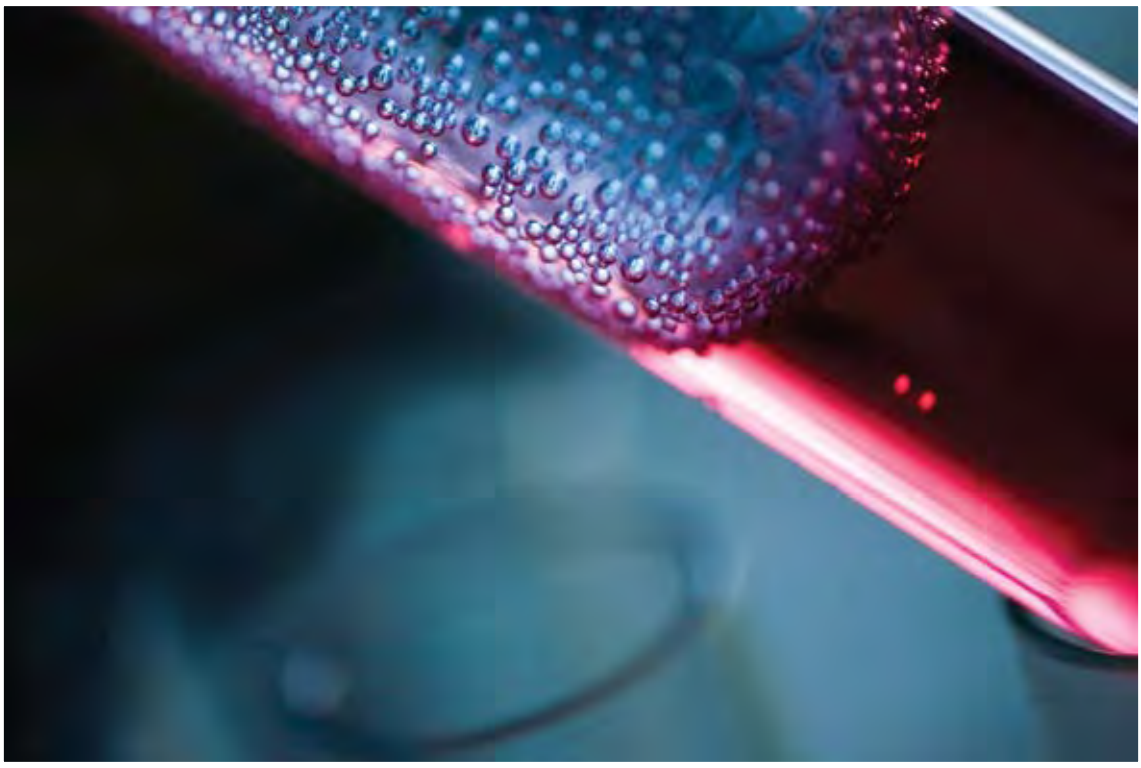
Riddet Institute

FOOD | INNOVATION | HEALTH

Annual Report 2008

for the year ended 31 December



A Centre of Research Excellence hosted by Massey University

The Riddet Institute brings together leading scientists from Massey University (host institution), the University of Otago, the University of Auckland, AgResearch Limited and the New Zealand Institute for Plant and Food Research Limited.

Riddet Institute
FOOD | INNOVATION | HEALTH

Riddet Institute

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CONTENTS

At a glance

The Riddet Institute is engaged in discovery-based scientific research into the structure and behaviour of complex food systems and how these interact with the consumer to influence quality of life.

The Institute is one of seven New Zealand government-funded **Centres of Research Excellence** (CoREs) and the only new CoRE since the scheme was set up in 2003. Partners in the national centre are Massey University, the University of Auckland, the University of Otago, AgResearch and Plant & Food Research.

The Riddet Institute commenced its CoRE research programme in mid-2008, and this is the Institute's first annual report.

Riddet Institute
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Massey University

Plant & Food RESEARCH
RANGAHAU AHUMĀRA KAI

UNIVERSITY OF OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

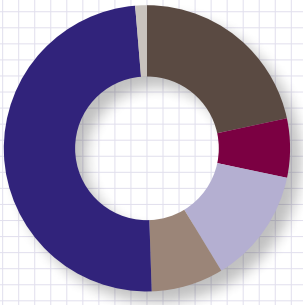
agresearch Farming, Food and Health. First

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

The Riddet Institute is named after Professor William Riddet (1898–1958), a pioneer in food science and university education.

Quick facts

Riddet Institute Income 2008
Total $6.37 million



>> *55 scientific staff nationwide*

>> *8 support staff*

>> *31 post-graduate scholars*

Our goal

The Institute's goal is to be a premier centre for original research and scholarship, delivering measurable and sustainable benefits to all segments of the New Zealand food industry, for the benefit of the nation.

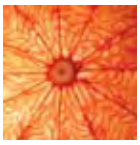
Strategies to realise the goal revolve around science and targeted knowledge transfer to underpin the development of innovative foods promoting health and wellness.

Indicators of success include:

- demonstrable and major benefits to individual sectors of the industry, the industry as a whole and New Zealand's economy
- recognition by industry and government that real benefits have been achieved and that the Riddet Institute has established its own clear and unique role.

Strategic priorities

- World-class fundamental and strategic research.
- Developing human capital (tomorrow's leaders).
- Transferring new knowledge and technologies.
- Partnering with industry to identify, capture and develop intellectual property.
- Exceptional international academic and industrial networks.






• Research project

Tea study to highlight health properties

Dilmah has commissioned the Riddet Institute to study the health properties of tea. Master's student Shiromani Jayasekera is studying how location, season and method of processing affect the chemical composition and antioxidant properties of tea.

Photograph: Paul Moughan and Dilmah founder Mr Merrill J. Fernando

Highlights 2008

- Formal establishment agreements with partner organisations and the Tertiary Education Commission finalised, Governance Board appointed and key managerial appointments made.
- Rebranding of Institute and shift to new premises completed.
- Installation and commissioning of $1.6m of new scientific equipment.
- A major contract with ZESPRI Group Ltd to manage its health and nutrition research programme.
- Agilent Foundation donates state-of-the-art analytical equipment.
- A Steering Committee, including key industry partners, established to oversee the development of a new industry/government-funding initiative leveraging off the Riddet Institute.
- Textbook edited by Riddet Institute staff and published by Academic Press – *Milk Proteins: From Expression to Food* – is launched.
- Riddet Foodlink established and 40 food companies join.
- Publication of special editions of the journals *Innovation: Management, Policy and Practice* and *Journal of the Association of Official Analytical Chemists* edited by Riddet Institute staff.
- Riddet Institute enters a major international collaboration involving participants from four countries: Australia, Canada, Greece and New Zealand. The International Food Research Collaboration (IFRC) is an international research consortium focused on the identification of global trends and challenges in agri-food systems.

