Australian
Stem Cell Research

strength in science

Australian Government

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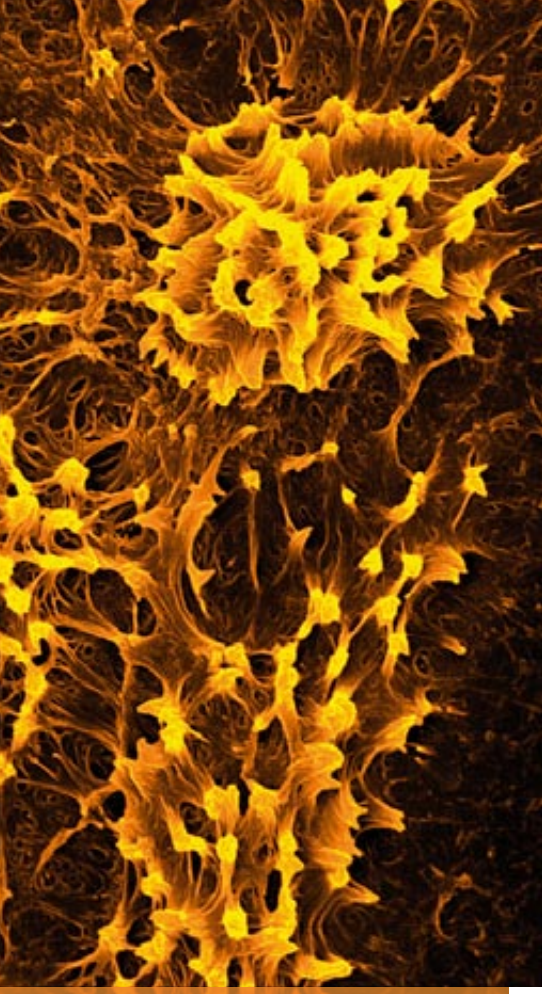


a strategic destination for stem cell research

Australia has cutting-edge capabilities in the field of stem cell research and is home to world-class scientists who undertake research and development on embryonic and adult stem cells under a clear and transparent legislative framework.

Regulatory framework

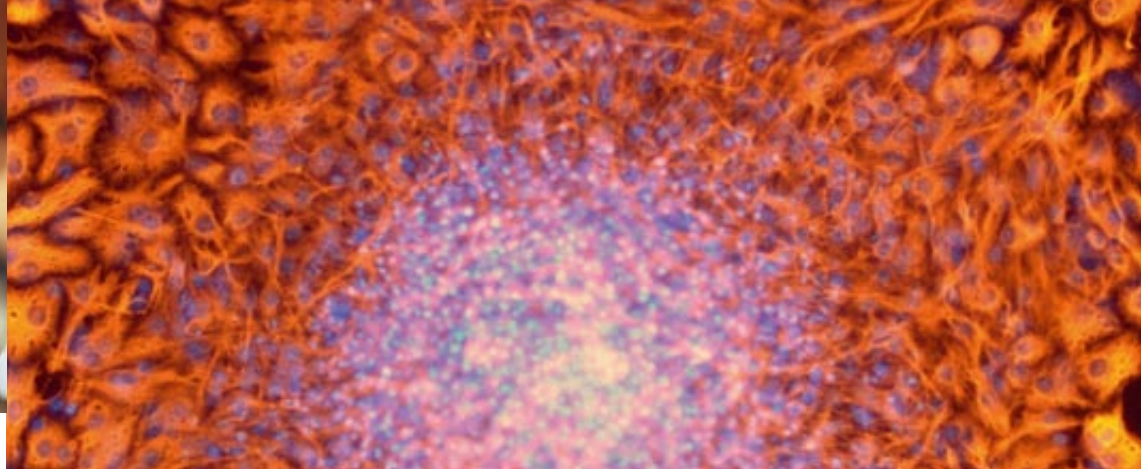
The regulatory framework is embodied in two pieces of Commonwealth Government legislation:

- *The Prohibition of Human Cloning Act 2002*, which bans all forms of human cloning; and
- *The Research Involving Human Embryos Act 2002*, which established a licensing system for the use of excess embryos from assisted reproductive technology.

The legislation was reviewed in 2005 by a committee chaired by Justice Lockhart QC. The Lockhart Review was tabled in Parliament in December 2005 and was considered by the Australian Government during 2006.

