VICTORIA'S RESEARCH EXCELLENCE

ERA Case Studies 2015

MELBOURNE Victoria Australia

A WORLD OF KNOWLEDGE

Melbourne, the capital city of Victoria, is a global leader in research and education.

The State of Victoria has one of the largest research and development clusters in the southern hemisphere producing world-leading, commercially focussed research.

Victoria has long been recognised as a global knowledge hub, attracting researchers, investment and collaboration from around the globe. The state has one of the highest university education participation rates in the world, and is home to experts dedicated to an impressive array of disciplines.

From ground-breaking research into the development of self-repairing carbon fibre composite materials for the aviation industry, to the synthesis of new molecules to combat diseases such as tuberculosis and prostate cancer, Victorian universities are solving problems of global significance.

Victoria's universities have forged productive partnerships with local and international universities and research institutes to deliver complete solutions to industry partners. This research is producing important discoveries across a full spectrum of research disciplines. The diversity and calibre of this research has led to Victorian universities being rated 'above world standard' in 96 disciplines in the *Excellence in Research for Australia* (ERA) 2015 rankings. Victoria is home to world-class research facilities and infrastructure which underpins its research excellence. These span six major precincts in the areas of advanced manufacturing and aerospace; biomedicine; agriculture and food technology; manufacturing and materials technology, agriculture and biosciences; and technology. Within these precincts Victoria boasts infrastructure such as the Australian Synchrotron, Carbon Nexus (carbon fibre research facility), AgriBio (agricultural biosciences research and development facility) and the Victorian Comprehensive Cancer Centre.

Victoria attracts the best and brightest from around the globe. Each year, more than 160,000 international students from 160 countries choose to study in Victoria, attracted by the state's excellent education institutions and high standard of living. Melbourne is ranked second to Paris as the world's best student city, and has been declared 'the world's most liveable city' for five consecutive years by *The Economist* magazine. Melbourne, and regional Victoria, are home to 10 universities, including two ranked in the world's top 100.

Victoria's reputation for delivering quality education has generated prosperity and success for countless people, communities and organisations around the world. Such a concentration of knowledge, expertise and experience makes Melbourne a true international centre of research and education.





THE EXCELLENCE IN RESEARCH FOR AUSTRALIA

In 2015, the Australian Research Council conducted the third full *Excellence in Research for Australia* (ERA) evaluation. This evaluation framework aims to identify and promote excellence across the full spectrum of research activity, including both discovery and applied research, within Australian higher education institutions.

The ERA initiative evaluates the quality of the research being undertaken in Australian universities using national and international benchmarks, with the submissions evaluated by 155 Research Evaluation Committee members and 1,300 peer reviewers from Australia and abroad.

The ratings are based around a variety of indicators relevant to different disciplinary areas, including citation profiles and peer reviews. The information is submitted by universities and covers all eligible researchers and their research outputs. At a national scale, the 2015 figures make impressive reading: 432,747 publications; 67,579 researchers and related staff; AU\$9.9 billion of external research income; and 936 patents.

The achievement of Victoria's universities is equally impressive. The following tables show the research strengths measured as 'well above world standard ▲', 'above world standard ■' and 'at world standard ●'. Notably, ninety-six discipline areas were rated as 'well above world standard', and numerous disciplines rated 'above world standard', at multiple institutions in areas such as Biomedical Engineering, Neurosciences, Condensed Matter Physics, Human Movement and Sports Science, Nanotechnology, Immunology, Architecture, Economics, Psychology, and Astronomical and Space Sciences.

INSTITUTION	AUSTRALIAN CATHOLIC	DEAKIN UNIVERSITY	FEDERATION UNIVERSITY AUSTRALIA	LA TROBE UNIVERSITY	MONASH UNIVERSITY	RMIT UNIVERSITY	SWINBURNE UNIVERSITY	UNIVERSITY OF MELBOURNE	VICTORIA UNIVERSITY
Mathematical Sciences									
Mathematical Sciences			•			•	•		
Pure Mathematics			•						
Applied Mathematics			•	•			•		
Statistics									
Mathematical Physics								•	
Physical Sciences									
Physical Sciences									
Astronomical and Space Sciences									
Atomic, Molecular, Nuclear, Particle and Plasma Physics									
Condensed Matter Physics									
Optical Physics									
Quantum Physics									
Chemical Sciences									
Chemical Sciences									
Analytical Chemistry		•							
Inorganic Chemistry									
Macromolecular and Materials Chemistry									
Medicinal and Biomolecular Chemistry									
Organic Chemistry								•	
Physical Chemistry (Incl. Structural)		-							
Theoretical and Computational Chemistry								•	
Earth Sciences									
Earth Sciences			•		•				
Atmospheric Sciences					•				
Geochemistry									
Geology					•				
Geophysics					•				
Physical Geography and Environmental Geoscience									