• Graduate news

Graduate is expert in HPLC techniques

Maggie Zou graduated from Massey University with an MSc in Nutritional Science in 2008, having undertaken a study on human energetics, and is now working at the Riddet Institute on CoRE projects. She is also undertaking work for ZESPRI Group Ltd.

Chairman's report

I accepted the role of Chairman of the Riddet Institute with a great deal of enthusiasm, because I believe the creation of a Centre of Research Excellence around the Institute gives it the ideal positioning to make a real difference to scientific food research in this country.

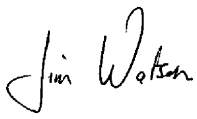
It seems to me that one of the great challenges of our time is the food crisis and the sustainability of our planet. The rising demand from developing and urbanising nations – India, China, Brazil and Russia – is putting huge pressure on food supplies while, at the same time, urbanisation is decreasing the amount of land available for agriculture. Greater input costs for farmers and climate change are reducing the amounts of food produced. The push to renewable fuels made from food crops is also increasing food shortages. In the developing world, where obesity and the metabolic syndrome are prevalent, there is a new push towards healthier foods.

As a nation dependent on food exports for its standard of living, New Zealand producers and processors now, more than ever before, have an enormous opportunity, but they have to get smarter to increase their margins. Scientific research can lift those returns and help create foods that command high premiums, promote health and wellness and, above all, appeal to consumers' tastes.

Already, within the Centre of Research Excellence framework, researchers from universities and Crown research institutes are working together to bring New Zealand up to world-class food science research standards. Our efforts will not stop here, however, and currently, the Co-directors are engaging in a further initiative to establish a Food Innovation Centre, which will be an augmented Riddet Institute, located alongside the hub of agri-food expertise in New Zealand in and around Massey University's Manawatu campus. This will offer a more effective scientific resource as well as improved linkages with industry and along the agricultural value chain from gate to plate.

We will continue to look for more opportunities to build capability in food scientific research. There is no doubt that the world economy is in crisis, but out of crisis comes opportunity, and I am confident that, in the years ahead, the Riddet Institute will lead the way and underpin New Zealand's ascent in the global smart food market.

Finally, I would like to pay tribute to the foundation Co-directors of the Riddet Institute – Professors Paul Moughan and Harjinder Singh – for skilfully establishing the fundamentals of what will be a premier internationally acclaimed research centre.



Dr James Watson
Chairman

"The Riddet Institute is significant in the development of a world-class food industry in New Zealand."

Steve Maharey
Vice-Chancellor, Massey University

Directors' report

It is our distinct pleasure to present the Riddet Institute's first formalised annual report.

The Riddet Institute was first established as the Riddet Centre in 2003 and, from its very inception, was successful in attracting considerable research funding from both New Zealand funding bodies and, notably, the international food industry. Such support has allowed a highly innovative research programme to flourish and a reputation to be secured. Most importantly, it has led to tangible knowledge-transfer to the New Zealand food industry, increasing the industry's international competitiveness.

We were delighted to learn in mid-2007 that the Riddet Institute was to be recognised as one of New Zealand's Centres of Research Excellence (CoREs) with funding to commence in July 2008. CoRE funding has allowed us to boost our suite of specialised scientific equipment, greatly extend and strengthen our collaborative linkages and put in place a longer-term strategically designed fundamental science platform, which provides critical underpinning of much of the work undertaken by the Institute. We are very appreciative of this crucial government support. Naturally, CoRE funding and status comes with particular responsibilities and obligations. The CoREs are inter-institutional research networks with researchers working together on a commonly agreed work programme. The Riddet Institute is, in effect, a national centre for scientific innovation in foods and health.

The government's vision for CoREs is that they:

- establish and promote excellent, collaborative, strategically focused research
- create significant knowledge transfer
- provide opportunities for the creation and diffusion of knowledge not available through other existing funds
- encourage tertiary education institutions to develop relationships and linkages with other research organisations, enterprises and communities that they serve.

The vision is embodied in three objectives:

- Excellent (world-class) quality.
- Focused on New Zealand's future development.
- Significant knowledge-transfer activities (including the training of future researchers).

The Riddet Institute is clearly meeting these key objectives and actively embodies the government's vision for the CoREs. A truly first-class multi-disciplinary team of scientists and support staff has been assembled spanning Massey University (the host of the CoRE), the University of Otago, the University of Auckland, Plant & Food Research and AgResearch and incorporating individual researchers from Victoria University of Wellington, the University of Canterbury and Fonterra Co-operative Group Ltd.

The Riddet team is working harmoniously and enthusiastically, and it is pleasing to note that completely new scientific synergies are beginning to emerge. An inclusive, forward-looking culture has been established that is not only generating top science but is also spilling over to our numerous wider community-related activities. A critical mass of scientific expertise in food and nutrition is accessible to industry and the New Zealand public. CoREs quite rightly have the highest of aspirations. If such aspirations are to be achieved, however, tightly linked and highly focused inter-disciplinary scientific teams are required. The Riddet team meets these criteria. We were pleased to recently receive positive external endorsement on the scientific quality of our programmes, via a written report from the initial appointee to our Scientific Advisory Board, Professor Eric Dickinson:

The major aim of the Riddet CoRE programme is to enhance knowledge and understanding of the way in which food components and structures are transformed and absorbed during the human digestive process. From the high calibre of presentations within the Future Foods theme, it seems clear that world-leading research is already underway involving Institute staff and their international collaborators … it appears that a dynamic and exciting research programme has been established.

Professor Eric Dickinson

Professor of Food Colloids, Procter Department of Food Science, University of Leeds

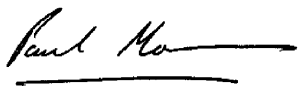
continued >>

The Riddet Institute has three overarching research themes: Functional Foods; Future Foods – Inspired by Nature; and Personalised Foods. We invite you to read more about our scientific enquiry into these areas elsewhere in this report. A special feature of the Riddet Institute is the close relationship we maintain with the New Zealand food industry, our key stakeholders. The Institute has a pivotal role in transferring knowledge to industry and in providing highly trained graduates for industry placement. In this way, we assist in innovation within the New Zealand economy. Our interconnectedness with industry has been greatly enhanced over the last year with the establishment of Riddet Foodlink, the purpose of which is to foster exchange of information between the Institute and the New Zealand food industry so our research is targeted at key market opportunities.

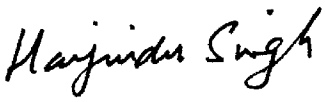
Our ongoing promise to New Zealand is that the Riddet Institute will pursue excellence, strategic focus, transparency, connectedness and accountability. Our aim is to be the premier research organisation in food science.

As this report goes to press, we are in negotiation with government and several major food companies to invest yet further to enhance New Zealand's capacity for food innovation based on leading science and built around an augmented Riddet Institute model. A considerable opportunity exists right now to use clever science to add significant value to New Zealand's food exports. As a nation, we are under-investing in this crucial sector.