In December 2006, the Australian Parliament enacted the *Prohibition of Human Cloning for Reproduction and the Regulation of Human Embryo Research Amendment Act 2006 (Act)*. The *Act* implements all but one of the 54 recommendations provided to the Australian Government by the *2005 Lockhart Review of the Prohibition of Human Cloning Act (2002)* and *Research Involving Human Embryos Act (2002)*. The amended legislation will provide Australian researchers with new opportunities to investigate stem cells with the aim of developing new therapies for the treatment of disease. In particular, the new legislation expands stem cell research to permit, under licence, somatic cell nuclear transfer or therapeutic cloning.

ABOVE LEFT This image shows the micro-architecture of a cluster of endoderm progenitor cells developed from human embryonic stem cell. The image, acquired by scanning electron microscopy (SEM) at 2,200X magnification, reveals cells that are decorated by a mass of plasma membrane projections.



Embryonic stem cell research

Australian Stem Cell Centre

The Australian Stem Cell Centre (ASCC) provides expertise and infrastructure aimed at creating a critical mass for research and development. The ASCC has established collaborative partnerships with nine stakeholder universities and research institutes across Australia.

The ASCC's research activities focus on adult stem cells, human embryonic stem cells, tissue repair mechanisms and immune system technology. Diseases which could be addressed using this technology include cardiac, haematological, respiratory, neural, orthopaedic and skin diseases.

Some of the ASCC's current collaborations include:

- **Stem Cell Sciences** for the development and distribution of new human embryonic stem cell lines to scientists without commercial and patent restraints—two cell lines have been generated, Mel-1 and Mel-2;
- **ES Cell International** for the development of new treatments for diabetes;
- **Centre for Green Chemistry** to produce stem cell proteins for research purposes;
- The licensing of technology from **LifeCell Corporation (US)** for use in tissue repair projects;
- **Innovative Dairy Products Ltd** for research on cellular reprogramming, relevant for some areas of therapeutic interest; and
- The **Cooperative Research Centre for Polymers** to develop smart surfaces for bioreactors, enabling better culturing methods.

Funding for the ASCC comes from a number of Federal Government sources. Key funding support to the Centre is through the Government's Innovation Statement, *Backing Australia's Ability*, which has assigned funding of over A$100 million through to 2011. Additional infrastructure funding is provided from the Victorian State Government.

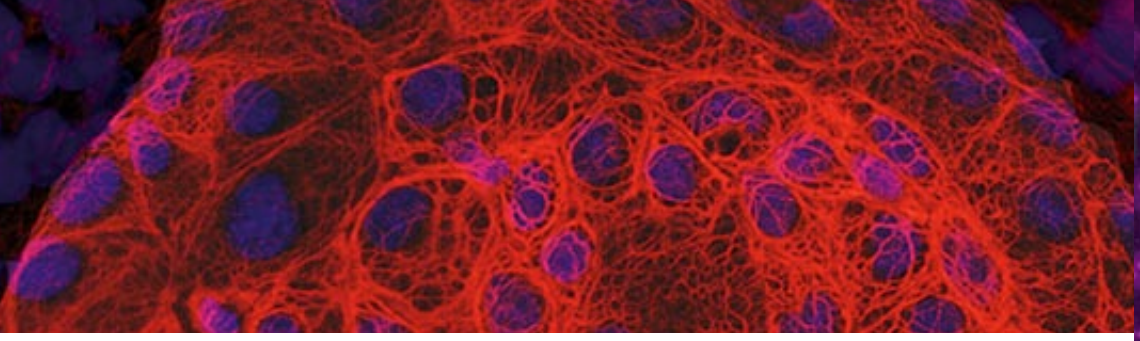
Monash University

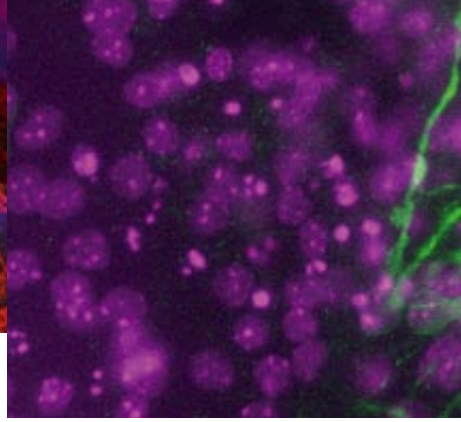
Monash University is one of the founding partners of the ASCC, which draws together the university's leading stem cell tissue and repair scientists. The coordinated effort is led by world-renowned stem cell researcher Professor Alan Trounson and incorporates the research groups of Associate Professors Martin Pera and Richard Boyd, Professor Graham Jenkin, Dr Andrew Elefanty and Dr Edouard Stanley.

