo Chen, Jake Gratten, Anjali Henders, Hong Lee, Robert Maier, Divya Mehta, Natalie Mills, Wouter Peyrot, Matthew Robinson, Restuadi Swatanto, Anna Vinkhuyzen. *QBI Bioinformatics Core:* Zong-Hong Zhang, Qiongyi Zhao. *Not pictured:* Cara Nolan. **Image:** Genetic relationship between disorders estimated from genomic data, published in the review Gratten, Wray, Keller & Visscher, *Nature Reviews Neuroscience*, and summarises results from four studies published by the Wray laboratory.

Probing of the genomic complexity between & within psychiatric disorders

Research in the Wray laboratory focusses on understanding the genetic contribution to psychiatric and neurological disorders. The group specialises in the development of new analytical methods and the application of advanced statistical methods to the analysis of neuro-disorders. Group members play leading roles in international consortia including the International Psychiatric Genomics Consortium. In 2014 the group has expanded its research to include motor neuron disease (MND) and is a founding laboratory within the new Centre for Neurogenetics and Statistical Genomics.

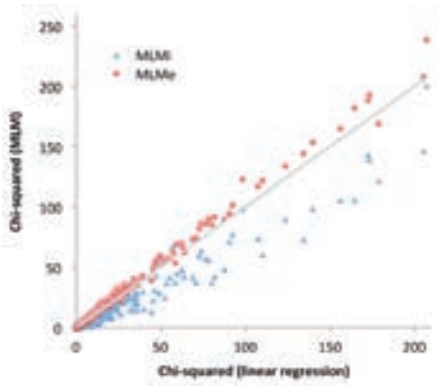
The breadth of research undertaken in the Wray laboratory is illustrated by the publication portfolio with studies of postnatal depression (*Archives of Women's Mental Health*), cannabis use (*Molecular Psychiatry*) and major depression (*Biological Psychiatry*). They played a role, both directly and over the past years, in the landmark paper published in *Nature* that identified >100 loci associated with schizophrenia. The group's international standing is recognised through invited reviews published in *Nature Reviews Genetics, Nature Reviews Neuroscience* and *Journal of Childhood Psychology & Psychiatry*. Current research focusses on the genetic relationship between schizophrenia and rheumatoid arthritis (using new genomic data to address an old epidemiological puzzle), the genetic heterogeneity of schizophrenia and the gene–environment interactions in the context of psychiatric disorders.

In 2014 the group worked with two genome-wide methylation data sets (the Lothian Birth Cohorts of 1921 and 1936, and the Sino-Australian MND Cohort) and these new data are providing novel insights into environmental and genetic risks. A National Health and Medical Research Council (NHMRC) Early Career Fellowship has taken Dr Enda Byrne to work at the sleep clinic at the University of Pennsylvania. Grants awarded in 2014 include an NHMRC Principal Research Fellowship, an NHMRC Career Development Fellowship to work on MND, three NMHRC project grants, a National Alliance for Research on Schizophrenia and Depression grant from the US Brain and Behaviour Foundation and an Arthritis Australia Fellowship.

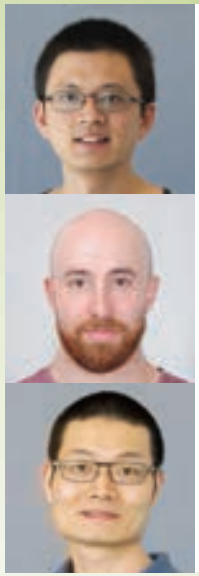


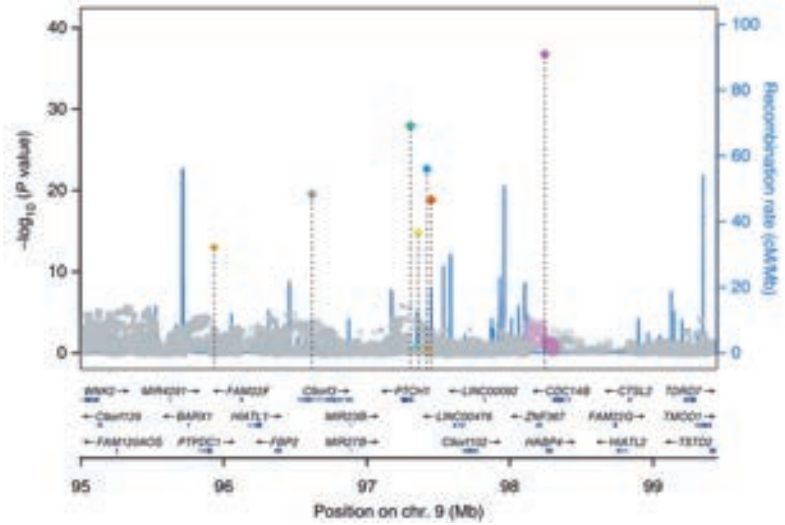
Genetic effects on disease, from Witte, Visscher and Wray, (*Nature Reviews Genetics*, 2014) in which methods from genetics and epidemiology are brought together under a unified framework.

Laboratory Head **Dr Jian Yang**



Mixed linear model-based association analysis excluding the target single nucleotide polymorphism (SNP) controls (red circles) for population structure and at the same time gains power, as compared to that including the target SNP, benchmarked by the traditional linear regression approach.





2014 Laboratory Members T–B: Jian Yang, Andrew Bakshi, Zhihong Zhu. **Image:** Seven independent height-associated single nucleotide polymorphisms (SNPs) clustered in a 2.5Mb region.

Research

Genetics and genomics of complex traits

The Yang laboratory, within the Centre for Neurogenetics and Statistical Genomics (CNSG), works on the interplay of genetics, genomics, statistics and computer science. Research in the Yang laboratory focusses on developing new statistical methods and performing large-scale analyses of high-throughput genetic and genomic data to understand the genetic architecture of complex traits in humans, with specific interests in model traits such as height, and common diseases such as obesity and schizophrenia. As demonstrated by the number of citations, the methods and software tools developed by the group have been widely used in the research community for a range of complex traits and diseases.

The mixed linear model (MLM) approach has become popular in genome-wide association studies (GWAS) since it controls for population stratification and relatedness in the GWAS cohort. The group used theoretical derivations, simulations and analyses of real data to demonstrate why the MLM-based association analysis approach is under-powered, and proposed a solution that controls for population structure without sacrificing the statistical power (Yang *et al.*, *Nature Genetics*, 2014).

In collaboration with the GIANT consortium, the group performed a large-scale genetic study for human height using a data set of ~250,000 individuals, with each individual having ~2.5 million single nucleotide polymorphism (SNP) markers, and identified 697 SNPs that are associated with height. These 697 SNPs clustered in 423 genomic loci are enriched for genes and pathways known to be involved in growth and also implicated genes and pathways not highlighted earlier. The paper was published in *Nature Genetics*, with Dr Yang as the joint first author.

Clem Jones Centre for Ageing Dementia Research

The Clem Jones Centre for Ageing Dementia Research (CJCADR) was opened in February 2013 as a major research centre within QBI. The Centre, headed by Professor Jürgen Götz, is focussed on research into the prevention and treatment of dementia.

During 2013 both Queensland State Government and the Federal Government awarded a total of $18 million over five years as a commitment to accelerate the research towards a cure for dementia. The research undertaken by CJCADR elucidates, at a biochemical, molecular, behavioural, electrophysiological, histological and systems level, how ageing dementia causes neurodegeneration, the decline of memory and motor functions.

Researchers from the following QBI laboratories undertake dementia-related research within CJCADR: Bartlett, Coulson, Hilliard, Mangelsdorf, Meunier, Anggono and Götz. To expand on this research, during 2014 the Centre commenced a program of recruitment to attract additional international researchers.

"A number of outstanding researchers have been appointed to the Centre: Dr Liviu Bodea from a leading neuroinflammation laboratory in Germany and Dr Robert Hatch from a leading epilepsy laboratory in Melbourne," Professor Götz said.

"We are very fortunate that in 2015 Dr Zhitao Hu from Harvard University will join the Centre as a Group Leader, as will Dr Patricio Opazo from the Bonhoeffer laboratory at the Max Planck Institute of Neurobiology in Munich later in the year. These recruitments will and will have synergistic effects on our research output."

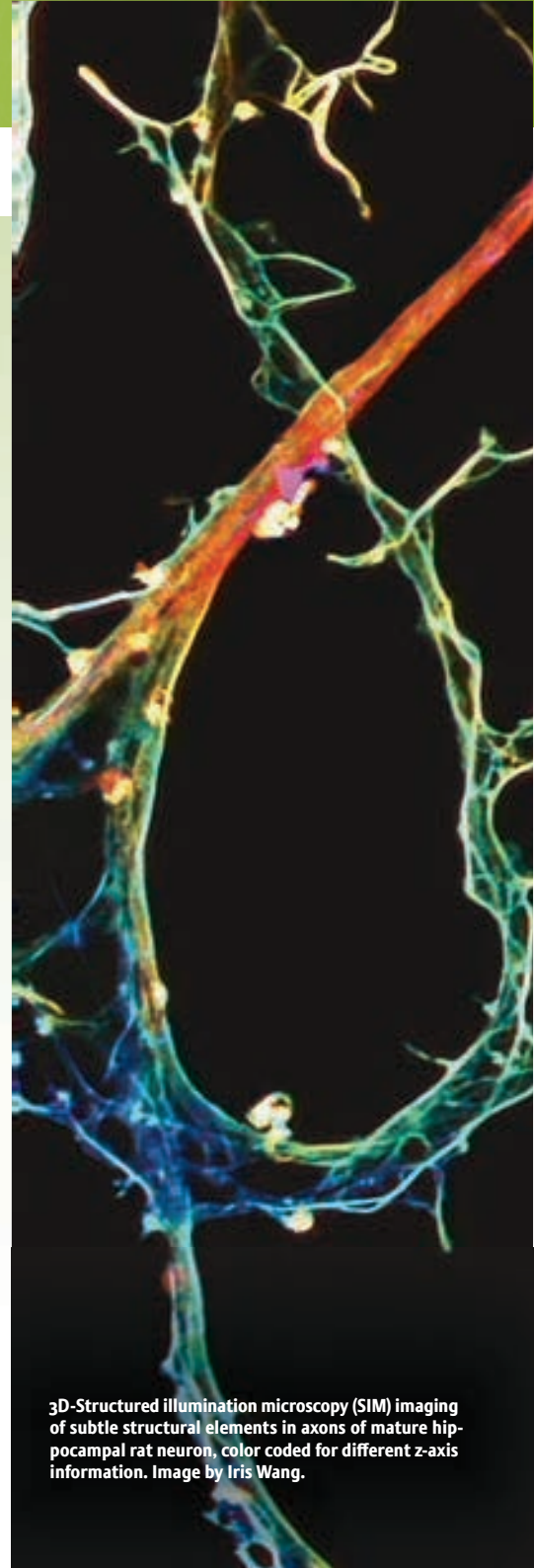
The Centre will further pursue novel strategies to reduce the burden of dementia.