Our first six months of activity under CoRE funding has been exciting and progressive, although, of course, not without the inevitable challenges that come with amassing a large inter-disciplinary, cross-institutional science team. Significant progress has been made, which will be built on in the following years. We would like to thank all stakeholders associated with the Riddet Institute and especially our Board members, our Chairperson, the Vice-Chancellor of our host institution and staff of the Tertiary Education Commission, who have all so willingly assisted us. Nothing would have been achieved, of course, without the dedication of our team of research scientists, support staff and post-graduate scholars. To all these individuals, we are most grateful.



Distinguished Professor Paul Moughan
Director



Professor Harjinder Singh
Director

• International links

Japanese collaborations initiated

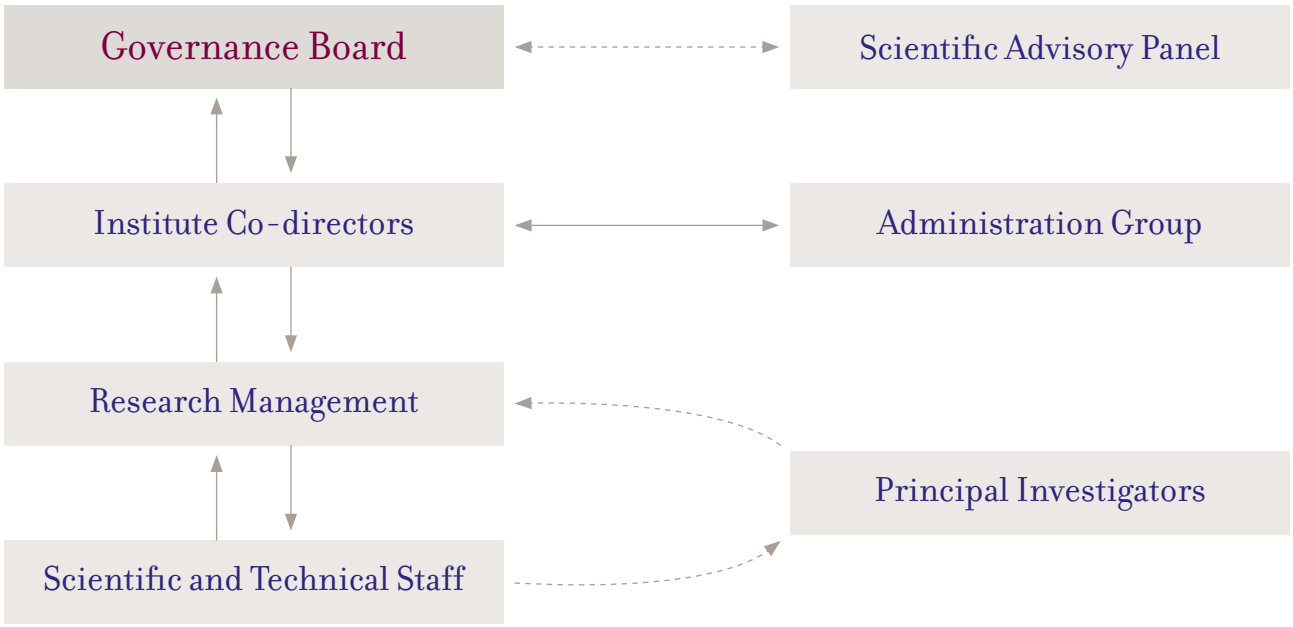
Professor Paul Moughan was part of a government-funded delegation to Japan to initiate collaboration with Japanese research and food organisations. The visit strengthened the Riddet Institute's existing collaborative alliance with Kumamoto University, provided an opportunity to work collaboratively in the area of omega-3 fatty acid enrichment of foods with the Tokyo University of Marine Science and Technology and forged a closer interaction with the Centre of Excellence at the University of Shizuoka.

Organisational structure

The Governance Board oversees the strategic decisions and direction of the Institute and has an advisory role. The Co-directors report to the Board and oversee the Administration Group, which is responsible for day-to-day operations.

The Research Management Group comprises the Co-directors and the Principal Investigators from the partner organisations, who, in concert, develop the science plan and oversee its execution.

The CoRE programme is led by 11 Principal Investigators, including the Institute's two co-directors, Professors Paul Moughan and Harjinder Singh. In addition, there are 22 Associate Investigators carrying out projects assisted by a number of PhD students and contractors.



• International links

Hungarian collaboration

A visit from the Rector (Vice-Chancellor) of Kaposvár University in Hungary has resulted in an invitation to the Riddet Institute to be part of the FP7 funding round in the European Union. Professor László Babinszky spent a day at the Institute in October to begin the process of forming closer research and teaching relationships.

Our people

Board of Directors

Dr James (Jim) Watson is well known in New Zealand scientific and business circles as the founder and CEO of Genesis Research and Development, a past president of the Royal Society of New Zealand and past chair of the National Science Panel. He has had a long career in Health Sciences and has held professorships at the University of California, Irvine and the University of Auckland.

Professor Robert Anderson is Pro Vice-Chancellor, College of Sciences based at the Massey University Manawatu campus. He first joined Massey University in 1971 and has a PhD degree from Cornell University, USA. In 2007, Professor Anderson was made an Officer, New Zealand Order of Merit.

Dr Jeremy Hill is Group Director Technology at Fonterra Co-operative Group Ltd. He graduated from Hull University in 1987 with a PhD, joined the staff of the New Zealand Dairy Research Institute (NZDRI) as a research scientist in 1991 and became Deputy Chief Executive of the NZDRI in 2000. He is President of the National Committee of the International Dairy Federation.

Mr Peter Landon-Lane is CEO of Plant & Food Research, joining the company in September 2008 from Fonterra where he had held a number of senior positions in New Zealand, Japan, Taiwan and Europe. Prior to entering the dairy industry in 1991, he worked with the Department of Trade and Industry (now NZTE) holding Trade Commissioner roles in China and the Philippines.

Professor Vernon Squire is currently Pro Vice-Chancellor, Sciences, at the University of Otago. He has a DSc from the University of Wales and graduated with a PhD from Cambridge where he was also employed subsequently for several years. He left the UK in 1987 to take up the post of Professor of Applied Mathematics at the University of Otago.

Dr Andrew West has been the Chief Executive of AgResearch since May 2004. In the late 1980s and early 1990s, Dr West played a major role in the New Zealand government's science reforms. In the late 1990s, he was Chief Executive of Crown research institute Geological and Nuclear Sciences Ltd. In 2001, he was Chief Executive of the New Zealand Qualifications Authority, and from 2001 to 2004, he was Executive Chairman of the Tertiary Education Commission.

Co-directors

Distinguished Professor Paul Moughan graduated PhD from Massey University in 1984 and was awarded Doctor of Science in 1996. He received the Distinguished Professor Award from Massey University in 2005 following international peer review. He has published in excess of 300 scientific works and is a Fellow of the Royal Society of New Zealand. Professor Moughan was co-founder of the Riddet Institute in 2003 and, prior to that, was Head of the Institute of Food, Nutrition and Human Health at Massey University.