above world standard



CONDENSED MATTER PHYSICS

Developing Diamond for Quantum Electronics



La Trobe University's Atom-scale Research Laboratory is focused on the development of quantum electronic devices using the material diamond. This work, which is supported by funding from the Australian Research Council, involves an international consortium of researchers from the United Kingdom, Germany, Singapore and Israel.

Facilities at the Australian Synchrotron, along with atom-scale microscopy at La Trobe University, have been used to investigate how to control the electronic properties of the diamond surface. Diamond is naturally an electrical insulator, but by functionalizing the diamond surface a perfectly flat layer of charge can be induced just below the surface. This charged sheet has been shown by the research team to possess important spin properties that demonstrate the potential of diamond for a new-generation of fast, low-power electronic devices for computing and sensing applications. The University of Melbourne will head an international research team involved in the SABRE (Sodium-iodide with Active Background REjection) project – the first ever direct-detection dark matter experiment in Australia, that aims to solve the next major challenges in particle physics. The project is being lead by Professor of Physics Elisabetta Barberio, a chief investigator of the Australian Research Council Centre of Excellence for Particle Physics at the Terascale. It will be hosted at the Stawell Underground Physics Laboratory, which is due to begin construction in 2016.

Alongside collaborators from other Australian universities, Princeton University, the Australian Nuclear Science and Technology Organisation and the Italian Institute for Nuclear Physics, researchers plan to construct a AU\$3.5 million laboratory underground surrounded by low-radiation basalt, to try to detect dark matter particles. Dark matter is thought to make up 23% of the mass-energy of the universe. It is yet to be detected by direct means and remains one of the most significant puzzles in modern astronomy and physics.

The Stawell Underground Physics Laboratory will be the first laboratory of its kind in the Southern Hemisphere.







AGRICULTURAL AND VETERINARY SCIENCES

Application of smart sensor technology to improve productivity and welfare of sheep

ENVIRONMENTAL SCIENCES

Ocean predators help to prevent climate change

Between 10 to 30 per cent of lambs die within the first two days of lambing resulting in significant losses in productivity for the sheep industry. Research carried out at La Trobe University aims to reduce lamb mortality by identifying ewes with strong maternal instincts using smart sensor technology. Detailed information on the coordinated behaviours of both the ewe and her lamb(s) are monitored so that it is possible to select ewes with strong mothering instincts. Smart sensors also provide real-time data on grazing, suckling as well as the location of animals in the paddock, enabling the monitoring of productivity, health and welfare of animals. Sharks might have a bad name, but they may well be heroes protecting the earth from the perils of climate change. As part of an international study, Deakin University scientists have discovered that the loss of sharks through hunting is causing instability in the ocean's food chain – leading to the release of carbon from the seafloor and coastal zones into the atmosphere. With fewer sharks, populations of the predators' food sources, such as sea turtles, are consuming more seagrass, releasing carbon that has been locked away for millennia into the atmosphere. The research team is calling for urgent research and stronger conservation efforts to restore the role of predators in the ocean's carbon cycle.