"A major outcome is the discovery of therapeutic interventions to delay the onset, prevent and even cure dementia in patients, using novel drugs and better methods to deliver them to the brain. Another outcome is the development of biomarkers to diagnose dementia earlier, more cheaply and with higher sensitivity and specificity and to monitor therapeutic interventions. Lifestyle strategies will also be formulated for maintaining a healthy brain", Professor Götz said.

The Honourable Ian Walker MP, then Minister for Science, Information Technology, Innovation and the Arts, toured the Centre on 19 November as part of the announcement of the $2.5 million philanthropically funded international fellowship to tackle stroke-induced dementia.

"It is of vital importance to understand this particular type of dementia, as it is the cause for around 40 per cent of dementias. This is another wonderful addition to our dementia initiative," said QBI Director Professor Perry Bartlett.

Above (L–R): Professor Warwick Anderson AM (National Health and Medical Research Council), CJCADR Director Professor Jürgen Götz, then Federal Health Minister The Hon Peter Dutton MP, and QBI Director Professor Perry Bartlett.



3D-Structured illumination microscopy (SIM) imaging of subtle structural elements in axons of mature hippocampal rat neuron, color coded for different z-axis information. Image by Iris Wang.

Centre for Neurogenetics and Statistical Genomics

2014 members of the Centre for Neurogenetics and Statistical Genomics.

In 2014 QBI launched the Centre for Neurogenetics and Statistical Genomics (CNS Genomics or CNSG) to bring together a team of researchers with expertise in neurogenetics, neuropsychiatric genetics, statistical genomics, bioinformatics and computational biology. QBI Faculty Professors Peter Visscher and Naomi Wray co-direct the Centre, while Dr Jian Yang heads the core theme of the Centre. CNSG also includes the laboratory of Dr Marie Mangelsdorf, linking QBI's analysis and wet-laboratory based research on motor neuron disease (MND). The Centre comprises about 30 staff, all funded by competitive grant funding.

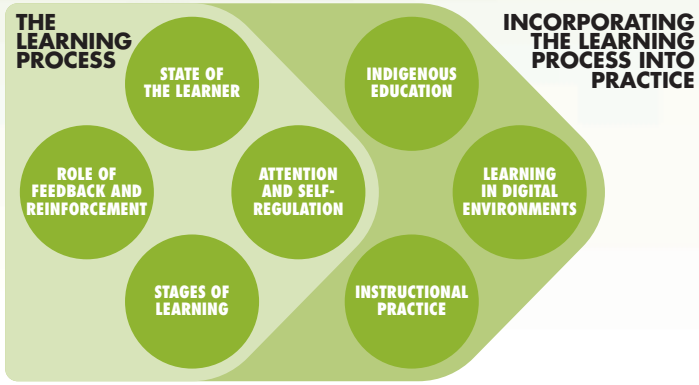
The core theme of the Centre is the genomics of complex traits. Complex traits are quantitative measures, diseases or disorders that are underpinned by multiple genetic and non-genetic factors, which includes all the common diseases such as cancers, immune disorders, as well as some central nervous system disorders. Research in the core theme focusses on development of new methodologies that are disseminated to the research community as publically available software for the analysis of genomic data, which can comprise a million data points on hundreds of thousands of individuals. Around this core theme are themes that focus on applications to disorders or traits. Three of these themes are phenotype based and represent some major national and international collaborations. The fourth theme focusses on the genetics of genetic expression and DNA methylation to further understand the mechanisms of genomic control of phenotypes. CNSG members work across multiple themes allowing important cross-fertilisation of ideas. CNSG also hosts the QBI Bioinformatics core led by Dr Qiong-Yi Zhao. Completed in October, Level 7 of QBI was refurbished to house the Centre.

In celebration of the new centre, the first Australian Neurogenetics Conference was organised, bringing close collaborator Professor Patrick Sullivan to Australia as the keynote speaker. In November Professors Visscher, Wray and Dr Yang spent three weeks touring research institutes in China to promote further collaborations there. CNSG experienced outstanding grant success in 2014 gaining two National Health and Medical Research Council (NHMRC) Fellowships, two NHMRC Career Development Fellowships, five NHMRC Project Grants, an Arthritis Australia Fellowship, a NARSAD grant and a UQ Early Career research grant.

Science of Learning Research Centre

The year started with QBI's Professor Pankaj Sah taking up the position of Director of the Science of Learning Research Centre (SLRC) following the departure of Professor Ottmar Lipp from UQ to take up a position at Curtin University in Perth. Professor Lipp did a fantastic job establishing the Centre and he continues to be involved with it as a research theme leader.

Under the leadership of Professor Sah the Centre undertook a review of its research, mapping out seven programs of research running across three themes: Understanding Learning, Measuring Learning and Promoting Learning. The programs are:



The Centre has several exciting new initiatives for 2015. A teacher intern, seconded from the Queensland Department of Education, Training and Employment, has been appointed to work with researchers in the Centre. The Centre is extremely grateful to the Queensland Department of Education, Training and Employment for supporting this 12-month seconded position. To support the Indigenous education program, Professor Cindy Shannon (Deputy Vice-Chancellor, Indigenous at UQ), has joined the SLRC Advisory Board, and a senior Indigenous Research Fellow, Tony Driese, has been appointed to the Centre and will take up an adjunct position at QBI in 2015.

A research translation group has also been established, headed by Professor John Hattie from the University of Melbourne and Associate Professor Annemaree Carroll from the UQ School of Education. Among other activities, this group will coordinate the development of course material for pre-service teacher training, Masters programs and on-going teacher professional development.

In order to ensure SLRC research remains relevant and its findings have an impact on learning, it will continue to engage with schools and the teaching community. During the year Centre researchers based at the UQ node delivered more than 20 presentations, including seminars hosted at QBI and at schools and professional development workshops for teachers. Throughout the year more than 80 Indigenous school students, ranging in age from nine to 15 years old, visited the Centre at QBI as part of the UQ Solid Pathways Program. The Centre is extremely grateful for all the support the schools have given us throughout the year and looks forward to our ongoing collaboration.

Image top left: Early-career researchers from the SLRC shared knowledge of learning and the brain with school children as part of UQ's Solid Pathways Program.

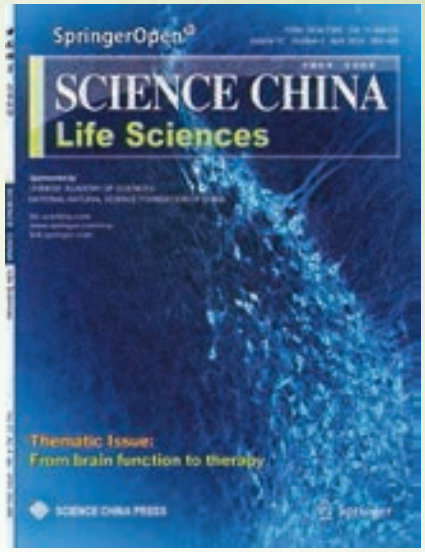
Finally, in partnership with Nature Publishing Group, we will launch a new journal *npj Science of Learning* in 2015, of which Professor Sah will be Editor-in-Chief. This international journal will cover cutting-edge research in all aspects of learning, and will provide a forum for discussion about learning.

The SLRC would like to acknowledge the support of the Australian Research Council and our Collaborating and Partner Organisations:

Collaborating Organisations:
- The University of Melbourne
- Australian Council for Educational Research
- Charles Darwin University
- Curtin University
- Deakin University
- Flinders University
- Macquarie University
- University of New England

Partner Organisations:
- University College London
- University of London
- Carnegie Mellon University
- North Carolina State University
- Questacon
- Benevolent Society
- Department for Education and Child Development, South Australia
- Department of Education and Early Childhood Development, Victoria
- Department of Education, Training and Employment, Queensland

Joint Research Laboratories



2014 was a productive year within QBI's joint research laboratories in China, with numerous visits occurring to progress current research projects and initiate new ones, and several papers being published. A highlight was the special issue of *Science China Life Sciences*, "From Brain Function to Therapy" published in April. The journal ran several reviews, research papers and commentaries, which showcased the collaborative work that is being undertaken within the *Joint Laboratory of Neuroscience and Cognition*, with colleagues at the Chinese Academy of Sciences' Institute of Biophysics (IBP) and the *Joint Sino-Australian Laboratory of Brainnetome* with the CAS Institute of Automation (CASIA) in Beijing.

In August the State of Queensland and the Chinese Ministry of Science and Technology (MOST) extended their partnership through the re-signing of a Memorandum of Understanding (MOU). This presented an ideal opportunity for the Institute to strengthen their relationship with China, with the signing of a Memorandum of Understanding for a new *Joint Australia-China Research Centre* focussed on understanding the circuitry and genetics in ageing dementia. The team, which includes researchers from QBI, IBP and CASIA, will focus on understanding the mechanisms that regulate cognitive decline and dementia in the ageing population and provide insights for diagnosis and therapy. Given the ever-increasing ageing population of both countries, this is an important endeavour.

The signing was witnessed by the Queensland Minister for Science, Information Technology, Innovation and the Arts, Ian Walker, and the Chinese Vice Minister for Science and Technology, Professor CAO Jianlin, with Minister Walker commenting that he was pleased to see that Australia's valuable relationship with China was continuing to grow.

The *Joint Sino-Australian Neurogenetics Laboratory,* with colleagues at The University of Queensland Diamantina Institute and the Second Military Medical University in Shanghai, is exploring how genes influence brain development and function, and focusses on discovering the genes that cause or make individuals susceptible to certain neurological and mental illnesses. The collaboration has been extended to include researchers from QBI's preeminent Centre for Neurogenetics and Statistical Genomics (CNSG). The joint program has already exome sequenced a large number of patients with neurodegenerative disease, with new samples continually being sourced through the CNSG. This exciting and promising work will continue in 2015.

Above: Professor Perry Bartlett and Professor Li Liu (foreground), witnessed by then Queensland Minister for Science, Information Technology, Innovation and the Arts, The Hon Ian Walker MP and the Vice Minister of the Chinese Ministry of Science and Technology, Cao Jianlin (background).

Students

Students play an integral role in the cutting-edge research undertaken at QBI.

Students travel from as far afield as China, Latin America and Europe to study, bringing fresh, innovative and international approaches to neuroscience research at the Institute.

Leonie Kirszenblat, van Swinderen Laboratory.

Postgraduate Students

2014 was a successful year for QBI in attracting research higher degree students, with student numbers increasing to 102 enrolled candidates. Of these enrolments, 42 were from international students across 20 countries. The total enrolment figure also includes 20 new domestic and international students who were all warmly welcomed at the Institute as they commenced their candidature during the year.