Professor Harjinder Singh is co-founder of the Riddet Institute. He graduated PhD in Food Science and Technology from the National University of Ireland, University College Cork, in 1986. He is a Fellow of the Royal Society of New Zealand and Fellow of the International Academy of Food Science and Technology. He was awarded the Massey University Research Medal in 2008. He is ranked in the top 15 in the world among agricultural scientists for citations.

Administration Group

Dr Mike Boland (Executive Officer and Principal Scientist)

Dr Boland joined the Riddet Institute in 2006 after 15 years in the dairy industry, first with the New Zealand Dairy Research Institute and then with Fonterra. During this time, he headed a group involved in protein research and was General Manager for Strategic Research. He was also Global Programme Leader for the New Zealand Dairy Board's Milk Characteristics programme, running a research portfolio with a budget of around $8m p.a.

Mr John Henley-King (Projects Manager)

Mr Henley-King has a degree in engineering from the University of Cambridge and spent 10 years working as a process engineer, primarily in the pulp and paper industry in Europe. He moved to Palmerston North in 1997 to take up a role in the Department of Process and Environmental Technology at Massey University. He worked in a variety of roles at Massey, including brokering research projects with industry and technology commercialisation, before joining the Riddet Institute as Projects Manager in May 2008.

Ms Paula McCool (Communications Officer)

Ms McCool has over 30 years' experience in journalism and communications. She previously worked for the Crown research institute HortResearch, based in Manawatu, and then for Vision Manawatu, an economic development agency, as Communications Manager. Her current role is to increase awareness about the work of the Riddet Institute and maintain its profile as a Centre of Research Excellence.

Mrs Terri Palmer (PA to the Directors)

Mrs Palmer has been at Massey University in various roles in the College of Sciences for 20 years including eight years in the Institute of Fundamental Sciences. She joined the Riddet Institute in 2006. She is currently completing a Bachelor of Business Studies.

Mrs Fliss Stibbards (Business Administrator)

After managing her own retail business for many years, Mrs Stibbards joined Massey University in 1996. In 2006, she joined the staff of the Riddet Institute on a part-time basis. Her main duty is managing the Institute's accounts.

Ms Willi Twight (Operations Manager)

Ms Twight joined the Riddet Institute in 2008 after seven years at Fonterra Co-operative Group Ltd in Palmerston North. Before that, she had a variety of roles in both Auckland and Hamilton. Her current role encompasses human resources, health and safety issues and general administration.

Principal Investigators

Professor Richard Archer holds a Doctor of Philosophy in Biotechnology from Massey University, where he is currently Professor and Head of the Institute of Food, Nutrition and Human Health. He is a Fellow of the Institution of Professional Engineers of New Zealand and, prior to his current role, was Professor and Head of the Institute of Technology and Engineering at Massey University. Professor Archer's career has focused on process engineering research and its commercialisation.

Professor Geoff Jameson graduated with a PhD from Canterbury University in 1971. He then spent nearly 20 years overseas in Switzerland and at the University of Georgetown in Washington DC before joining Massey University in 1994. Professor Jameson is Professor of Structural Chemistry and Biology and Director of the Centre for Structural Biology in the College of Sciences, Massey University. He is a Fellow of the Royal Society of New Zealand.

Dr Nigel Larsen graduated from Massey University in 1980 with a PhD in Chemistry and is currently Science Group Manager, Processed Foods at Plant & Food Research, Lincoln, Canterbury. He is widely recognised as an authority on the processing of foods and grains and is a specialist in bakery products.

Professor Warren McNabb has a PhD from Massey University and is currently Section Manager, Food & Textiles Group at AgResearch. Last year, he was appointed Adjunct Professor at Massey University. Professor McNabb holds the position of Eminent Research Scientist at AgResearch and is a Fellow of the New Zealand Institute of Agricultural and Horticultural Sciences.

Professor Jim Mann is a physician and is currently Professor of the Department of Human Nutrition and Professor of the Department of Medicine at the University of Otago. He is Director of the Edgar National Centre for Diabetes Research, Co-Director of the WHO Collaborating Centre for Human Nutrition and a Fellow of the Royal Society of New Zealand. Professor Mann is a Companion of the New Zealand Order of Merit. He was educated at the University of Capetown and the University of Oxford.

Professor Laurence Melton graduated with a PhD in Organic Chemistry from Simon Fraser University in Canada in 1971. He is Director of the Food Science Programmes at the University of Auckland and Professor of Food Chemistry. He is a Fellow of the Royal Society of Chemistry, a Fellow of the American Institute of Chemists and was a Fulbright Research Scholar.

Professor Andrew Pullan is head of the Department of Engineering Science at the University of Auckland. He graduated from the University of Auckland with a PhD in Engineering in 1988. He currently leads a research team of seven post-doctoral fellows and six PhD and Masters' students investigating a variety of biomedical problems. Professor Pullan is also an Adjunct Associate Professor, Department of Surgery at Vanderbilt University, USA.

Distinguished Professor Paul Singh graduated PhD in Agricultural Engineering from Michigan State University in 1974. He was inducted into the Food Engineering Hall of Fame in 2003 in the US. He is currently Distinguished Professor of Food Engineering at the University of California, Davis, California, where his responsibilities include research and teaching in food science and engineering. In 2008, he was elected to the US National Academy of Engineering.

Professor Gerald Tannock joined the University of Otago in 1974 and was awarded a Professorial Chair in 1996. He held a half-time position in the Department of Agricultural, Food and Nutritional Science at the University of Alberta, Edmonton, Canada from 2001 to 2005. He was awarded a Royal Society of New Zealand Silver Medal in 2000 for his contributions to science and technology and was elected a Fellow of the American Academy of Microbiology in 2002.

Associate Investigators

Dr Mike Boland	Massey University
Associate Professor John Bronlund	Massey University
Dr Lawrence Creamer, FRSNZ	Massey University
Professor Clive Davies, FRSNZ	Massey University
Dr Kevin Davies	Plant & Food Research
Professor Peter Derrick	Massey University
Dr David Everett	University of Otago
Professor Juliet Gerrard	University of Canterbury
Dr Paul Kilmartin	University of Auckland
Dr Julian Lee	Plant & Food Research
Associate Professor Roger Lentle	Massey University
Associate Professor Kate McGrath	Victoria University of Wellington
Professor Robert McLachlan, FRSNZ	Massey University
Dr John Monro	Plant & Food Research
Dr Gill Norris	Massey University
Professor Charmian O'Connor, FRSNZ	University of Auckland
Professor David Parry, FRSNZ	Massey University
Dr Nicole Roy	AgResearch
Dr Tanya Soboleva	AgResearch
Professor Graeme Wake, FRSNZ	Massey University
Dr Bill Williams	Massey University
Professor Ray Winger	Massey University