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Environmental Sciences									
Environmental Sciences				•					
Ecological Applications									
Environmental Science and Management									
Soil Sciences									
Biological Sciences									
Biological Sciences							•		
Biochemistry and Cell Biology		•							
Ecology		•							
Evolutionary Biology									
Genetics									
Microbiology							•		
Physiology									
Plant Biology									
Zoology									
Agricultural and Veterinary Sciences									
Agricultural and Veterinary Sciences									
Agriculture, Land and Farm Management									
Animal Production									
Crop and Pasture Production									
Fisheries Sciences									
Forestry Sciences									
Veterinary Sciences									

above world standard

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Information and Computing Sciences									
Information and Computing Sciences		•	•	•		•	•		
Artificial Intelligence and Image Processing		•		•			•	•	•
Computation Theory and Mathematics									
Computer Software									
Data Format					•		•		
Distributed Computing							•		•
Information Systems		•		٠					•
Library and Information Studies									
Engineering									
Engineering									
Aerospace Engineering									
Biomedical Engineering									
Chemical Engineering									
Civil Engineering			•						
Electrical and Electronic Engineering		•			-		•		
Food Sciences						•		•	
Geomatic Engineering								٠	
Manufacturing Engineering		-							
Maritime Engineering									
Materials Engineering									
Mechanical Engineering									
Resources Engineering and Extractive Metallurgy								•	
Technology									
Technology									
Medical Biotechnology									
Communications Technologies									
Nanotechnology									

above world standard



AEROSPACE ENGINEERING Composites fly high

MATERIALS ENGINEERING Energy Storage

RMIT researchers have collaborated with Boeing Research & Technology Australia (BR&T Australia) to develop innovative methods for damaged hightech carbon fibre composite materials to repair themselves without human intervention.

Through the use of 'self-healing', an aircraft with an outer shell is able to mimic the regenerative powers of skin and can repair itself when cracked or damaged.

Researchers are undertaking a number of futuristic research projects in advanced composites that may, in coming years, find applications on civil and military aircraft and allow for a lighter aircraft. This will increase airplane efficiency, reduce fuel consumption, lower greenhouse gas emissions and reduce maintenance. Professor Dan Li at Monash Engineering has invented a cost-effective and scalable way to split graphite into microscopic sheets and introduce ions or molecules between the layers to form a stable graphene gel.

Professor Li has produced next generation super-capacitors, where improved performance of the gel allows for more than a 3-fold increase in storage capacity. The gel can also be converted into a high strength, highly porous and elastic graphene foam for use as a biosensor and tissue scaffold. This technology and its applications have been licensed to SupraG Energy as a Monash spinout company backed by private investment for use in renewable energy storage, portable electronics and electric vehicles.



MONASH University



NANOTECHNOLOGY

Nano Lab facilitating research and education

ELECTRICAL AND ELECTRONIC ENGINEERING

Wearable Technology

Swinburne's Nano Lab, housed in a clean room in the Advanced Technologies Centre, has a suite of tools capable of three-dimensional and traditional two-dimensional structuring, device fabrication and materials processing. Researchers use the laboratory to explore a wide range of phenomena including light propagation, absorption and scattering by nanoparticles and nanostructures, and the efficiency of nanofabrication. Areas of research include solar cells, light harvesting and fabrication of surfaces for photo-catalytic application. Applications of this research include the mass production of sensors that can be used for detection of Alzheimers bio-markers, the development of black silicon which has a bactericidal effect and has biomedical applications and the creation of unique and new nanomaterials using ultra-short laser pulses.

Victoria University researchers in partnership with Melbourne based company Ventou are developing a new wearable technology that will allow wearers to control devices in an augmented/ virtual reality setting.

The research team are developing a wearable glove based on Ventou's new conductive textile technology and Victoria University's wireless body area network research. Prototype software applications are being developed across a multiplatform ecosystem and will demonstrate integration of sensor data from an external network of sensors with augmented and virtual reality.

In these applications, the glove will provide users with a more natural way to manipulate objects that they see in devices such as the Google Glass and Oculus Rift. The technology once developed has the potential to be deployed in a large array of industries from real time gesture manipulation of virtual data in health and sports, to enabling dexterous handling of virtual objects in training programs for industrial manufacturing and defence.







PHARMACOLOGY AND PHARMACEUTICAL SCIENCES

Drug development

HUMAN MOVEMENT AND SPORTS SCIENCE Do some athletes carry the injury gene?

The Monash Institute of Pharmaceutical Science has leading researchers in the area of modulating activity of G-protein coupled receptors (GPCRs) which are drug targets for a large number of existing pharmaceuticals. GPCRs sit on the surface of cells, interacting with molecules to activate chemical processes inside the cell. There are hundreds of types of GPCRs and while some medicines currently on the market work via GPCRs there are many more that remain targets for the development of new drugs.