QBI was delighted to see the conferral of 14 PhDs and one MPhil* upon the following students, and we congratulate each scholar on their significant academic achievement: Anna Bode (Lynch); Wen-Sung Chung (Marshall); Sean Coakley (Hilliard); Christine Dixon (Lynch); Helen Gooch (Sah); Veronika Halasz (Cunnington); Callista Harper (Meunier); Shao-Chang Huang (Reinhard); Thai Vinh Nguyen (Cunnington); David Painter (Mattingley); Simandeep Poonian (Cunnington); Vikram Ratnu (Bredy); Amanda Robinson (Reinhard); Aanchal Sharma* (Coulson); and Vanesa Tomatis (Meunier). Following the completion of their research higher degree, these graduates obtained employment in postdoctoral positions or in other research administration roles within Australia or internationally.

Competitive scholarships were awarded to QBI students throughout 2014. It was also a historic time for QBI as the Institute offered its very first PhD Scholarship to international candidate Annalisa Paolino (Italy). She was also awarded the UQ International (UQI) Tuition Fee Scholarship. In future years, QBI aims to utilise our scholarships to attract the best students to undertake their research higher degrees in neuroscience. Anne Maallo (Philippines) was awarded the top international scholarship offered at UQ, the International Postgraduate Research Scholarship (IPRS), in conjunction with the UQ Centennial Living Allowance Scholarship. She also received the QBI Top-Up Scholarship. Loc Duyen Pham (USA) was awarded the IPRS in conjunction with the top Australian Government scholarship of Australian Postgraduate Award (APA), and the UQ Advantage Top-Up Scholarship. Xiaoqing Zhou (China) was awarded the China Scholarship Council (CSC) Scholarship and the UQI Tuition Fee Scholarship. Lisa Wittenhagen (Germany) was selected to receive the Australian Research Council (ARC) Australian Laureate Fellowship living allowance scholarship, and was awarded the UQI Tuition Fee Scholarship. Six domestic PhD students who commenced their studies in 2014 each secured the APA living allowance scholarship. Also, one domestic student was awarded a living allowance scholarship from Boeing Defence Australia Ltd. PhD student Toni Turnbull was the recipient of a Top-Up Scholarship awarded by the Alzheimer's Australia Dementia Research Foundation.

A number of QBI students were also successful in receiving competitive awards and prizes during the year. Some of the most successful recipients were:

- Dr Ramesh Narayanan and Dr Roger Marek received the 2013 Dean's Award for Research Higher Degree Excellence (awarded in 2014).
- Stephanie Biergans, Ming Soh and Morgane Nouvian were each awarded a UQ Graduate School International Travel Award (GSITA) to spend some time working on their research projects in laboratories in Germany, Denmark and France, respectively.
- Karly Turner won the 2014 Chapter Travel Award to attend the Society for Neuroscience meeting held in Washington in November.
- Xiang Li was selected as the winner of the QBI Student Publication Prize for the best published paper in 2014 sponsored by Sigma-Aldrich, and Laura Fenlon won the QBI Student Publication Prize for the best published paper in 2014 sponsored by QBI.

The QBI Student Association organised a number of events and seminars for students during the year, including the inaugural QBI Graduate Student Symposium held in December. The Symposium showcased students' work and provided a forum for four graduating students to give plenary lectures on their research findings. Another seven QBI students were selected to present short talks on their research during the event. Students were judged on their presentations with prizes being awarded to Sean Coakley (best plenary talk), Karly Turner (best short talk), and Laura Fenlon (runner-up award, short talks). QBI congratulates these students on their accomplishment. Professor Miguel Nicolelis, a world-renowned neuroscience researcher from Duke University, USA was invited to present the keynote address at the Symposium and his superb talk was enthusiastically received by the audience. The Institute sincerely thanks its Student Association for organisation of the inaugural event, which was an enormous success.

QBI welcomed two UQ MBBS students, Casey Linton and Timothy Edwards, who were accepted into the School of Medicine's intercalated MBBS-MPhil program. Casey and Tim are based at the Institute to undertake their research higher degree studies under the supervision of QBI researchers. As Tim and Casey have made excellent strides in their MPhil studies, they have progressed up to the PhD program to continue their research, working towards this award. Both students received the UQ Research Scholarship (UQRS) to support them during their research higher degree.

QBI was also pleased to receive undergraduate and postgraduate coursework students through the annual UQ Winter and Summer Research Programs. The Winter Research Program involved a total of four students who participated in various laboratory-based projects across four different laboratory groups over a six-week period. For the Summer Research Program 2014/2015, QBI accepted 19 domestic and international students to undertake a range of projects across 13 different laboratory groups within QBI over a 10-week period.

Above: Casey Linton is studying a Bachelor of Medicine & Bachelor of Surgery, as well as undertaking a PhD at QBI.

Students chart course to success

Students at QBI are provided with opportunities to pursue their research interests, while working closely with dedicated neuroscientists. This research experience provides the students with a solid foundation for career success.

Dr Sean Coakley

In 2009 I joined the laboratory of Associate Professor Massimo Hilliard to begin my PhD at QBI. The goal of my PhD was to discover novel genes involved in axonal regeneration and degeneration. The Hilliard laboratory studies these processes in the genetic model organism *Caenorhabditis elegans* (*C. elegans*), a free-living non-parasitic nematode. The transparency, small size and powerful genetic tools of *C. elegans* make it an attractive system in which to study the fundamental mechanisms of neurobiology. I was particularly excited about the prospect of being able to see nerves regenerating in living animals, in real time, and manipulating these events with genetic tools. This is something that still takes my breath away every time I see it.

As part of my PhD I developed a method of causing damage to the nematode's neurons using a light stimulated protein called KillerRed, which generates reactive oxygen species (ROS) upon irradiation. We hope this tool will allow a greater understanding of how neurons respond to damage caused by ROS, which are also generated in several neurodegenerative diseases.

In addition, a second major focus of my research is how the axon of a neuron, which is the component responsible for sending electrical signals, can be repaired following damage. To study this regenerative process I developed an experimental paradigm utilising mutant animals that lack a component critical for the axon's stability. In these animals the axons are fragile and spontaneously break, allowing the study axonal repair to be achieved without the need to surgically damage the animals. A major advantage of this approach is that it facilitates large-scale genetic screens for molecules involved in axonal regeneration. Using this model, I made a major contribution to the discovery of a novel molecular mechanism that enables severed axons in *C. elegans* to rapidly fuse and repair the original connection.

Since the completion of my PhD in 2014 I have continued my exciting research in the Hilliard laboratory. I hope my research will lead to a better understanding of nerve repair caused by injury, which remains largely untreatable.

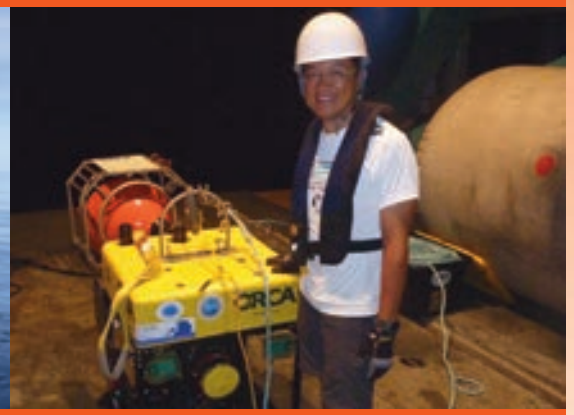
Dr Vanesa Tomatis

After performing my research training in Argentina, I joined Professor Frederic Meunier's laboratory in 2010 to undertake my doctoral studies. I was sure that studying at QBI was going to be a challenge, but also a very exciting time. QBI offers great tools that students need to overcome difficult times and promote success, excellent facilities equipped with world-class technologies, very good management, as well as the possibility to discuss science with well-known researchers (QBI and UQ-based, and invited visitors). This combination makes studying at QBI an enjoyable experience.

My research focussed on deepening the understanding of neurotransmitter release and their regulatory mechanisms. By gaining experience in different techniques such as mass spectrometry, biochemistry and microscopy, I obtained evidence of how secretory vesicles are tethered to the plasma membrane of cells before their fusion, allowing sustained neurotransmitter release upon stimulation. One of the key molecules that I found to participate in this process is myosin VI. During my PhD, I showed that myosin VI regulates the availability of secretory vesicles that release their content to the extracellular space. This is a key event behind neuronal communication. My findings have not only contributed to the better understanding of neurotransmission, but also and more importantly have opened new avenues for research that could help us to develop new molecular therapies for diseases characterised by altered levels of neurotransmitter or hormone release. The results of my research during my PhD were published in the *Journal of Cell Biology* in 2013 and I was joint winner of the QBI Student Publication Prize of the Year 2013 sponsored by Sigma-Aldrich.

After obtaining my PhD in 2014, I started as a Postdoctoral Researcher in Professor Meunier's laboratory working on the mechanism underpinning myosin VI function during neuroexocytosis.

Dr Wen-Sung Chung



Above left: Launch of the manned submersible, Triton, on a mission to find giant squid.
Above right: Dr Wen-Sung Chung standing next to the camera platform, Medusa, in the mid-water drifter configuration for unobtrusive observation of deepwater fauna down to 2,000m.

A passion for finding unseen marine creatures and my curiosity about their sensory world drove me to do research. I commenced my PhD in the laboratory of Professor Justin Marshall in 2009, investigating visual ecology of cephalopods. As a student within the Deep-Australia project, I have been able to sample surface waters around Moreton Bay (an area rich with cephalopod species), as well as investigate deep-sea habitats down to below 2,000 metres, both with cameras and nets. Aside from the excitement of working at sea, investigating the squid visual system through laboratory work has uncovered new adaptation mechanisms of this soft-bodied creature that were unexpected prior to my PhD. Firstly, a new range-finding mechanism in the coastal squid proposed that the retinal deformation and the resulting image blur, combined with a unique head-bobbing behaviour, are vital for searching for food and avoiding threats in the featureless open ocean. Also, my project uncovered that the simple squid eye has developed complex visual adaptations associated with a variety of light regimes and different modes of life. Furthermore, I operated a UQ-designed underwater camera platform, Medusa, which filmed the first giant squid behaviour in their natural habitat (770 metre depth) in 2012. The feeding behaviour of the giant squid, particularly striking the light lure, demonstrated that they are aggressive and active visual predators. Given their fast movement ability, enormous eyes and corresponding visual capability, these new observations help paint a picture of a top predator.

Following the completion of my PhD thesis, I am continuing my research to describe and explain the new retinal design elements, undertake more behavioural observations on both shallow and deep-living species large and small, as a Postdoctoral Researcher in Professor Marshall's laboratory.

Master of Neuroscience

The Master of Neuroscience program was introduced in 2010 as an initiative of QBI Director Professor Perry Bartlett and former UQ Senior Deputy Vice-Chancellor Professor Deborah Terry, as a pathway for students who wish to shift their career focus to neuroscience and pursue independent research and teaching careers.

The program is coordinated by QBI and the Faculty of Social and Behavioural Sciences (now Faculty of Health and Behavioural Sciences) but also spans other centres for neuroscience research at UQ. To ensure quality of student experience and teaching, a quota of 12 students per semester has been imposed upon the course.