Resident Fellow

Dr Lawrie Creamer	

Researchers

Dr Libei Bateman	Research Associate
Jian Cui	Technologist
Dr Derek Haisman	Senior Technical Adviser
Dr Simon Loveday	Research Officer
Dr Kay Rutherfurd	Senior Lecturer
Shane Rutherfurd	Senior Research Officer
Dr Jaspreet Singh	Research Officer
Amit Taneja	Research Officer
Dr Aiqian Ye	Senior Research Officer
Dr Xiang Zhu	Technologist
Maggie Zou	Research Associate

Post-doctoral Fellows

Dr Anil Anal
Dr Ajay Awati
Dr Sharon Henare
Dr Jason Hindmarsh
Dr Lovedeep Kaur
Dr Kyoung-Sik Han

Technical Staff

Valentine Borges
Janiene Gilliland
Chris Hall
Thanuja Herath
Nok Sawadeenaruenat
Ranjita Sengupta
Michelle Tamehana
Namrata Taneja

Resident Visiting Scientists

Professor Andy Rao	Cornell University, USA
Professor David Horne	Scotland
Dr Ruzita Ahmad	Universiti Sains Malaysia
Professor Jim Harper	Ohio State University, USA
Dr Shantanu Das	PepsiCo Inc

Post-graduate students supervised by the Riddet Institute 2008

NAME	SUPERVISOR	DEGREE	CoRE FUNDED
Amelie Déglaire*	P Moughan	PhD	
Visaka Anantawat	H Singh	PhD	
Jiahong Su	H Singh	PhD	
Leah Coles	P Moughan	PhD	
Daniel Ries	H Singh	PhD	
Sylvia Chung	P Moughan	PhD	
Warren Miner-Williams	P Moughan	PhD	
Shiromani Jayasekera	P Moughan	MSc	
Prabhu Balan	P Moughan	PhD	
Emmanuelle Riou	H Singh	PhD	
Anwesha Sarkar	H Singh	PhD	
Rangita Sengupta	W McNabb	PhD	√
Amit Taneja	H Singh	PhD	
Janina Kuhn*	H Singh	PhD	
Maggie Zou*	P Moughan	MSc	
Xiang Li Wang	H Singh/S Loveday	MSc	
Arup Nag	K Han	MSc	
Dulantha Ulluwishewa	W McNabb	PhD	√
Mallesh Peram	H Singh/S Loveday/A Ye	PhD	
Christina Streicher	A Ye	MSc	
Samantha Noel	R Lentle	PG Dip	√
Davide Mercadante	L Melton	PhD	√
Ofir Benjamin	D Everett	PhD	√
Muhammed Azeen	K McGrath	PhD	√
Lisa Te Morenga	J Mann	PhD	√
Megan Levers	J Mann	MSc	√
Teresa Wegrzyn	R Archer	PhD	√
Sandra Kim	R Archer	PhD	√
Hongyan Yuan	K Foster	PhD	√
Richard Sun	P Xu	PhD	√
Lakshmi Chaitanya	R Love	PG Dip	√

* Graduated 2008

Interns 2008

Kristina Bak Japelt	University of Copenhagen, Denmark
Thilo Berg	Technical University of Berlin, Germany
Anne Dartois	ENSAIA, Nancy-Université, France
Daniela Endt	Technical University of Berlin, Germany
Aubree Le Floc'h	IUP IIA, Pole Universitaire, France
Michäel Foucault	ENSAIA, Nancy-Université, France
Charline Le Lann	UBO, University of Western Brittany, France
Louise Lee	University of California, Davis, United States
Katja Mader	University Hohenheim, Germany
Audrey Mascle	Agro Paris Tech, France
Lucille Le Mene	IUP IIA, Pole Universitaire, France
Lotte Boge Sorensen	University of Copenhagen, Denmark
Carina Svendsen	University of Copenhagen, Denmark

Science overview

Our goal is to generate essential underpinning knowledge that will provide the base of tomorrow's innovations in advanced foods.

Our research focuses on the nexus of food science and human nutrition.

We have structured our research into three broad themes, driven by multi-disciplinary teams:

- Future Foods – Inspired by Nature (CoRE research programme)
- Functional Foods and Ingredients
- Individualised Foods, including Personalised Nutrition.

The research activities in the theme Future Foods –Inspired by Nature are fully funded by the New Zealand Tertiary Education Commission, while the other two themes are funded by the Foundation for Research, Science and Technology, the New Zealand food industry and the international food industry.

Future Foods – Inspired by Nature

The following overview of our CoRE science projects covers the period from 1 July to 31 December 2008. Although our contract with TEC commenced in January 2008, the science programmes were not set up and funding did not commence until July 2008.

Our initial focus is on novel foods that address obesity, weight management and gut health.

By coupling understanding of how food structures change as they traverse through the entire gastrointestinal tract (GIT) with metabolic and physiological consequences, it will be possible to design foods explicitly for a new generation of health and sensory attributes.

'Natural' structures in foods not only provide textures and flavours and supply nutrients, but also support metabolic regulation of energy and the controlled absorption of nutrients and bioactive compounds. Our hypothesis is that food behaviour post-ingestion, and the consequent availability of nutrients, can be managed through selecting and manufacturing of food ingredients to produce food structures that will control the release of nutrients and bioactive molecules. These 're-engineered' structures will mimic the functions of the 'natural' structures and will change in response to external stimuli in a predictable manner, for example, they may be digested rapidly enough to be an efficient delivery carrier of nutrients and bioactive molecules, but slowly enough to preserve the structure during the tasting and perception processes.

We have organised our Future Foods science programme into four platforms, bringing together for the first time in New Zealand a diverse set of disciplines – chemistry, biophysics, mathematics, engineering, biology, materials science, colloid chemistry, digestive physiology, nutrition, and microbial ecology. We actively promote research interactions across platforms and projects, ensuring a high degree of interconnectedness.

The four platforms are:

- Food Materials and Structures
- Gastrointestinal Biology
- Modelling and Engineering
- Innovative Food Solutions.

Food Materials and Structures

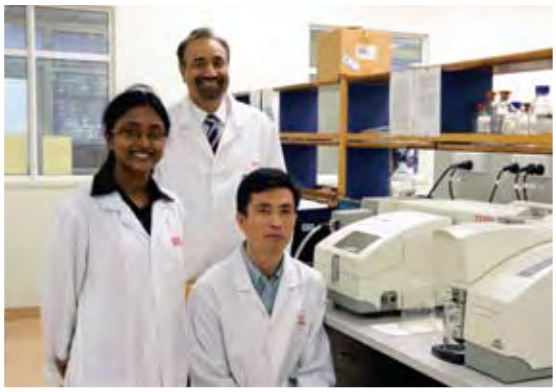
We want to determine underlying fundamental principles controlling the assembly, breakdown and behaviour of food structures and to understand how these processes work.

Project examples:

- Interfacial engineering and properties of food emulsions (Project leader: Professor Harjinder Singh).
- Ingredient interactions in complex foods (Project leader: Professor Laurence Melton).
- Protein self-assembly and nanostructures in foods (Project leader: Professor Geoff Jameson).

Case study

Emulsions hold the key to controlling lipid digestion in the body



Anwesha Sarkar, Professor Harjinder Singh and Dr Aiqian Ye.