Dr Andrew Elefanty is working in the Monash Institute of Reproduction and Development. He has mastered a technique to train human embryonic stem cells to become blood-forming stem cells using mouse embryonic stem cells. His work aims to develop cells that can be used for replacement therapies, blood deficiencies or for diabetes.

Professor Martin Pera has been appointed to head the newly created Institute for Stem Cell and Regenerative Medicine at the University of Southern California, USA.

ABOVE RIGHT In the laboratory, embryonic stem cells can be directed to form all the cells of the central nervous system (CNS). This is an example of development along the ectodermal pathway. In this image, a carpet of astrocytes, star-shaped neuroglia support cells denoted by orange fluorescent staining can be observed under a transparent cloud of nerve cells whose nuclei are depicted by blue fluorescent staining.





Monash Immunology and Stem Cell Laboratories

Professor Alan Trounson is the Director of the newly established Monash Immunology and Stem Cell Laboratories (MISCL). MISCL is a centre of research excellence within the School of Biomedical Sciences, Faculty of Medicine at Monash University. The researchers in MISCL have international reputations in immunology, stem cells and tissue repair, and are closely linked to the ASCC.

MISCL contains the world renowned Monash University research interests in stem cell science, with a strong emphasis on embryonic stem cell research and the potential applications in the repair and regeneration of blood, pancreatic, respiratory and renal diseases. The stem cell interests include both adult (mature) and embryonic stem cells, particularly in lung and kidney tissues. There is also a major interest in the immune system and the potential induction of immune tolerance for transplantation using stem cells for chimeric population of the haematopoietic and thymic systems. Other interests include mammalian germ stem cells, gamates and preimplantation embryo development.

Prince of Wales Hospital – Diabetes Transplant Unit

The Prince of Wales Hospital Diabetes Transplant Unit (DTU) is conducting innovative research in its attempts to reverse type I diabetes (insulin-dependent diabetes) in humans. The technique involves isolating islets and transplanting them into diabetic recipients to normalise blood glucose levels without the need to inject insulin.

The DTU is developing strategies to turn adult and embryonic stem cells into insulin-producing cells. The DTU has grown human embryonic stem cells (hESC) and has been successful in turning hESC into insulin-producing cells. The team is now using a combination of cell culture and tissue engineering tools to optimise this approach.

In a collaboration with IVF Australia, the DTU team were one of the first to receive a licence from the National Health and Medical Research Council to create new hESC lines for use in stem cell research. Further collaborative research funded by the NSW Ministry for Science and Medical Research is focusing on the use of hESC lines to overcome spinal cord injuries.

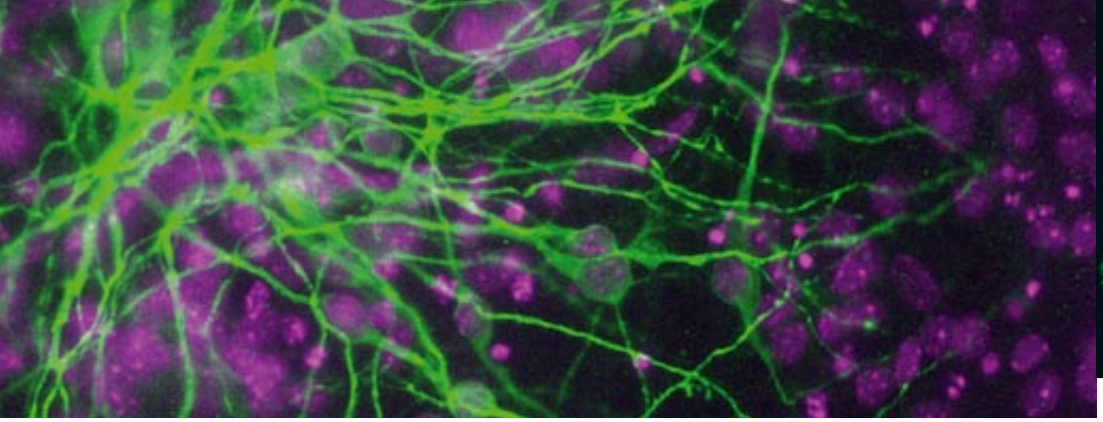
Prince of Wales Medical Research Institute