Providing research training and core professional skills, the program is a pathway to specialist streams including molecular and cellular neuroscience, neural imaging and computational neuroscience, developmental neurobiology, cognitive and behavioural neuroscience, visual and sensory neuroscience, and epigenetics. The Master of Neuroscience runs for three semesters (24 units), although students with Honours or equivalent can complete the program in two semesters (16 units).

In 2014, a total of four students graduated with the Master of Neuroscience degree: Adekunle Bademosi, Samuel Fynes-Clinton, Muthmainah, and Ozlem Yetim.

In 2014 the program also welcomed three international and five domestic students: Aprianto Dirga, Arezoo Fallah, Sheridan Harvey, Meera Jacobs, Apurva Kumar, Kelly Munro, Joseph Peard, and Matthew Trewella.

Students completing their Master of Neuroscience program say that the experience has encouraged them to pursue further study opportunities, such as PhDs.

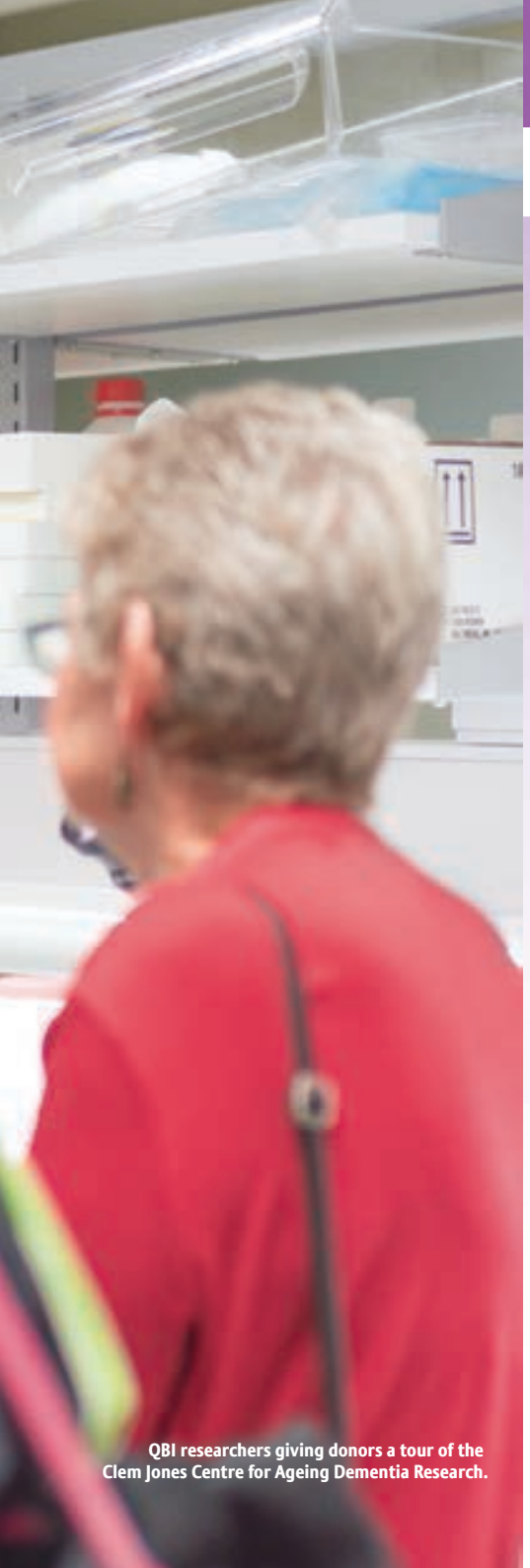
Compulsory core lecture-based courses in the Master of Neuroscience program:

- Systems Neuroscience: Sensory and Motor (NEUR7004), which uses a systems approach to explore the brain with respect to circuits that integrate and process information.
- Cognitive and Behavioural Neuroscience (NEUR7005), which focusses on the elucidation of the neural basis of cognitive and behavioural phenomena.
- Molecular and Cellular Neuroscience (NEUR7006), which is concerned with cellular and molecular biology of the neuron.

Together with the three Master of Neuroscience laboratory rotations, which offer 300 hours of supervised practical experience, these courses provide a cohesive introduction to the theoretical and practical aspects of neuroscience. Rotations can be undertaken in a wide number of participating schools, including QBI, UQ's Schools of Psychology, Pharmacy, Medicine, Biomedical Sciences, Microbial and Molecular Biosciences, Information Technology and Electrical Engineering, the Perinatal Research Centre, Centre for Clinical Research, the Institute for Molecular Bioscience, the Centre for Advanced Imaging (CAI) and the QIMR Berghofer Medical Research Institute.

A new initiative has been taken to convert the current coursework Master of Neuroscience program to a research Master of Philosophy (MPhil) in Neuroscience. The UQ Graduate School and QBI are currently developing the MPhil in Neuroscience program for commencement in 2016. Although the Master of Neuroscience program has been successful, given recent changes in the research higher degree environment, and the need to align program offerings with university systems world wide, it was decided to modify the coursework program to a research-based study program. The Master of Neuroscience has been withdrawn as from 2015, and Semester 2, 2014 saw the final intake of students into the program. The coursework Masters program ran for five years and 31 students have graduated from the program.


Therapeutic applications to clear pathogenic Tau



QBI researchers giving donors a tour of the Clem Jones Centre for Ageing Dementia Research.

Community

QBI's goal is to make a positive impact on the Australian community by helping to reduce the huge social and financial cost of neurological and mental illness.

In 2014, QBI hosted a series of high profile events and conducted a range of community outreach programs. In addition to educating Australians about the latest research findings, staff also continued their efforts to encourage the next generation to consider careers in neuroscience.

Peter Goodenough Lecture

Progress in schizophrenia: three stories

The 2014 Peter Goodenough Lecture was delivered on 10 September by Distinguished Professor Patrick Sullivan of the University of North Carolina, USA.

Professor Sullivan investigates the molecular genetics and pharmacogenetics of schizophrenia, major depressive disorder, and anorexia nervosa.

Based on his decades of experience, he presented a lecture on three stories that are central to the current efforts to identify the genetic basis of schizophrenia.

Firstly, he outlined the unprecedented international collaborations that made advances announced in 2014 possible—including those at QBI.

Secondly, Professor Sullivan spoke about the findings that have led to a much wider appreciation of the complexity of schizophrenia by discovering the large number of genes involved in the disorder.

Thirdly, he emphasised how researchers can begin to go beyond finding genes to using genes, with the objective to improve diagnosis, treatment, and prevention.

The Peter Goodenough annual lecture is named in honour of the late Mr Peter Goodenough (1936–2004), a QBI benefactor, whose personal battle with motor neuron disease led to a bequest to fund fundamental scientific research.

Mr Goodenough's gift is a showcase example of how members of the community can make a powerful and lasting contribution to the future health of all Australians.

Merson Lecture

Developing better treatments for Alzheimer's disease: the long and short of it

Professor Lennart Mucke of the Gladstone Institute of Neurological Disease and University of California, San Francisco, USA, presented an informative 2014 Merson Lecture on understanding Alzheimer's disease.

QBI was fortunate to listen to Professor Mucke, a Distinguished Professor of Neuroscience, give insight into processes that result in memory loss and other deficits.

Professor Mucke discussed some of the obstacles on the path of translating scientific insights into more effective treatments for Alzheimer's disease, and the potential strategies that could be employed to overcome them.

He expressed his opinion that more effective links are needed between basic scientists and clinical investigators, and between academia and the pharmaceutical industry.

He stressed the urgent need to expedite the discovery and validation of potential drug targets and the production of new therapeutics, and the roles these players have.

The Merson Lecture is named in honour of Dr David Merson, member of the QBI Advisory Board, whose philanthropic sponsorship of this lecture is indicative of a strong community interest in neuroscience.

Right: Professor Patrick Sullivan delivering the 2014 Peter Goodenough Lecture.
Far right (L-R): Professor Perry Bartlett, Professor Lennart Mucke and Dr David Merson.

Hand Heart Pocket Gala Evening

QBI partnered with the Alzheimer's Australia (Qld) to create a lavish event to raise funds and awareness for Alzheimer's disease research and care.

Generously supported by Hand Heart Pocket, The Charity of Freemasons Queensland, the gala evening was attended by more than 160 enthusiastic supporters who were dazzled by a night of opera and classical music.

Brisbane's iconic Customs House proved to be the perfect backdrop for the event held on 5 September, with performances held indoors and a cocktail party overlooking the Brisbane River.

The night's operatic repertoire included *Madama Butterfly's* dramatic and captivating 'Un Bel Di', sung by Zara Barrett, winner of the Covent Garden (1995) and Metropolitan Opera Scholarships. (1993, 2000, 2001).

Singapore Lyric Opera soprano Cherylene Liew also captivated the audience, as well as basso profundo David Hibbard, who won the 1990 German Operatic Award.

String quartet *Cerebrum*, consisting of the Conservatorium and UQ's finest string players, performed the well-known 'Trout Quintet'.

Funds raised on the night supported research conducted at the Clem Jones Centre for Ageing Dementia Research (CJCADR).

ASSC18

QBI researchers played an integral role in bringing the Association for the Scientific Study of Consciousness (ASSC) conference to Australia for the first time, with ASSC18 being held at UQ during 16–19 July.

Seeking to answer what consciousness is, and how it can be measured, the conference covered topics as broad as studying pain, sleep, and attention.

The conference was organised by QBI group leader Associate Professor Bruno van Swinderen.

The conference had a number of high profile speakers, including Professor Emery Brown from the Massachusetts Institute of Technology, who addressed the audience on the topic of what happens to us when we 'go under' and are anaesthetised.

Distinguished Professor Jesse Prinz from the City University of New York, USA, also spoke on whether consciousness and attention are dissociable.

The conference closed with a free public lecture at the State Library of Queensland by Professor Stanislas Dehaene, an international leader in the field of cognitive neuroscience at the Collège de France.

Super-Resolution Symposium

As part of UQ Microscopy Week 2014, QBI hosted the Super-Resolution Symposium on 4 April.

With speakers from across UQ, the event showcased some of the work being conducted at the University, including seven QBI staff who presented their work: Luke Hammond, Dr Ilan Gobius, Dr Callista Harper, Dr Miriam Matamales, Dr Brent Neumann, Dr Andreas Papadopulos, and Professor Frederic Meunier.

Super-resolution microscopes enable single molecule imaging, which allow the study of individual receptors on synaptic terminals.

The program featured sessions of advanced imaging techniques, live imaging, tissue imaging and presentations on facilities at the University.

QBI's Advanced Microscopy Facility is home to two of Australia's most powerful super-resolution microscopes.

The equipment housed in QBI has capabilities to create 3D reconstructions of brain sections and rapidly image neuronal outgrowth and intracellular trafficking.

Ross Maclean Fellowship Race Day

More than 200 guests helped to raise $25,000 for motor neuron disease (MND) research by attending the Ross Maclean Fellowship Caloundra Cup on 28 June.