In modern processed foods, fat (lipids) from plants and animals is put into food in the form of emulsions. Examples include spreads, imitation creams, salad dressings, gravies, sauces, soups, confectionery and chocolate. Lipids play a major part in determining the texture, flavour and taste profile of these foods, and they provide essential fatty acids that the human body cannot produce itself. They also act as carriers of pre-formed fat-soluble vitamins (vitamins A, D, E and K).

Some food researchers are beginning to realise that the behaviour of emulsions in the gastrointestinal tract is affected by their physico-chemical properties and that they modulate fat digestion and consequently influence the bioavailability of lipid nutrients. This area of research needs to be further developed before the knowledge can be used to develop specific strategies for controlling fatty acid absorption and bioavailability.

The emulsion science research undertaken by Professor Harjinder Singh, Dr Aiqian Ye and PhD student Anwesha Sarkar is at the forefront of this new field. They want to know how the action of lipase is modified by the composition and the structure of adsorbed layers on the emulsion droplet surface, the role of bile salts in exchanging/displacing original emulsifying material from the emulsion droplet, the final state of the droplet when it is ready to be absorbed and how the emulsion droplets interact with enterocyte membranes for transport into the blood system. Finding this out will help to design functional foods that could manipulate the bioavailability of fatty acids, which will aid people with high blood lipid levels and at a high risk of cardiovascular disease and obesity.

Creating food emulsions requires generating stable oil-water interfaces, which are critical in determining the interactions of droplets with other components in foods. Phospholipids and proteins can be used as emulsifiers, but monoacylglycerols and diacylglycerols also often feature as emulsifiers and stabilisers. Until recently, the research emphasis has been on understanding how the composition of interfaces of emulsion droplets can be manipulated to control the stability of emulsions in order to improve product quality.

Gastrointestinal Biology

The human gastrointestinal tract (GIT) is a fitting target for the development of specialised functional foods, acting as it does as the interface between diet and the metabolic events that sustain life. We want to understand how the GIT functions and how it processes different diets and food materials.

Project examples:

- Foods targeting nutrient uptake kinetics, satiety and gut function (Project leader: Professor Paul Moughan).
- The genetic and physiological basis for biotransformations of food (Project leader: Professor Warren McNabb).
- Dietary intervention targeting physiological endpoints (Project leader: Professor Jim Mann).

Case study

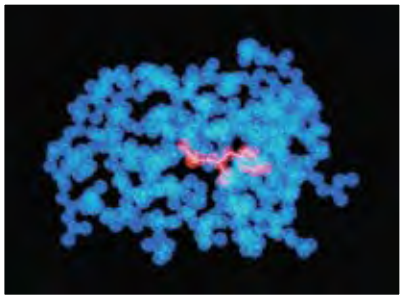
Discovering how bacteria transform digestion-resistant carbohydrates

Professor Gerald Tannock with students Charlotte Wilson and Kay Appleyard.

Professor Gerald Tannock from the University of Otago is devising novel methods that will reveal the types of bacteria associated with digestion-resistant carbohydrates (DRC) in human faeces and to understand how these bacteria carry out biotransformations of DRC. An important outcome of this work is likely to be the discovery of novel bacterial genes whose products are involved in the hydrolysis of complex polysaccharides.

Bacterial communities in the large bowel of humans utilise DRC as energy sources. The bacterial cells and metabolic products interact with the bowel mucosa and affect bowel physiology. Little is known of the degradative processes used by bowel bacteria in the utilisation of DRC. Indeed, the majority of the bacterial phylotypes (species revealed by nucleic acid-based analysis of communities) that inhabit the human bowel have not yet been cultivated in the laboratory.

Particulate DRC present in human faeces are being harvested in RNAprotect solution and examined by scanning electron microscopy to demonstrate the presence of attached bacteria involved in hydrolysis of the complex polysaccharide materials. RNA, extracted from the bacterial cells, is being used in a new technology known as meta-transcriptomics. This technology permits the sequencing of mRNA obtained even in tiny amounts from bacterial communities. High throughput pyrosequencing of the transcriptomes of the bacteria will therefore reveal the enzymes used in hydrolytic pathways. It is highly likely that many of these enzymes will be novel and may have biotechnological application in fermentation processes. The genes detected by meta-transcriptomics will be used as molecular probes to detect the hydrolytic bacteria on culture plates. New culture media and methods will need to be developed since the bacteria of interest are probably unknown and not yet cultivated in the laboratory.



Modelling and Engineering

We are developing advanced mathematical and computational models of aspects of the human gut and subsequent food processing systems, together with the experimental techniques and instrumentation required to validate the models. This platform underpins all the other platforms and, importantly, contributes to the development of innovative food formulations and of creative process specifications for food manufacturing.

Project example:

- Modelling of the human digestive process (Project leaders: Professor Andrew Pullan and Professor Paul Singh).

Case study

Disintegration of solid food – differences in breakdown



Professor Andrew Pulllan, Professor Paul Singh and Dr Maria Ferrua.

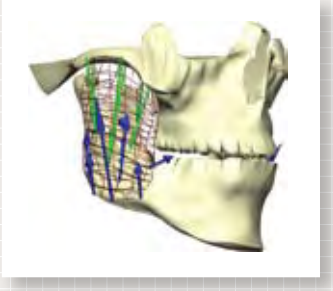
Professor Paul Singh from the University of California, Davis, and his team are developing a fundamental understanding of how solid foods disintegrate due to the combined influence of physical forces and biochemical reactions.

The digestion process in a human stomach depends on the biochemical environment and the flow field that causes mixing, grinding and dissolution of solid foods.

An *in vitro* system has been custom designed and constructed to mimic the same magnitude of physical forces as published from *in vivo* studies. The disintegration rate of several types of solid foods is being measured to develop quantitative models. For example, studies on almonds and carrots show that any steps used to process these products have a dramatic influence on how they break down in the simulated stomach environment.

Professor Singh's team has also developed a computational model of the predicted flow field. The next steps are to combine the results of the food disintegration studies and the computational model of the flow field to develop a predictive simulation of the human digestion process.

A parallel study has been undertaken by Professor Andrew Pullan from the University of Auckland, which investigates electrical activity within the stomach. This electric activity controls, affects and mediates motility (the ability to move spontaneously), contraction and digestion. He and his team are creating detailed mathematical models and validating them by carefully measuring electrical activity within the intact stomach. In 2008, his team made initial recordings of gastrointestinal electrical activity and also developed initial models of a human stomach.



Model of muscle force direction.

Innovative Food Solutions

We want to create completely new processes or processing routes for the development of new products, in particular, those that could deliver personalised high-quality food products.

Novel food concepts, processes and services are being developed based on the knowledge generated by all the research platforms and existing knowledge in the scientific literature.

Project examples:

- Technofoods (Project leader: Professor Richard Archer).
- Novel technologies for food extrusion (Project leader: Dr. Nigel Larsen).
- Future market directions (Project leader: Professor Ray Winger).