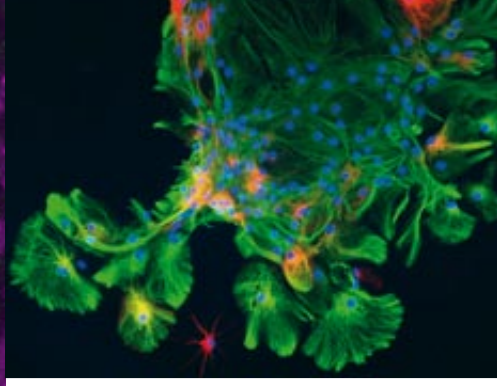
The Prince of Wales Medical Research Institute focuses on potential cellular therapies to repair the spinal cord. It is one of the largest brain and nervous system research centres in Australia. The Institute is trialling both embryonic and adult stem cells in rats, testing for improvements in locomotion, bladder and cardiovascular functions.

ABOVE LEFT This close-up image shows the spectacular detail of a cluster of human embryonic stem cells grown on a mouse embryonic fibroblast feeder layer. These human embryonic stem cells have been artificially manipulated to develop into epithelial precursor cells. The red colour is a marker that identifies a protein present on particular epithelial cells. Epithelial cells form a thin tissue covering of most of the internal and external surfaces of the body and its organs. The blue stain marks the nuclei of the cells.

ABOVE MIDDLE This spectacular celestial-like image shows development of stem cells along the ectodermal pathway. This photo depicts a bundle of mouse neurons (stained green) formed from embryonic stem cells in tissue culture. The nucleus containing the genetic material of each cell is stained purple. The ability to form mature brain cells such as neurons from embryonic stem cells has stimulated much excitement about the possibility of using stem cells to treat brain disease.

ABOVE RIGHT The image shows a neurosphere, which is a ball of primitive cells that give rise to new neuronal cells such as neurons, astrocytes and oligodendrocytes. This image shows development of an adult mouse neurosphere into neurons stained red and fan-like astrocytes stained green. The cell nucleus is stained blue. Astrocytes are star shaped neuroglia type cells of the nervous system which function as part of the blood-brain barrier and restrict the movement of certain substances into the brain.





Adult stem cell research

Peter MacCallum Cancer Institute

The Peter MacCallum Cancer Institute's Research Division is one of the largest cancer research groups in Australia. The Institute's stem cell biology program focuses on studying the fundamental properties of stem cells in adult tissues and using their unique biological properties in novel cellular therapies for graft engineering and tissue regeneration.

Associate Professor Paul Simmons' group is conducting Australia's first clinical trial with transplants of patients' own blood stem cells at the Institute, with the aim of improving bone marrow recovery following high doses of chemotherapy. The first patient cohort has displayed a significant improvement in the rate of peripheral blood count recovery. Initial results suggest that a significant decrease in the morbidity associated with high-dose chemotherapy can be achieved.

The Institute's stem cell biology program is also working in the following important areas:

- The regulation of self-renewal, a fundamental but poorly understood property of haemopoietic stem cells;
- The mechanisms responsible for cytokine-induced migration of haemopoietic stem and progenitor cells from their site of residence within the bone marrow to the peripheral blood; and
- The biology of the skin through the isolation and characterisation of keratinocyte stem cells.

Norwood Immunology

Norwood Immunology, a division of Norwood Abbey, is undertaking groundbreaking research to improve the immune system. Two alternative technologies are being employed to produce new T cells using US Food and Drug Administration (FDA) approved GnRH analogs to rebuild the thymus and improve bone marrow and grow a completely new thymus from stem cells.

In February 2005, Norwood Immunology received US FDA approval for an Investigational New Drug (IND) for a Phase II clinical study of the immunological effects of Lupron in patients undergoing autologous bone marrow transplantation.