The Monash Institute of Pharmaceutical Science has developed GPCR expertise comprising technology, research facilities and world leading scientists that enable it to conduct fundamental research, drug discovery and preclinical drug development activities on GPCR targets. The therapeutic potential includes fields such as metabolism, cardiology, neurology and psychiatry, rheumatology, and oncology.

Monash is involved in a significant collaboration with Servier, a French pharmaceutical company, to develop new drugs against GPCRs. Scientists are investigating whether certain genes can make you more prone to injury in sport.

Victoria University and a team of international researchers are gathering genetic profiles from people who have ruptured their Anterior Cruciate Ligament, or ACL, in search of a common genetic thread.

ACL rupture is one of the most severe musculoskeletal soft tissue injuries in sport and is often career-ending for athletes, particularly in ball sports such as football and soccer.

Previous studies with smaller samples suggested a link between the collagen genes controlling ligaments and tendon structure in humans and susceptibility to injuries such as ACL rupture. This is the first large-scale study to test whether this gene actually predicts such injuries. It could also lead to the discovery of other genetic compounds that may be associated with ACL injuries.







PHARMACOLOGY AND PHARMACEUTICAL SCIENCES

Chemists make promising TB find

NEUROSCIENCES Neuroimaging in epilepsy

A Deakin University team has discovered a group of molecules that target and kill tuberculosis (TB) bacteria through the pioneering approach of 'click chemistry'. In 2014, the Deakin team synthesised 50 previously unknown molecules, several of which show outstanding promise for combatting TB, while others have gold standard potential for targeting prostate cancer. The molecules have been successfully tested by the US National Institute of Allergy and Infectious Diseases and could help to combat the current global TB pandemic. Arrival of a new drug on the market could be critical, given the disease's growing resistance to current drug treatments. In collaboration with Melbourne's St Vincent's Hospital, Swinburne's Brain and Psychological Sciences Research Centre has developed a revolutionary imaging technique to locate and help plan surgical treatment for patients with focal epilepsy. The condition affects about 40 per cent of all epilepsy sufferers (approximately 100,000 in Australia). The technique uses magnetoencephalography, or MEG, a noninvasive way of reading and measuring the magnetic signals generated by brain activity, and locating their source. Used in combination with electroencephalography, MEG is opening a new window into the processes and the precise location of the electrical storms that trigger an epileptic event.





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Medical and Health Sciences									
Medical and Health Sciences			•	•		•	•		
Medical Biochemistry and Metabolomics									
Cardiovascular Medicine and Haematology									
Clinical Sciences									
Complementary and Alternative Medicine						•			
Dentistry									
Human Movement and Sports Science			•						
Immunology									
Medical Microbiology									
Neurosciences									
Nursing		•							
Nutrition and Dietetics									
Oncology and Carcinogenesis									
Ophthalmology and Optometry									
Paediatrics and Reproductive Medicine									
Pharmacology and Pharmaceutical Sciences									
Medical Physiology									
Public Health and Health Services							•		
Other Medical and Health Sciences									
Built Environment and Design									
Built Environment and Design					•				
Architecture					•				
Building								•	
Design Practice and Management							•		
Urban and Regional Planning							•		

above world standard



ARCHITECTURE AND DESIGN

PUBLIC HEALTH AND HEALTH SERVICES

Getting to the heart of disease in vulnerable communities

The IHearYou® System is designed to put patients in control of their own hearing. Consisting of hearing aids and online services, a Bluetooth enabled programmer is used to connect hearing aids to a smartphone application. This allows patients to tune their own acoustic preferences without the need for a trained audiologist.

Blamey Saunders Hearing has collaborated with RMIT's Leah Heiss, Planet Innovation, SRX Global, Hearing Lab Technologies, Commercialisation Australia and the Victorian Government to design the system and bring it to market.

The design was awarded the Good Design Australia's inaugural Social Innovation Design Award for its innovative approach to accessible design and business model.

Image credits: Narelle Portanier, courtesy Blamey Saunders Hears.