Held at Corbould Park Racecourse at the Sunshine Coast Turf Club, the day was one of the jewels of the 2014 Queensland Winter Racing Carnival.

MND, a fatal disease with no cure, is being actively fought at QBI, and the vital funds directly helped to support the work.

The event was made possible thanks to a number of generous supporters including Ross Maclean Racing, Shaun Flanigan, Jeff Maclean, the Index Group, Village Roadshow Themeparks, Naomi Kito Baliey, McKinney's Jewellers, Rumba Resort, Euromarque Maserati Brisbane and Willims Motor Group, The Training Spot Albion and Ricky Gibson, the Australian Wallabies and Treasury Wine Estate.

The Ross Maclean Fellowship was established in 2004 by the late Ross Maclean to raise funds to fight this most devastating disease.

Since that time, his family have been instrumental in carrying on the legacy established by Mr Maclean, and have championed the cause of promoting and raising funds for MND research at QBI.

Right: Guests at the Hand Heart Pocket Gala Evening at Brisbane's Customs House.

Community Outreach

QBI's community outreach program engages people with an interest in discovering more about neurological disorders and how the brain functions. The program's success is proof of the public's thirst to learn more about the latest research.

The Institute conducts regular tours through its world-class facilities, and the researchers frequently present lectures, talks and discussions that form the core of the community outreach program. This interaction has continually proven beneficial for both the public and scientists.

In 2014 QBI held a number of events designed to celebrate the support that both individuals and community groups have provided for QBI's research.

Breakfast Series

What causes brain malformation?
Professor Linda Richards and
Associate Professor Helen Cooper

The power of attention: how attention filters sensory information which underpins perception, choice and action
Supported by Mind Gardner
Professor Jason Mattingley

Women in business & science: why are there so few women CEOs and Professors in Australia?
Dr Terrance Fitzsimmons, Lecturer and Postdoctoral Research Fellow, UQ Business School
Professor Linda Richards

Motor neuron disease (MND): what is the current state of play?
Professor Naomi Wray, Centre for Neurogenectics and Statistical Genomics (CNSG) at QBI
Dr Rob Henderson, Director of Neurology at the Royal Brisbane and Women's Hospital (RBWH)

New Fellowships

Stafford Fox Medical Research Fellowship in stroke-induced dementia
The Stafford Fox Medical Research Foundation's generous support will enable this fellowship for research into vascular dementia. Caused primarily by strokes, vascular dementia accounts for up to 40 per cent of dementias, and consequently is a vital area of research as we seek to address the dementia epidemic.

Scott Sullivan Research Fellowship in motor neuron disease
This fellowship, supported by the MND and Me Foundation and the Royal Brisbane and Women's Hospital Foundation, will accelerate research output and co-ordinate preclinical trials for promising new therapies in motor neuron disease research. The Fellow will act as a bridge between the clinic at the Royal Brisbane and Women's Hospital and QBI.

John Trivett Foundation Senior Research Fellowship in brain cancer
The John Trivett Foundation, newly merged with Cure Brain Cancer Foundation, initiated philanthropic support to consolidate research in brain cancer at UQ. The John Trivett Fellowship will be a joint appointment between QBI and the Institute for Molecular Bioscience at UQ.

Australian Brain Bee Challenge

The Australian Brain Bee Challenge (ABBC) is a public outreach program for high school students that aims to provide an opportunity to engage young Australians, as well as their families, teachers and the wider community, to learn about neuroscience and neuroscience research. The ABBC is Australia's only neuroscience competition for high school students and provides opportunities for all Australian students, including those from regional areas, to participate and to consider a career in science, and, in particular, neuroscience.

The ABBC has three rounds, with round one taking place in March during the annual Brain Awareness Week. Round one of the ABBC is an online quiz in which students demonstrate their knowledge and understanding of brain structure, function, anatomy, and their understanding of neurological disease and disorders. 6,000 students completed round one in 2014.

Round two is an ABBC state/territory final hosted by universities or research institutes across Australia. The round two Queensland ABBC final took place at QBI on 22 July and was attended by 200 Year 10 students and teachers, some of whom travelled from as far as Cairns, Weipa and Ingham to participate. During the day the students competed in the competition, toured the facilities at QBI, observed experiments and talked to QBI scientists about their research, discoveries and how they became involved in scientific research as a career. The students and teachers also had the opportunity to hear from Professor Melvyn Goodale, Canada Research Chair in Visual Neuroscience and Director of The Brain and Mind Institute, Western University, Ontario, Canada. After a close individual competition, Somerville House student Sophie Watson was the winning student on the day, becoming the 2014 Queensland ABBC Champion.

Round three is the ABBC National Final, in which each state/territory Champion competes to become the ABBC Champion. The 2014 ABBC National Final will be held in April 2015 at the University of Western Australia.

The ABBC is affiliated with the International Brain Bee (IBB) and each year the Australian Champion has the opportunity to compete in the IBB. The 2013 Queensland and Australian Champion Eva Wang attended the IBB in Washington DC in August 2014 and placed second against competitors from 22 countries. It was an outstanding effort from Eva, who has a keen interest in neuroscience and completed work experience placements at QBI in both 2013 and 2014.

The ABBC has had more than 30,000 students participate in round one over the nine years since it was established in Australia by Professor Linda Richards and QBI. ABBC student alumni have gone on to undertake undergraduate degrees in a wide variety of disciplines. Some have now completed research higher degrees in neuroscience and have worked throughout their studies at QBI. Many state and national winners have also completed work experience in laboratories at QBI. As of January 2015, the national headquarters will move from QBI to the University of Western Sydney. QBI will continue to host round two, the Queensland ABBC Final and to engage high school students in understanding the importance of neuroscience research and learning about neuroscience.

Above: Students competing in the Queensland Final of the ABBC, with winner Sophie Watson far left of image.

Lavinia Codd (Bartlett laboratory) discusses her research with the then Queensland Minister for Science, Information Technology, Innovation and the Arts, The Hon Ian Walker MP.

Recognition

QBI houses more than 300 researchers, working across the span of neuroscience to understand the body's most remarkable organ.

Our researchers are highly regarded, and represent the Institute in a number of pivotal scientific organisations and serve on prestigious editorial boards. The quality of our publications, grants and awards stands QBI in the top echelons of scientific research.

National Health and Medical Research Council

Research Fellowships

Commencing in 2014 Professor Joe Lynch was promoted to Principal Research Fellow. During the course of his fellowship Professor Lynch will study inhibitory neurotransmission in the central nervous system, which is mediated by GABA type A ($GABA_A$) and glycine receptors. $GABA_A$ receptors have long been important clinical targets for therapies directed at muscle relaxation, epilepsy, anxiolysis, sedation and anaesthesia, whereas glycine receptors are emerging as clinical targets for chronic pain and spasticity. Professor Lynch will capitalise on his expertise in the molecular pharmacology of these receptors to develop new treatments for neurological diseases and to understand the molecular mechanisms of receptor and synaptic dysfunction in neurological disease.

Nerve terminals and neurosecretory cells contain synaptic vesicles and secretory vesicles, respectively, which are filled with the neurotransmitters responsible for neuronal and hormonal communication. A range of diseases of the nervous system are caused by defects in vesicular trafficking, including neurodegenerative conditions such as Alzheimer's disease as well as epilepsy. As a newly promoted Level B Senior Research Fellow, Professor Frederic Meunier will explore the molecular mechanisms underpinning vesicular trafficking pathways using a variety of complementary techniques, including super-resolution microscopy. The ultimate goal of this research is to use this knowledge to drive the development of new therapeutic strategies.

Australian Research Council

Australian Laureate Fellowship

Professor Justin Marshall received a prestigious Australian Laureate Fellowship to investigate the specialised visual systems of marine creatures from the Great Barrier Reef. In particular, he will focus on how they receive and interpret colour and polarisation information, much of which is invisible to the human eye. The resultant data will then be used to inform the design of the next generation of polarisation cameras, which may improve our ability to detect dysfunction in neurons and other cells.

Discovery Outstanding Researcher Award

As part of a major ARC Discovery project grant to commence in 2014, Professor Mandyam Srinivasan received a professorial-level Discovery Outstanding Researcher Award, making him one of only 15 such recipients Australia-wide. During the course of his three-year study Professor Srinivasan will explore whether the relatively simple nervous system of the honeybee is capable of higher cognitive functions that are commonly ascribed to vertebrates, including a rudimentary level of consciousness, basic emotions, and the sensation of pain.

Awards

Australasian Neuroscience Society Distinguished Achievement Award

In recognition of "an outstanding contribution by an individual to neuroscience in Australia", Professor Perry Bartlett received the Distinguished Achievement Award from the Australasian Neuroscience Society, making him only the seventh recipient of award since it was inaugurated in 1993. Professor Bartlett was honoured for his individual research excellence, his advocacy for Australian neuroscience, including as a past President of the society, and his contribution to the growth of national research capacity through the establishment of QBI.

Queensland Government Science Champion

The Queensland Government has acknowledged the contribution of Professor Srinivasan to the study of insect and bird navigation and unmanned aerial vehicle design by naming him as one of two inaugural Science Champions. The Champions program forms part of the Government's Science and Innovation Action Plan, and is designed to recognise excellence in research and innovation.

Australasian Neuroscience Society Paxinos-Watson Prize

The 2014 Paxinos-Watson Prize for the most significant paper published by a member of the Australasian Neuroscience Society in the 2012 calendar year was awarded to a publication from the laboratory of Professor Geoffrey Goodhill. Correct wiring of the nervous system relies on the molecular guidance of the axons of nerve cells to their appropriate targets. The Goodhill study (Forbes, Thompson, Yaun & Goodhill, *Neuron* 174: 490-503, 2012), which appeared in one of the world's leading neuroscience journals, constructed a mathematical model to explain the way in which calcium and cyclic AMP, two key regulators of whether axons are attracted or repelled in particular molecular gradients, interact to produce correct guidance responses in the nervous system. They then used this model to generate predictions that they were able to confirm experimentally. This work has important implications for our understanding of how correct neural circuits form during development and regeneration.