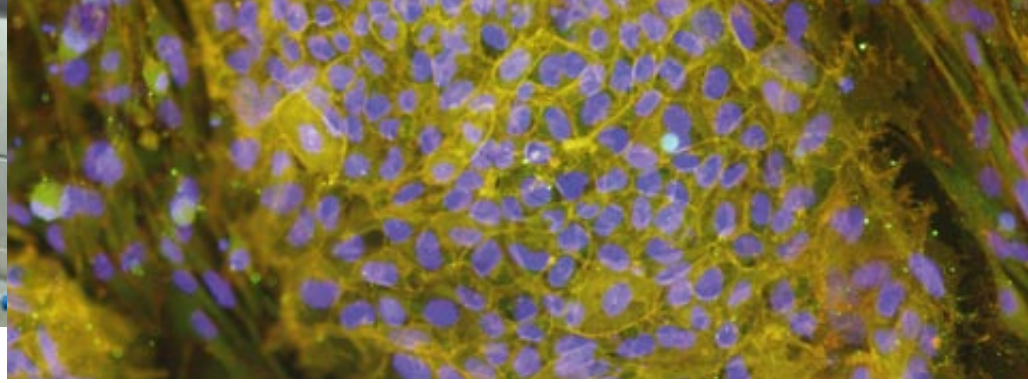
Queensland Brain Institute

In 2004, the University of Queensland received A$20 million funding from the Queensland Government towards the Queensland Brain Institute (QBI). The QBI is directed by internationally renowned neuroscientist Perry Bartlett, who was the first to report on a method for purifying mouse brain stem cells (*Nature 2001*).

In September 2004, the QBI announced a breakthrough in spinal regeneration research with the discovery of a molecule that blocks regrowth of damaged nerve processes. The research is in collaboration with the University of Melbourne's Centre for Neuroscience.

QBI researchers have also identified progenitor cells that could lead to the development of repair mechanisms for people suffering from dementia and acquired brain injury. In November 2005, the study by Dr Natalie Bull and Professor Perry Bartlett featured on the front cover of the *Journal of Neuroscience.*

Australian Stem Cell Centre Ltd



Institute for Molecular Bioscience

The University of Queensland is home to the Institute for Molecular Bioscience (IMB), which is recognised around the world as one of Australia's leading centres for molecular bioscience research.

The IMB is investigating the regeneration or repair of the kidney, a tissue previously thought to lack a persistent stem cell population, using either factors, recruitment of stem cells from distant sites or embryonal stem cells. Professor Brandon Wainwright is contributing to the understanding of lung development and the role of stem cells when airways become injured due to diseases such as cystic fibrosis.

Nephrogenix

Nephrogenix commercialises the outcomes from a group of researchers, referred to as the Renal Regeneration Consortium which is based at the University of Queensland and Monash University. Nephrogenix is developing renal growth factors and stem cell markers for cell-based therapies for kidney disease and in 2004 received a A$250,000 grant from the Australian Government to further its groundbreaking work on renal disease and kidney regeneration. The grant enables Nephrogenix to continue its work on stem cell markers and methods for generating cell types needed to develop cellular therapies and therapeutics for renal disease.

Mesoblast

Mesoblast work focuses on the development of novel treatments for orthopaedic conditions, including the commercialisation of a unique adult stem cell technology aimed at the regeneration and repair of bone and cartilage.

A trial for the treatment of cardiovascular disease being conducted at the John Hunter Hospital in Newcastle, New South Wales, in February 2006 is using Mesoblast technology. Adult stem cells developed using Mesoblast technology were safely implanted in the first two patients participating in the clinical trials. The trial is one of two currently being conducted in Australia to test the safety of implanting Mesoblast's proprietary adult stem cells in humans. Its technology is also undergoing animal trials in the US.