Case study

Novel technologies for food extrusion

Dr Richard Love, Lakshmi Chaitanya and Allan Hardacre.

A team is working on novel technologies for food extrusion to deliver new textural and nutritional properties in foods. For example, the injection of supercritical carbon dioxide into an extrudate (US Patent 5120559) has exciting potential to deliver shear- and temperature-sensitive nutritional extracts into extruded foods and, at the same time, deliver textures with enhanced sensory appeal.

High-power ultrasound (HPUS) is also commonly used in research as a means of disrupting inter-molecular interactions, and it has been the subject of recent research interest in polymer processing. Application of ultrasound to food processing (in addition to the use of low-power ultrasound for process measurement and control), such as continuous bread processes, was patented in 1970 (US Patent 3503343). However, the strong attenuation of ultrasound waves by food matrices such as bread dough cause problems with the application of this technology.

The project team comprises Dr Nigel Larsen (Science Group Manager, Plant & Food Research), Dr Richard Love (Lecturer, Massey IFNHH), Allan Hardacre (Scientist, Plant & Food Research), Dr Susie Meade (Scientist, Plant & Food Research) and Lakshmi Chaitanya (Post-graduate Diploma student, Massey IFNHH).

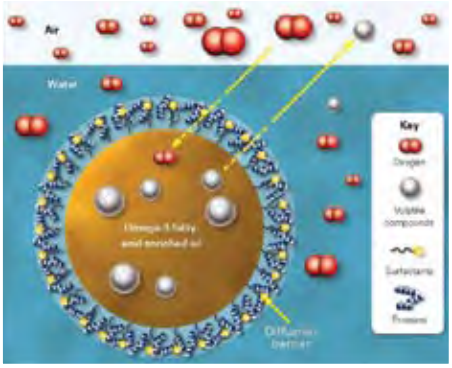
Ms Chaitanya is carrying out a review of extrusion technologies that use supercritical fluid, high pressure gases, ultrasound or vacuum applications to modify the texture and nutritional properties of extruded foods. This review will include patent literature and current actual use of these technologies in the food industry.

In parallel with this, the team will be conducting controlled studies and measuring changes in protein structures during extrusion to determine the methodologies and benchmarks that will define the effects of the texture-modifying application. Also under study will be the physical and chemical changes to food components during extrusion.

Functional Foods and Ingredients

Knowledge of foods and their formulations as they pertain to human health and wellness will allow industry to develop new functional foods and novel ingredients. To provide this knowledge, we have to understand the structures and functions of food materials and their functionality in terms of health effects, sensory attributes and other quality attributes.

We have made major progress in understanding the physico-chemical properties of protein and polysaccharide interactions, developing novel systems for encapsulation and delivery of bioactive compounds, developing *in vitro* digestibility systems that allow predictions of amino acid, fat and carbohydrate digestibility in complex foods, and understanding the effect of bioactive peptides on gut endogenous amino acid flow and identification of their mode of action. We have developed, patented and commercialised a novel encapsulation system for the delivery of omega-3 oils (see page 21).



Individualised Foods, including Personalised Nutrition

We have a highly original approach to the delivery of innovative foods and beverages customised for the individual and manufactured at point-of-sale. It brings together a truly multi-disciplinary team consisting of researchers with expertise in food engineering, computer engineering and robotics, food ingredient formulations and physical functionality, nutrient utilisation/functional foods and human/clinical nutrition.

We have successfully developed a patented point-of-sale manufacturing machine and associated computer software, able to interact directly with the consumer. We have made major progress in our understanding of the physical, functional and nutritional properties of food ingredients and bioactive compounds in relation to this challenging technological concept.

• Student success

Successful PhD student earned conjoint degree

Amelie Déglaire, co-supervised by Professor Paul Moughan and Professor Daniel Tomé, based in France, gained her PhD in Human Nutrition. Ms Déglaire came to New Zealand in 2004 from SupAgro, Montpellier to embark on her PhD studies into human protein metabolism. Her four years of study were divided between France and New Zealand.

Ms Déglaire will receive formal recognition of her degree from both Massey University and the University of Paris.

Realising our goals – knowledge transfer

Global opportunities for emulsion technology

Foods for health and wellness containing marine omega-3 fatty acids are among the fastest growing food product categories in the United States and Europe. But fish oils, a rich source of these acids, can't be added directly to food as they are susceptible to oxidation, leaving unpleasant fishy tastes and odours.

The Riddet Institute has found a way of adding significant quantities of omega-3 to foods using a unique nanotechnology-based micro-encapsulation technology that prevents oxidation. The technology, which has international patent protection, is owned by the Riddet Institute's joint venture company, Speirs Nutritionals Ltd, a partnership between the Riddet Institute, Massey University, the Bio Commerce Centre and Speirs Foods.

Speirs Nutritionals Ltd has a factory located in Marton, Rangitikei, for the production of the emulsion product. The company provides new employment opportunities (six staff) and offers great potential in the world-wide functional foods market.

Rodney Wong, Chairman, and David Speirs, General Manager, Speirs Nutritionals Ltd and Dean Tilyard, CEO, the Bio Commerce Centre.

Huge potential for New Zealand meat industry

Extensive work has been carried out by Riddet Institute researchers for the Meat Biologics Consortium to extract hydrolysates (proteins that have been broken down into peptides) from lamb meat. The aim is to produce convenient and effective dietary supplements for high-health functional foods that are particularly beneficial for older people and athletes.

As people age, they lose body protein and muscle mass. People training for sports also need to build and maintain muscles. The Meat Biologics product developed by the Riddet Institute is a food based on lamb muscle, which will have high absorption and utilisation within the human body. This material has been incorporated into a tasty soup, and our clinical studies prove that the amino acids are highly digestible and available. Metabolic studies have also been conducted that prove the efficacy of the material after it has been absorbed.

This study may lead to the first specialised meat-based products in the global market, providing the New Zealand meat industry with the opportunity to be the first to establish a valuable niche market for lamb.

Dr Sharon Henare (Riddet Institute) and Kaylene Larking, Consortium Manager, Meat Biologics Consortium.

Awards and achievements

Professor Paul Singh, Principal Investigator, was elected to the US National Academy of Engineering, one of the highest professional distinctions for engineers.

Distinguished Professor David Parry, Associate Investigator, received New Zealand's top science honour, the Rutherford Medal.

Professor Harjinder Singh received the Massey Research Medal (Individual). He also received the William C Haines Award from the Californian Dairy Research Foundation.

Distinguished Professor Paul Moughan was invited to present the 2008 J M Bell Distinguished Lecture series in Canada. He was also appointed Chair of an international committee to undertake an academic review at Wageningen University in the Netherlands.

Dr Warren McNabb, Principal Investigator, was appointed Adjunct Professor at Massey University.

Professor Laurence Melton was made a Fellow of the International Academy of Food Science and Technology, awarded at the 14th World Food Congress (IUFoST) in Shanghai, China, where he was the official representative of New Zealand.