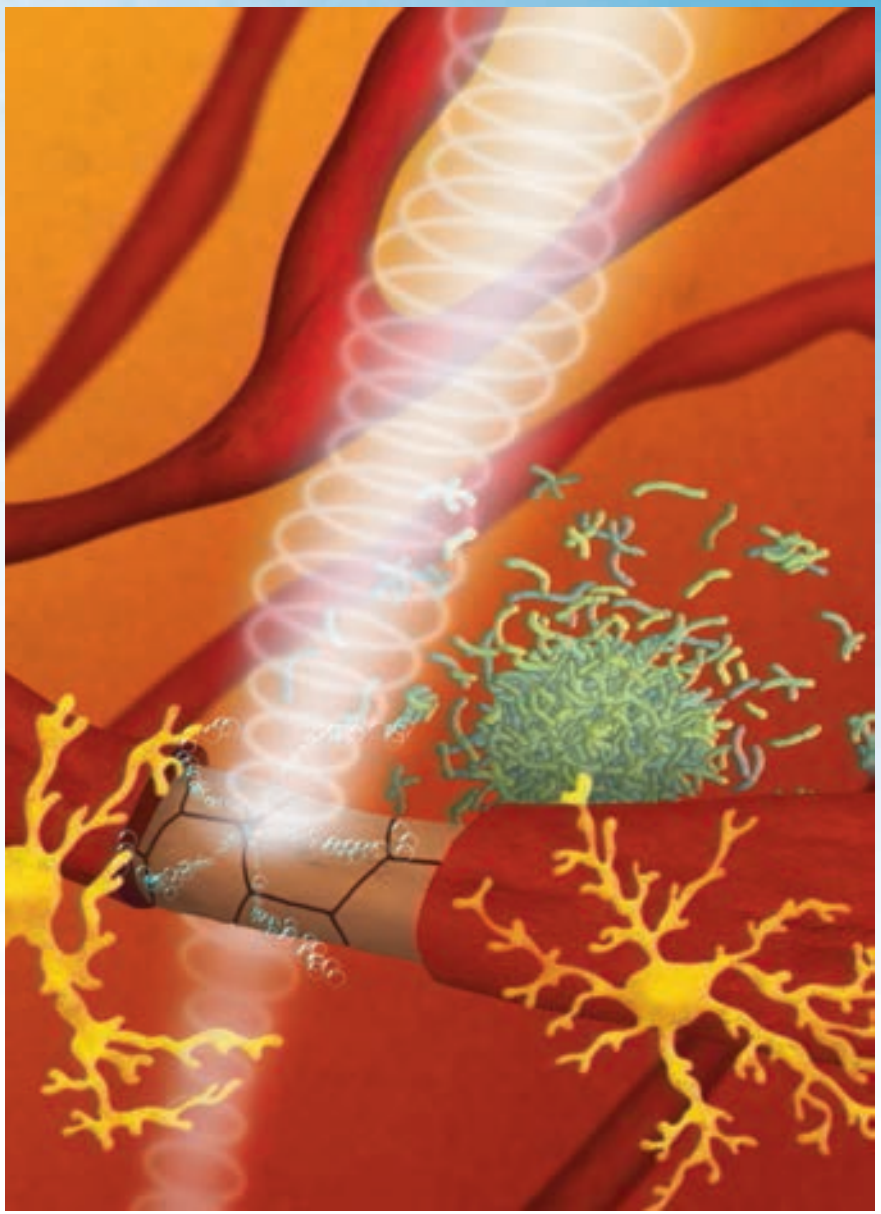
Royal Institute of Navigation Harold Spencer-Jones Gold Medal

The UK-based Royal Institute of Navigation awarded Professor Srinivasan their highest honour, the Harold Spencer-Jones Gold Medal, and have elected him a Fellow of the Institute, in recognition of his outstanding contributions to our understanding of animal navigation techniques. Professor Srinivasan studies insects and birds to elucidate how animals with small brains navigate complex environments. He then applies this information to improve the collision avoidance strategies of unmanned aerial vehicles.

Sylvia and Charles Viertel Foundation Senior Medical Research Fellowship

In 2014 Dr Jian Yang commenced his Sylvia and Charles Viertel Charitable Foundation Senior Medical Research Fellowship, which will develop methods and large-scale genomic analyses to study the genetic basis of neuropsychiatric disorders. One of only two recipients of this prestigious national fellowship, Dr Yang will apply his background in genetics and statistics together with his outstanding skills in computational biology to answer fundamental questions about the genetics of common disease and to develop software tools capable of analysing millions of DNA markers. The goal of this ambitious five year program is to gain a better understanding of why some people are more susceptible to disease than others.

Commercial Development Overview



QBI commercialisation activities in 2014 focussed on the business development and maintenance of existing intellectual property, and the business development and protection of new intellectual property (IP) through its relationship with UniQuest. UniQuest is one of Australia's leading commercialisation companies, specialising in global technology transfer and facilitating access for all business sectors to world-class university expertise and IP.

A new provisional patent was filed for the use of ultrasound methodology to treat neurodegenerative diseases. This IP originated from CJCADR and current activities are focussed on the potential market and development opportunities.

New IP related to a patented therapeutic protein for the treatment of spinal cord injury and MND has been developed, which will provide additional protection for the project. Plans to take the protein into clinical trials are ongoing with support from a successful application for grant funding from Biopharmaceuticals Australia (BPA). Another patent for a potential treatment for spinal cord injury or neurodegenerative disorders (c29 peptide), based on the discovery of a mechanism for preventing apoptotic cell death, has progressed to *in vivo* testing. NuNerve Pty Ltd, the QBI spin-out company supported this through an ARC linkage grant that finished in 2014.

Three patents licenced to NuNerve (neural stem cell generation, methods of isolating stem cells, and factors that promote the generation and survival of endogenous neural stem cells for therapeutic benefit in dementia) have continued to be maintained and will be reviewed in 2015.

Other projects with potential commercial value that were progressed in 2014 included a discovery around the use of kinase inhibitors to prevent excess neuroinflammation after stroke and the potential use of GlyR alpha3 modulators for the treatment of chronic pain. Commercial partners are being explored for both projects.

The ARC linkage agreement with QBI researchers continues with Boeing to develop collision avoidance systems. In addition, QBI researchers continue to participate in the Cooperative Research Centre (CRC) for Living with Autism Spectrum Disorders that commenced in 2013, and the Science of Learning Research Centre funded by the Australian Research Council.

Agreements were negotiated in the last period with Euclideon, whereby QBI researchers will collaborate with Euclideon to build new 3D visualisation tools to support brain research.

In 2014, QBI attended and exhibited at BIO2014 in San Diego. BIO is one of the largest international conferences for biotechnology, and QBI and UniQuest held a number of discussions around research and commercial opportunities. QBI also exhibited as part of the Life Science Queensland delegation and looks forwards to attending the 2015 event in Philadelphia.

UniQuest will continue to work alongside the Institute's research teams to pursue any commercial opportunities arising from the researchers. To further support this, UniQuest provides educational support to QBI's postgraduate and early career researchers about how they can use technology transfer to ensure their research has commercial potential. One way that this can be achieved is through attending UniQuest's annual commercialisation workshop which provides researchers with the opportunity to receive expert advice and guidance from professionals working in the pharmaceutical, biotechnology, investment, IP and research sectors.

Left: Ultrasound can be used to clear amyloid plaques in the brain.

Publications

QBI researchers (indicated in bold) contributed to the following publications, published either in print or electronically, in 2014.

Publications that were omitted from the 2013 Annual Report are also included.

[S] next to an author indicates the author is or was enrolled as a research higher degree student at QBI.

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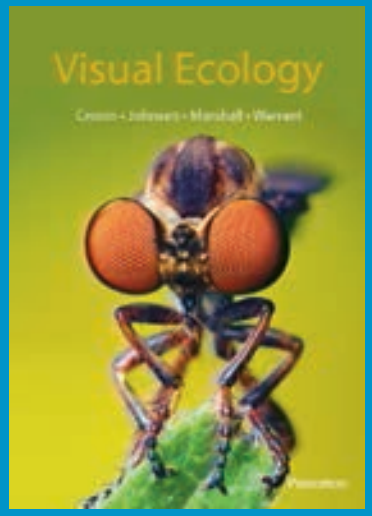

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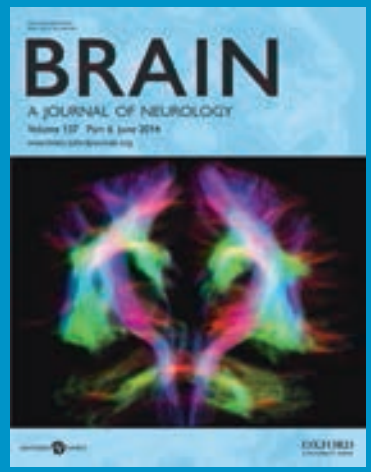

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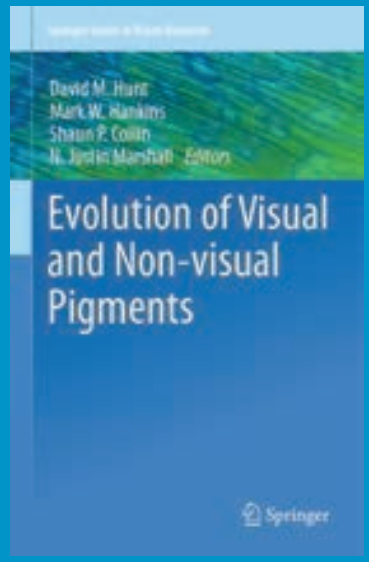

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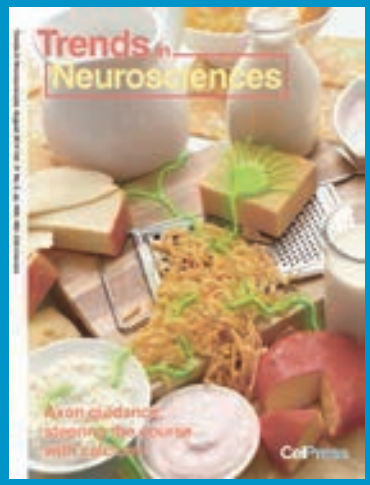

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Grants

We are grateful for the following national and international competitive grants and fellowships starting in 2014; GST and yearly increments are not included in the amounts shown. Grants and fellowships awarded by The University of Queensland have also been included. **QBI researchers** are denoted in bold.

Alzheimer's Australia Dementia Research Foundation

Postdoctoral Fellowship

Nisbet R, Targeting pathogenic tau with phosphorylated-tau specific intrabodies, $220,000, 2 years.

Top-Up Scholarship

Turnbull M, Neurotrophin regulation of Alzheimer's disease pathology, $15,000, 2 years.

Australasian Society for Autism Research

PhD research grant

Yong An J, PhD research grant, $1,125, 1 year.

Australian Government Department of Education

Endeavour Research Fellowship

Leiter O, 2014 Endeavour fellowship, $26,500, 0.5 year.

Stieb S, 2014 Endeavour fellowship, $26,500, 0.5 year.

Australian Government Cooperative Research Centres

Project Grants

Voingeagu I, Feng J, **Claudianos C**, Eapen V, Project 1.019RI Transcriptome analyses of human ASD brain tissue as a complementary method to aid the identification of ASD susceptibility genes, $50,000, 1 year.

Australian Research Council

Australian Laureate Fellowship

Marshall J, Revealing the 'invisible': new principles of vision in Australian animals, $2,970,898, 5 years.