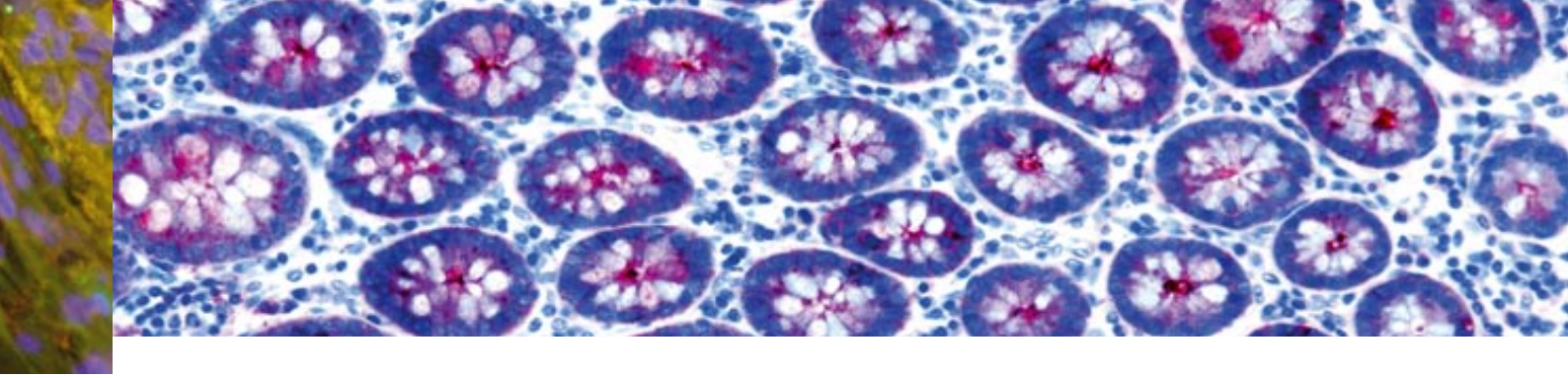
The Australian Government, through the Commercial Ready program, has supported Mesoblast with a A$2.7 million grant for testing its stem cell technologies.

Walter and Eliza Hall Institute

The Walter and Eliza Hall Institute (WEHI) is one of Australia's foremost medical research institutes. WEHI Professor Don Metcalf's basic research discoveries led to the development of biological entities to accelerate the regrowth of blood cells in people with cancer, following chemotherapy, bone marrow or peripheral blood transplantation. In recognition of his significant contributions, Professor Metcalf was awarded the inaugural Salk Medal for Research Excellence in La Jolla, California in 2005. Professor Jane Visvader's laboratory, in conjunction with a Canadian team, recently announced they have discovered the rare stem cell that drives the formation of all breast tissue (using a mouse model). This research may have consequences for the understanding of breast cancer mechanisms.

ABOVE MIDDLE Two proteins involved in cell adhesion have been labelled with different fluorescent markers. One protein is labelled green while the other protein is labelled red. Where the two colours overlap appears yellow. The nuclei are stained pale blue. As you can see, these two proteins are expressed in the same pattern within the colonies of human embryonic stem cells.

ABOVE RIGHT This image shows a cross-section of crypts in the adult human gastrointestinal tract, an area where a stem cell population is known to reside. The tissue has been stained with pink antibody marker - an indicator of endodermal progenitor cells. The nuclei are counterstained blue. Magnification: 400X.



Howard Florey Institute

The Howard Florey Institute undertakes clinical and applied research in an effort to develop treatments to combat brain disorders and new medical practices. In 2004, Malcolm Horne and his research team started new research into Parkinson's disease by looking at how a combination of reactions damage brain cells in people with this disease.

The Institute's Neuromuscular Diseases Research Centre is researching possible cures for inherited muscular dystrophy such as Duchenne Muscular Dystrophy and Spinal Muscular Atrophy. They are performing trials in mice with Duchenne Muscular Dystrophy to implant stem cells with the capacity to regenerate muscle fibres.

CyGenics

Adult stem cell and immunology company CyGenics is actively involved in developing new stem cell-based medical therapies. One area of its work is in the production of human T-cells, a critical component of the immune system. In November 2005, CyGenics entered into a collaborative research agreement with the Johns Hopkins University School of Medicine (USA). CyGenics' proprietary stem cell expansion platform will be used in combination with the Johns Hopkins stem cell purging technology as part of a pre-clinical study directed at a new treatment strategy for patients with Acute Myeloid Leukaemia.

Eskitis Institute for Cell and Molecular Therapies

Griffith University's, Eskitis Institute for Cell and Molecular Therapies, research focuses on the development of cell therapies, building on pioneering work to harvest and cultivate nasal cells for transplantation for spinal cord regeneration and the development of small molecules from natural products and combinatorial libraries against a range of cell signalling targets.

Professor Alan Mackay-Sim is leading Griffith's research into olfactory cells. Recent discoveries have proven olfactory stem cells are multipotent – they can give rise to nerve, heart, liver, kidney and muscle cells. They can be easily grown in the laboratory and are obtained painlessly from the patient's own nose. Professor Mackay-Sim and his team have started preclinical animal studies of the use of olfactory stem cells as a therapy for Parkinson's disease.

Government support

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