Statement of financial performance (CoRE activities)

for the period ended 31 December 2008

INCOME		ACTUAL (NZ$)
Revenue	TEC funding	
	Operational funding	2,134,666
	Scholarship fund	1,000,000
	Interest received (scholarship fund)	84,000
	Total revenue	**3,218,666**
Funds carried forward	Scholarship fund[1]	(1,084,000)
	Operational funding	(1,043,352)
	Total funds carried forward	**(2,127,352)**
TOTAL INCOME		**1,091,314**
EXPENDITURE		
Research platforms[2]	Partner research subcontracts[3]	99,893
	Massey research costs	132,456
	Total research platforms	**232,349**
Administration and infrastructure[4]	Staff-related costs	496,984
	Consumables and other direct costs	73,722
	Travel and accommodation	28,006
	Computers and fittings	46,842
	Total administration and infrastructure	**645,553**
Overheads	Massey University overheads (research)	68,668
	Massey University overheads (administration)	157,091
	Total Massey University overheads	**213,412**
TOTAL EXPENDITURE		**1,091,314**

Notes

1 $1 million for Research Scholarship Fund taken from 2008 funding.
2 Expenditure on research programme covers period 1 July to 31 December 2008.
3 Some payments to research partners due in 2008 deferred until 2009 due to delays in contracting and invoicing.
4 Expenditure on administration and infrastructure covers period 1 January to 31 December 2008.

Notes to the financial statements

Entity reporting

These financial reports are for the Riddet Institute, a Centre of Research Excellence established in 2008 consequent to an agreement with the Tertiary Education Commission for funding and an agreement between Massey University, AgResearch Ltd, the New Zealand Institute for Crop and Food Research Ltd and the University of Otago for its operation.

The Riddet Institute is hosted by Massey University, and these financial reports have been generated from Massey University financial records, which are audited annually. These financial reports cover income and expenditure for the Riddet Institute CoRE budget centre and do not include income and expenditure related to non-CoRE activities in the Riddet Institute.

Reporting period

These reports are for income and expenditure in the 12 months ending 31 December 2008, but noting that expenditure under the research programme covers the period 1 July 2008 to 31 December 2008 only.

Income

Revenue is recognised in the statement of financial performance as that actually received. Income is then adjusted to account for research activity completed in advance or yet to be completed. From the first year of TEC CoRE funding, $1 million was set aside for a scholarship fund, which will be used to support students working on the CoRE research programme over the term of the TEC CoRE contract. Massey University has agreed to invest this funding in order to accrue interest, for the benefit of the CoRE.

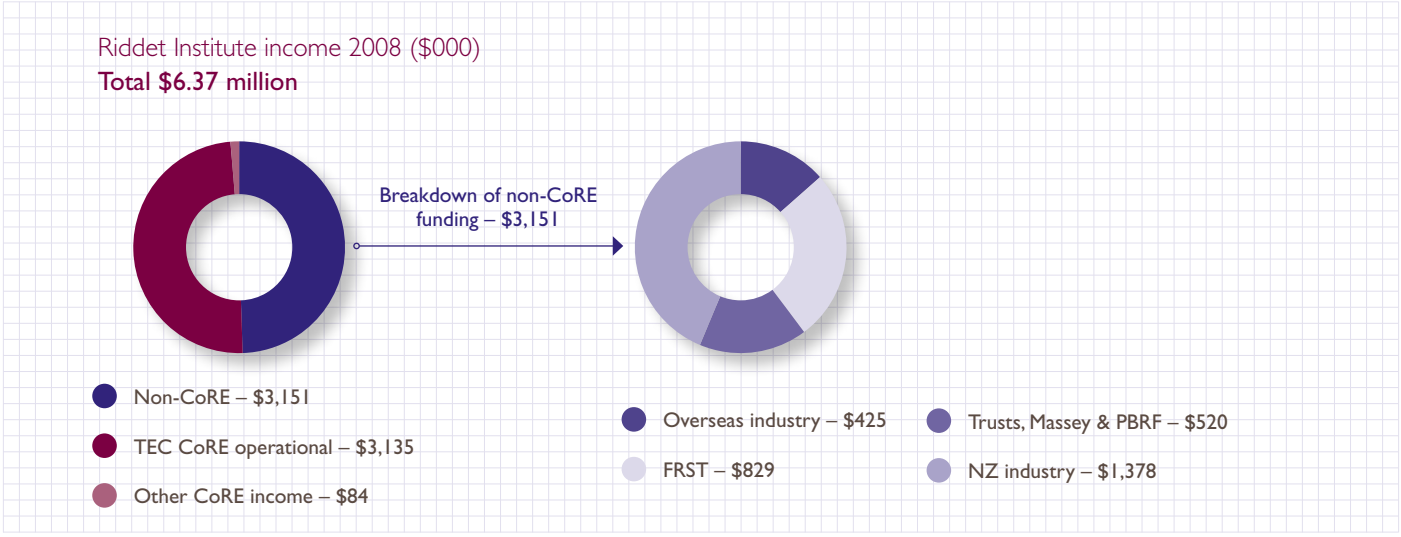
Expenditure

A large proportion of the Riddet Institute's expenditure related to the CoRE research programme is by partners and collaborators under research subcontracts. This expenditure is recognised in the statement of financial performance as payments to those institutions rather than expenditure incurred by them.

Goods and services tax (GST)

These financial reports have been prepared so that all figures are stated exclusive of GST.

Funding breakdown



Capital equipment purchased (from TEC Capital Equipment Grant)

for the period ended 31 December 2008

DESCRIPTION	COST (NZ$)
High performance liquid chromatograph x 2	105,423
Diode array detector	18,322
Refractive index detector	8,341
Gel scanning equipment	17,260
Spray dryer	51,360
Mastersizer particle size analyser	138,007
Realtime PCR system	81,000
Gas chromatography mass spectrometer	111,869
Ultracentrifuge	73,982
High speed centrifuge	45,774
Low speed centrifuge	17,426
Surface tension system	38,056
Spectrophotometer and nanodrop spectrophotometer	17,472
Scanning fluorimeter	16,595
Hydrolysis oven	1,545
Balance (5 figure)	5,240
Freezer (-80°C)	13,760
Speedvac centrifugal concentrator	49,899
Autoclave	14,890
Ultraviolet PCR workstation	4,721
DCode gradient gel electrophoresis system	11,620
Protean isoelectric focusing system	21,135
Microfluidiser	39,283
Rheometer	104,062
Milli Q water purifier	13,398
Magnetic stirrer	566
Micro centrifuge	480
pH meter	924
Plate reader	4,700
Ultrasonic bath	1,162
TOTAL	**1,028,272**
Capital Equipment Grant from TEC	**1,630,590**
Funds carried forward to 2009	602,318

All capital equipment listed above is located at the Riddet Institute at Massey University, Palmerston North.

Scientific publications 2008

Publications directly related to CoRE science programme

Peer-reviewed journal articles

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