Centre of Excellence

Egan G (CI), Rosa M (CI), **Mattingley J** (CI), Robinson P (CI), **Sah P** (CI), Stuart G (CI), Ibbotson M (CI), Lowery A (CI), Arabzadeh E (CI), Paxinos G (CI), Martin P (CI), Petrou S (CI), Grunert U (CI), Skafidas E (CI), **Garrido M** (CI), Breakspear M, (PI), Mitra P (PI), Victor J (PI), Margrie T (PI), Diamond M (PI), Johnson A (PI), Leopold D (PI), Movshon J (PI), Markram H (PI), Hill S (PI), Jirsa V (PI), Tanaka K (PI), ARC Centre of Excellence for Integrative Brain Function (awarded to and administered by Monash University), $20,000,000, 7 years.

Discovery Early Career Researcher Award

Powell J, Novel approaches for understanding how genetic variation regulates the transcriptome [awarded to UQ's Diamantina Institute in 2013; transferred to QBI in 2014], $364,525, 3 years.

Discovery Projects

Richards L, Early formation of the preplate establishes the cerebral cortex, $785,000, 3 years.

Srinivasan M, Perez T, Biologically-inspired detection, pursuit and interception of moving objects by unmanned aircraft systems, $430,000, 3 years.

Srinivasan M, Perception of pain in simple nervous systems [with Distinguished Outstanding Research Award], $1,042,837, 3 years.

van Swinderen B, Dopaminergic mechanisms of visual selective attention in the fly, $365,000, 3 years.

Linkage Infrastructure, Equipment and Facilities

Gaus K, Gooding J, Boecking T, Lee L, Whisstock J, Rossjohn J, Hertzog P, Heath W, Godfrey D, Hatters D, Quiney H, Abbey B, Braet F, King N, Grau G, van Oijen A, Goldys E, Mak J, **Meunier F**, Yap A, Eyre N, Russell S [project administered by UNSW], $560,000, 1 year.

Belgian Medical Genomics Initiative

Visscher P, Belgian Medical Genomics Initiative [awarded to UQ's Diamantina Institute in 2011; transferred to QBI in 2014].

Brain Foundation

Research Gift

Nisbet R, Generation of phosphorylated tau-specific intrabodies for the treatment of tauopathies, $28,050, 1 year.

European Commission 7th Framework Programme

International Research Staff Exchange Scheme

Mattingley J, Bellgrove M, O'Connell R, Robertson I, Four world nodes for brain networks of attention and awareness, [collaboration funds], 3 years.

Fondation Leducq

Career Development Fellowship

Brion, M-J, Determining novel causal risk factors for CVD from early life to adulthood: An original genome-wide Mendelian randomization approach [awarded in 2012; transferred to QBI in 2014].

French Embassy

Scientific Mobility Program

Bertran-Gonzalez J, Scientific Mobility Program 2013, $2,500, 1 year.

National Computational Merit Allocation Scheme

Visscher P, National Computational Merit Allocation Scheme, [value in computing time], 1 year.

Motor Neurone Disease Research Institute of Australia

Grant-in-Aid

Benyamin B, **Visscher P**, **Wray N**, Trans-ethnic and trans-omic statistical analyses to identify new ALS risk variants, $100,000, 1 year.

Mangelsdorf M, **Bartlett P,** McCombe P, Henderson R, Targeting EphA4 as a treatment for MND, $100,000, 1 year.

Wray N, McCombe P, Henderson R, **Mangelsdorf M**, **Zhao Q**, Whole exome sequencing of sporadic MND, $100,000, 1 year.

National Health and Medical Research Council

NHMRC Project Grant

Bartlett P, **Blackmore D**, Stimulation of neurogenesis by growth hormone to improve cognition in an aged animal model of dementia, $532,697, 3 years.

Bredy T, Early development, microRNAs, dendritogenesis and cognition, $303,447, 3 years.

Burne T, Adult vitamin D deficiency and cognitive dysfunction in a mouse model, $405,669, 3 years.

Collins B, Teasdale R, **Coulson E**, King G, Hong W, Endosomal sorting of amyloid precursor protein in Alzheimer's disease [awarded to and administered by UQ Institute for Molecular Bioscience], $659,354, 4 years.

Cooper H, **Mowry B**, Dissecting the role of RYK in cortical neuron specification and schizophrenia, $1,004,152, 3 years.

Cooper H, Understanding the embryonic origins of cortical malformations, $800,574, 3 years.

Eyles D, Meyer U, Do the developmental vitamin D-deficiency and maternal immune activation animal models of schizophrenia have convergent early pathways? $646,894, 3 years.

Eyles D, **Burne T**, The developmental vitamin D-deficiency animal model of schizophrenia: critical window for intervention and optimal dose, $353,447, 3 years.

Grants

Hilliard M, Xue D, Axonal fusion to promote nerve repair: molecules and mechanisms, $441,174, 3 years.

Hilliard M, Noakes P, Understanding the role of TDP-43 in motor neuron disease, $632,562, 3 years.

Lynch J, Capon R, A novel mechanism for therapeutically modulating neurotransmitter-activated ion channels, $645,558, 3 years.

McGrath J, **Eyles D**, Is developmental vitamin D deficiency associated with autism-related phenotypes: a birth cohort study, $334,596, 4 years.

McRae A, Painter J, Inheritance of DNA methylation state in humans, [awarded to the QIMR Berghofer Medical Research Institute in 2012; transferred to QBI in 2014], $579,766, 3 years.

Meunier F, Collins B, Uncover how Myosin-6 underpins the Ca2+-dependent recruitment of secretory vesicles to the cortical actin network, $541,855, 3 years.

Mowry B, **Visscher P**, Thara R, **Gratten J**, Genetic analysis of de novo and inherited exome variation in schizophrenia, $1,319,165, 3 years.

Richards L, Targeting of callosal axons to duplicate cortical areas in the contralateral hemisphere, $580,171, 4 years.

Sah P, **Lynch J**, Function and physiological role of inhibitory circuits in the amygdala, $711,868, 4 years.

Sah P, **Bartlett P**, Neurogenesis in the amygdala and hippocampus: a role in learnt fear? $749,192, 4 years.

van Swinderen B, **Zhao Q**, **Byrne E**, Discovering deep sleep genes and determining their roles for preserving cognitive functions, $469,169, 3 years.

Visscher P, Montgomery G, CAGE: Consortium for the Architecture of Gene Expression [awarded to UQ's Diamantina Institute; transferred to QBI in 2014], $484,191, 3 years.

NHMRC Research Fellowships

Lynch J, NHMRC Principal Research Fellowship: Inhibitory neurotransmitter receptors as therapeutic targets for chronic pain and anxiety disorders, $727,610, 5 years.

Meunier F, NHMRC Senior Research Fellowship: Vesicular trafficking pathways underpinning neuronal secretion and survival Fellowship B, $664,515, 5 years.

Visscher P, NHMRC Senior Principal Research Fellowship [awarded to QIMR in 2010; transferred to QBI in 2014], $816,250, 5 years.

National Institutes of Health (USA)

Exploratory/Developmental Research Grant Award [R21 subcontract]

Visscher P, (Isaac Kohane, Harvard Medical School, US lead investigator), Analysis of Genome-Wide Gene-Environment (G x E) Interactions, $156,125, 3 years.

Research Program Project Grant [P01 subcontract]

Visscher P, **Wray N**, (Bruce Weir, University of Washington, US lead investigator), Statistical and Quantitative Genetics (awarded to UQ's Diamantina Institute in 2012; transferred to QBI in 2014).

Research Project Grant Program [R01 subcontract]

Eyles D, **McGrath J**, (Brian Lee, Drexel University, US lead investigator), Early life vitamin D levels and risk of autism spectrum disorders, $110,565 2 years.

Visscher P (Bruce Weir, University of Washington, US lead investigator), Theoretical population genetics (awarded to UQ's Diamantina Institute in 2011; transferred to QBI in 2014).

NSW Environmental Trust

Environmental Education Program

Dean A (on behalf of CoralWatch), Corals at your doorstep - marine conservation through active learning, 3 years.

The Royal Australasian College of Physicians

ARA & Starr Open Fellowship

Robinson P, Investigating the relationship between genetic changes in ankylosing spondylitis and changes in immune cell subsets, $40,000, 2 years.

Stanley Medical Research Institute

Gaughran F, **McGrath J**, Vitamin D in first episode psychosis - Neuroprotective design (D-FEND), [administered by King's College London] US$ 1,443,293, 4 years.

Stockholm School of Economics

Visscher P, Statistical genetic analyses of social and economic outcomes [awarded to UQ's Diamantina Institute; transferred to QBI in 2014], [funding ongoing].

Sylvia and Charles Viertel Charitable Foundation

Senior Medial Research Fellowship

Yang J, Methods and large-scale genomic analyses to study the genetic basis of neuropsychiatric disorders and obesity, $1,225,000, 5 years.

The University of Queensland

Early Career Researcher Grants

Anggono V, Transcriptional profiling of long non-coding RNAs in synaptic plasticity, $20,000, 1 year.

Garrido M, Human electroencephalographic markers of schizophrenia: towards a neurobiologically informed diagnosis, $21,000, 1 year.

Foundation Research Excellence Award

Yang J, Quantifying the overall contribution of all the DNA variants to motor neuron disease, $70,000, 1 year.

Major Equipment and Infrastructure

Goodhill G, **Meunier F**, **Richards L**, **Cooper H**, **Coulson E**, **van Swinderen B**, Two-photon microscopy for live and fixed imaging in model organisms and thick tissue, $174,941, 1 year.

NHMRC Equipment Grant

Burne T, **Bredy T**, **Coulson E**, Piper, M, **Götz J**, **Bartlett P**, Touchscreen-automated cognitive testing for mice, $49,150, 1 year.

Postdoctoral Research Fellowship

Estrada-Mondragon A, Molecular basis of ivermectin binding to pentameric ligand-gated ion channels, $318,587, 3 years.

UQ-Indonesian Partnership Award

Benyamin B, UQ Indonesian Partnership Award, $4,900, 1 year.

UQ-Queensland Institute of Medical Research AID seed grant

Meunier F, Harrich D, Use of single particle tracking and super resolution microscopy to uncover key molecular steps underpinning viral infection, $50,000, 1 year.

Neuroscience Seminars

Through a weekly seminar program, QBI gives neuroscientists an opportunity to learn more about the latest scientific developments. The series challenges researchers in their thinking, promotes excellence through the exchange of ideas and leads to future collaborations.