Non-communicable disease states impose a particularly high burden in vulnerable communities in transition from traditional lifestyles towards more sedentary behaviours and salty, more saturated fat-laden diets. The consequence of premature morbidity and mortality is particularly high among women and younger individuals when compared to affluent communities. Researchers at the Mary MacKillop Institute for Health Research at Australian Catholic University have been at the forefront in research that highlights and responds to this challenging phenomenon with a particular focus on the health of Indigenous Australians and those living in the urban townships of sub-Saharan Africa. Seminal studies conducted by MacKillop researchers include the unique Heart of the Heart Study in Central Australia and the world-renowned Heart of Soweto Study in South Africa.







PSYCHOLOGY AND COGNITIVE SCIENCES

Innovations in motor and cognitive rehabilitation using virtual-reality (and other new technologies)

Research in Australian Catholic University's Centre of Disability and Development Research has been geared to knowledge translation in the field of neurorehabilitation, in both children and adults. The Centre has developed two innovative virtual-reality based solutions – Elements and Resonance – for rehabilitation of hand function in children with neurodevelopmental disorders and in adults with brain injury. These systems were developed with the support of two Australian Research Council Linkage Grants, and two partner grants from the Australia Council for the Arts.

The results of several clinical evaluations indicated that patients found the Elements system engaging and easy to use. Patients' movement skills improved significantly, and, importantly, the treatment transferred positively to day-to-day functioning. These results were shown for adults with a traumatic brain injury and children with various forms of hemiplegia resulting from cerebral, stroke and other conditions. The outcomes of Resonance evaluations are ongoing.

ECONOMICS Homeless or at risk of homelessness

The University of Melbourne hosts the *Journeys Home Survey*, a national longitudinal study following people experiencing homelessness or at risk of homelessness. The study, undertaken by the Melbourne Institute of Applied Economic and Social Research and funded by the Australian Government Department of Social Services, analyses the social, economic and personal factors that contribute to homelessness. The Journeys Home data is the largest and most comprehensive study of its kind and contributes to policy and service provision of individuals experiencing homelessness or at risk of falling into homelessness.

Journeys Home will be used by policy makers, academics and service providers to understand the needs and experiences of Australians in the field of housing and will help all levels of government to provide better services to people who have living and housing challenges. The recently completed study is anticipated to have ongoing impact on policies and programs.





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Education									
Education	•			•		•			•
Education Systems	•	•				•			
Curriculum and Pedagogy	•	•							
Specialist Studies in Education				•	•	•			•
Economics									
Economics		•		•					
Economic Theory									
Applied Economics		•		•		•			
Econometrics									
Commerce, Management, Tourism and Services									
Commerce, Management, Tourism and Services		•							
Accounting, Auditing and Accountability				•					
Banking, Finance and Investment		•				•			
Business and Management	•	•					•		
Commercial Services		•							
Marketing		•				•	•		
Tourism				•	•				•
Transportation and Freight Services				•					
Studies in Human Society									
Studies in Human Society	•	•	•	•		•			
Anthropology				•	•				
Criminology		•						•	
Human Geography					•				
Policy and Administration				_		-		-	
Political Science	-			-	-			-	
				-	-			-	
Psychology and Cognitive Sciences	-			-					
Psychology and Cognitive Sciences									
Psychology				-					
Cognitive Sciences									

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Law and Legal Studies										
Law and Legal Studies	•	•		•		•				
Law	•	•		•		•				
Studies in Creative Arts and Writing										
Studies in Creative Arts and Writing		٠				•				
Art Theory and Criticism										
Film, Television and Digital Media		٠				•				
Journalism and Professional Writing									•	
Performing Arts and Creative Writing		٠		•						
Visual Arts and Crafts									•	
Language, Communication and Culture										
Language, Communication and Culture		٠								•
Communication and Media Studies		•								
Cultural Studies				•						•
Language Studies										
Linguistics										
Literary Studies		٠		•						
History and Archaeology										
History and Archaeology	•	•	•				•			
Archaeology										
Curatorial and Related Studies		٠								
Historical Studies										
Philosophy and Religious Studies										
Philosophy and Religious Studies		•		•				•		
Applied Ethics	•									
History and Philosophy of Specific Fields		•								
Philosophy		•		•						
Religion and Religious Studies								•	•	

For more information contact the International Education Unit, within the Victorian State Government, on +613 9651 9560 or email studymelbourne@ecodev.vic.gov.au

KEY A well above world standard

- above world standard
- at world standard

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