Professor Vicki Anderson
Critical Care & Neurosciences,
Murdoch Children's Research Institute
Neurobehavioral plasticity after early brain insult

Associate Professor Markus Barth
Centre for Advance Imaging,
The University of Queensland
MR neuroimaging at 7 Tesla: structure and function

Dr J. Bertran-Gonzalez
Queensland Brain Institute,
The University of Queensland
Ageing and the (dis)organisation of goal-directed behaviour

Professor Emery Brown
Department of Brain and Cognitive Sciences,
Massachusetts Institute of Technology, USA
Deciphering neural information representations using state-space point process models

Associate Professor Thomas Burne
Queensland Brain Institute,
The University of Queensland
Translational neuroscience; from epidemiology to animal models

Associate Professor Charles Claudianos
Queensland Brain Institute,
The University of Queensland
Genome to phenome: characterising autism spectrum disorder

Dr Allen Cheung
Queensland Brain Institute,
The University of Queensland
Tuning the release kinetics of neurotransmission

Lavina Codd
Queensland Brain Institute,
The University of Queensland
Neurogenesis and functional recovery in the adult mouse brain after hippocampal stroke

Dr Brett Collins
Institute for Molecular Bioscience,
The University of Queensland
Structural biology of membrane trafficking in neurodegeneration

Dr Wen-Sung Chung
Queensland Brain Institute,
The University of Queensland
Complex visual adaptions in squid for different environments—comparison between common reef squid and rare deep-sea squid (the giant squid)

Professor Luciano D'Adamio
Department of Microbiology & Immunology,
Albert Einstein College of Medicine, USA
Is the function of APP relevant to the pathogenesis of dementia?

Dr Mario de Bono
MRC Laboratory of Molecular Biology,
University of Cambridge, England
Encoding a global animal state

Dr Anthony Don
Prince of Wales Clinical School,
University of New South Wales
Loss of brain lipid homeostasis as a driving influence in Alzheimer's disease pathogenesis

Professor John Duncan
The University of Cambridge, England
A core brain system in assembly of cognitive episodes

Dr Anne Eckert
Molecular & Cognitive Neuroscience, University of Basel, Psychiatric University Clinics Basel, Switzerland
New insights into Alzheimer's disease: mitochondrial dynamics and circadian rhythms

Associate Professor Erica Fletcher
Department of Anatomy and Neuroscience,
The University of Melbourne
The role of microglia in regulating photoreceptor integrity

Dr Helen Gooch
Queensland Brain Institute,
The University of Queensland
Using optogenetics to unravel the amygdala

Professor Jürgen Götz
Queensland Brain Institute,
The University of Queensland
Tau and amyloid-β in Alzheimer's disease: from basic mechanisms to therapeutic strategies

Dr Christine Cong Guo
Queensland Institute of Medical Research
Functional network breakdown in neuropsychiatric disorders—from rest to naturalistic stimuli

Callista Harper
Queensland Brain Institute,
The University of Queensland
The regulation of membrane trafficking pathways at the presynaptic nerve terminal

Associate Professor Neil Harris
UCLA Brain Injury Center, Department of Neurosurgery, UCLA, USA
Cortical reorganization after experimental TBI: how much can we achieve?

Professor Allan Herbison
Centre for Neuroendocrinology,
University of Otago, New Zealand
Regulating neuronal networks with a kiss

Professor Andrew Hill
Department of Biochemistry and Molecular Biology, The University of Melbourne
Exosomes and their role in neurodegenerative diseases

Dr Kate Hoy
Monash Alfred Psychiatry Research Centre
The emerging field of cognitive neurotechology: using brain stimulation to enhance cognition

Dr Zhitao Hu
Harvard Medical School,
Massachusetts General Hospital, USA
Tuning the release kinetics of neurotransmission

Shao-Chang Huang
Queensland Brain Institute,
The University of Queensland
Colour vision of Ischnura heterosticta (Insecta: Odonata): role in sexual selection, communication and visual plasticity

Professor Richard Huganir
Howard Hughes Medical Institute, The Johns Hopkins University School of Medicine, USA
Receptors, synapses and memories

Georg Kerbler
Queensland Brain Institute,
The University of Queensland
The basal forebrain plays a central role during the development of Alzheimer's disease

Dr Vikram Khurana
Massachusetts Institute of Technology, USA
Capturing Parkinsonism in a dish: from genes to yeast to patient iPS cells

Professor Joe Lynch
Queensland Brain Institute,
The University of Queensland
Glycinergic synapses in the spinal cord: their relevance to chronic pain and its treatment

Neuroscience Seminars

Professor Jason Mattingley
Queensland Brain Institute,
The University of Queensland
Eye movements and visual stability

Dr Linda Miller
Children's Medical Research Institute (CMRI)
Isolating the bulk endosome from nerve terminals

Dr John Morris
Queensland Brain Institute,
The University of Queensland
The neural basis of the partial reinforcement extinction effect

Annika Nichols
IMP - Research Institute of Molecular Pathology, Vienna, Austria
Lethargus-quiescence in C. elegans is a systemic brain state under tight control of arousal circuits

Professor Miguel Nicolelis
Duke University Medical Center, USA
Beyond brain-machine interfaces

Dr Patricio Opazo
Max Planck Institute for Neurobiology, Germany
The synaptic capture of membrane diffusing AMPA Receptors as a substrate for memory formation and disease

Dr Michael Piper
School of Biomedical Sciences and Queensland Brain Institute, The University of Queensland
Nuclear factor one transcription factors and cortical development

Associate Professor Roger Pocock
Biotech Research and Innovation Centre,
The University of Copenhagen, Denmark
MicroRNAs, sugars and the nervous system

Associate Professor Jose Polo
Faculty of Medicine, Monash University
Dissecting the molecular events during reprogramming of somatic cells into induced pluripotent stem cells

Dr Simmy Poonian
Queensland Brain Institute,
The University of Queensland
The causal inference between goal-directed actions and their sensory consequences

Professor Caroline (Lindy) Rae
The University of New South Wales
Two orthogonal topics of interest: brain acetate metabolism and new insights from T2 imaging*

Dr Tobias Rasse
Hertie-Institute for Clinical Brain Research, Center for Neurology, University Hospital, Tübingen
Use of Drosophila to address the pathomechanisms underlying neurodegenerative diseases that are associated with defects in synaptic structure and function: increased mitophagy in Parkinson's disease: curse or cure?

Dr Judith Reinhard
Queensland Brain Institute,
The University of Queensland
From memories to molecules: how sensory experience shapes the brain

Dr Amanda Robinson
Queensland Brain Institute,
The University of Queensland
Multisensory interactions between olfaction and vision: the influence of odours on visual perception and attention

Associate Professor Jennifer Rodger
School of Animal Biology,
The University of Western Australia
Low intensity magnetic stimulation of the brain: evidence for reorganisation of neural circuits and frequency specific effects

Professor Bert Sakmann
Nobel Prize Winner (1991), Max Plank Institute of Neurobiology, Germany
3D reconstruction of cortical networks and circuits for decision making in rodents

Dr Vanesa Tomatis
Queensland Brain Institute,
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Role of myosin VI in neuroexocytosis

Professor Li-Huei Tsai
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The role of epigenetic-regulated gene expression in cognitive function and neurodegenerative disorders

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Genome-wide methylation from human blood samples: genetics, environmental exposures and a role in ageing and disease

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Transcriptional networks in autism spectrum disorders

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Coupling movement and creative discovery to transform health and learning landscapes

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Queensland Brain Institute,
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The assessment of diffusion-weighted MRI as a novel method for functional brain imaging

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The University of Cambridge, England
Probabilistic models of sensorimotor control and decision making

Professor Naomi Wray
Queensland Brain Institute,
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Research strategies that embrace the complex genetic etiology of psychiatric disorders

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Fujian Medical University, China
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Menzies Research Institute Tasmania
Myelin plasticity in the adult CNS

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Center for Cognititve Neuroscience, Duke-NUS Graduate Medical School, Singapore
Multimodal brain connectome: applications in neurodegenerative diseases

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- *Society for Mental Health Research, Queensland Representative*

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- *Chinese Society for Anatomical Sciences, Standing Member of Board of Directors*
- *Chinese Society for Cognitive Science, Member of Board of Directors- Hunan Key Laboratory of Diagnosis and Therapy of Psychiatry, Scientific Committee Deputy Chair*
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- *Key Laboratory for NeuroInformation of the Ministry of Education of China, Scientific Committee Member*
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Professional Services

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- *Australian Disorders of the Corpus Callosum (AusDOCC), Scientific Advisor*
- *Medical Research Council, UK, Grant Reviewer*
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- *Australian Neurogenetics Meeting, Convener*
- *Consortium for Lithium Genetics, Advisor*
- *World Congress Psychiatric Genetics, Copenhagen, Scientific Committee Member*

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- *Chinese Rheumatology Association, Vice President*
- *Chinese Clinical Immunology, Association Standing Member*
- *National Natural Science Foundation of China, Program Review Committee Member*

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Researchers at QBI are dedicated to unlocking the mysteries of neurodegenerative diseases and mental health disorders, which currently account for a staggering 45 per cent of the burden of disease in Australia.

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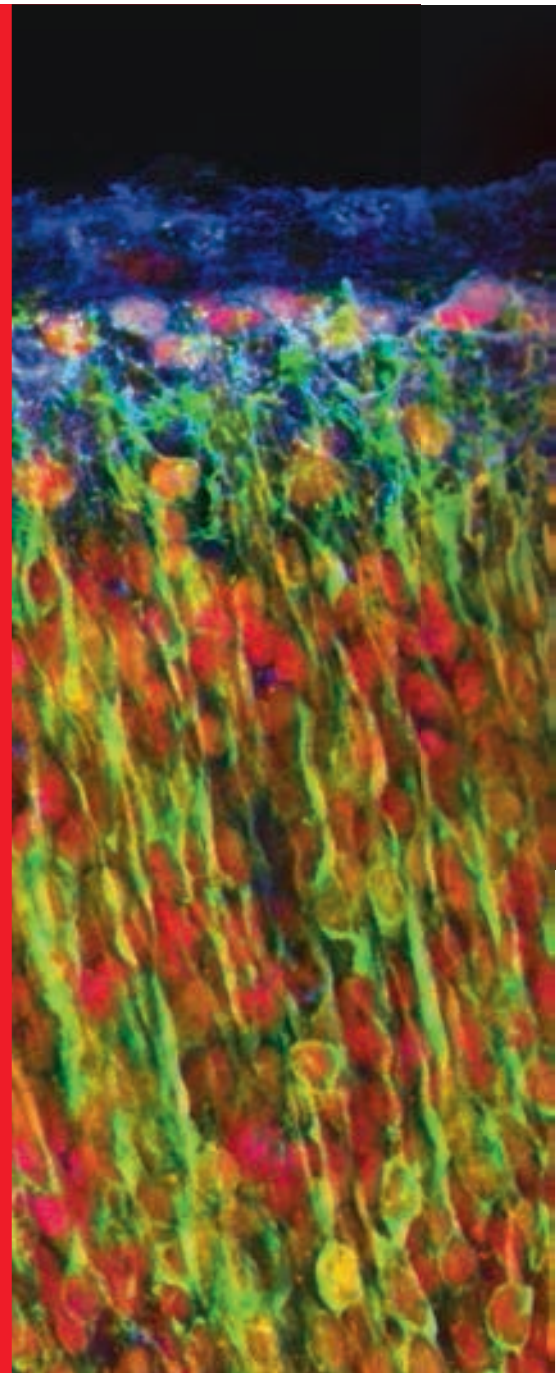

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