



# Australian Centre for NanoMedicine Annual Report 2014

Never Stand Still

Australian Centre for NanoMedicine



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## Centre Faculties and Associate Organisations

The Australian Centre for NanoMedicine is a unique Centre in that it draws members from several faculties, schools, institutes and centres across UNSW.

Presiding Faculty	-	Faculty of Engineering
Associate Faculties	-	Faculty of Science Faculty of Medicine
Host School	-	School of Chemical Engineering
Associate Schools	-	School of Chemistry School of Mechanical and Manufacturing Engineering
Associate Institutes	-	Children's Cancer Institute Australia Australian Nuclear Science and Technology Organisation
Associate Centres	-	Centre for Vascular Research Centre for Advanced Macromolecular Design Mark Wainwright Analytical Centre

## Centre Management

Co-directors	-	<b>Prof Justin Gooding</b> School of Chemistry Faculty of Science	<b>Prof Maria Kavallaris</b> Children's Cancer Institute Australia Faculty of Medicine
Deputy Director	-	<b>A/Prof Cyrille Boyer</b> School of Chemical Engineering Faculty of Engineering	
Centre Manager	-	<b>Ms Carla Gerbo</b> (to October 2014)	<b>Dr Joshua Peterson</b> (from January 2015)

# Director's Report



In this 2014 Annual Report of the Australian Centre for Nano-Medicine (ACN) we reflect over the last twelve months with much pride on our research achievements and how the work of our 60+ team is impacting from our research benches, all the way to clinical bedside. Team ACN continues to work on diseases including neuroblastoma, lung, blood and pancreatic cancers, while diabetes, asthma and uveitis are part of our non-cancer portfolio. Our skills in drug delivery, imaging agents and diagnostic devices are producing valuable outcomes reflected in the over 100 publications released between our inception in July 2011 to the end of 2014.

Our success in grants through Australian/State Governments, cancer institutes and industry collaboration reached more than \$AUD14M (\$6.36M in 2014). This year saw the commencement of two ARC Centres of Excellence with which the ACN is heavily involved. The ARC Centre of Excellence in Convergent Bio-Nano Science and Technology includes ACN Team members Scientia Prof Justin Gooding, Prof Maria Kavallaris, A/Prof Palli Thordarson; while the ARC Centre of Excellence in Advanced Molecular Imaging, includes Prof Kat Gaus.

The International Nanomedicine Conference was again a great success welcoming more than 200 attendees from 23 countries. Highlights included the wonderful plenary speakers, Prof Mark Davis (California Institute of Technology), Prof Shana Kelley (University of Toronto), Prof Jason S. Lewis (Memorial Sloan-Kettering Cancer Center), Prof Tanya Monro (University of Adelaide) and Prof Andrew Whittaker (University of Queensland). In addition, we hosted six high school students to attend one day of the conference and judge poster presentations – the trial run of this high school program was very successful and we look forward to it again at next year's conference.

The decision taken by UNSW in 2011 to establish our unique research centre incorporating researchers from UNSW's faculties of Engineering, Medicine and Science and our strategic vision to create disease focused teams incorporating Team ACN's skills in drug delivery, diagnostics and imaging, has brought recognition to UNSW and recognition to Australia that we are world leaders in this research/medical discipline.

We hope you enjoy reading about all these important activities and events of the Centre and we look forward to reporting on more exciting research and successes in the future.

PROFESSOR MARIA KAVALLARIS || SCIENTIA PROFESSOR JUSTIN GOODING

# Mission of the ACN

The Australian Centre for NanoMedicine (ACN) through world leading interdisciplinary researchers in diagnostics and therapeutic delivery will provide solutions to clinical challenges in medicine.

# Vision of the ACN

The ACN will become the hub of all nanomedicine research in Australia and a gateway for international collaboration.



Dr. Adam Martin inspects a sample of a fluorescein-labelled hydrogelator. The material, synthesised in the Thordarson group, will be used to study the properties of self-assembled gels for localised, controlled drug delivery.

# Goals of the ACN

## Internal UNSW Goals 2014 – 2018

- Establish UNSW as the hub for NanoMedicine in Australia
- ACN to become an actual rather than a virtual centre via being provided with centralised space
- Encourage postgraduate students to UNSW to study within ACN
- Establish six times per annum a medical event series where medics/medical researchers visit ACN to discuss the problems they have and which ACN could work together to solve.
- Establish a (Northern Hemisphere) Summer School on NanoMedicine in late June each year.

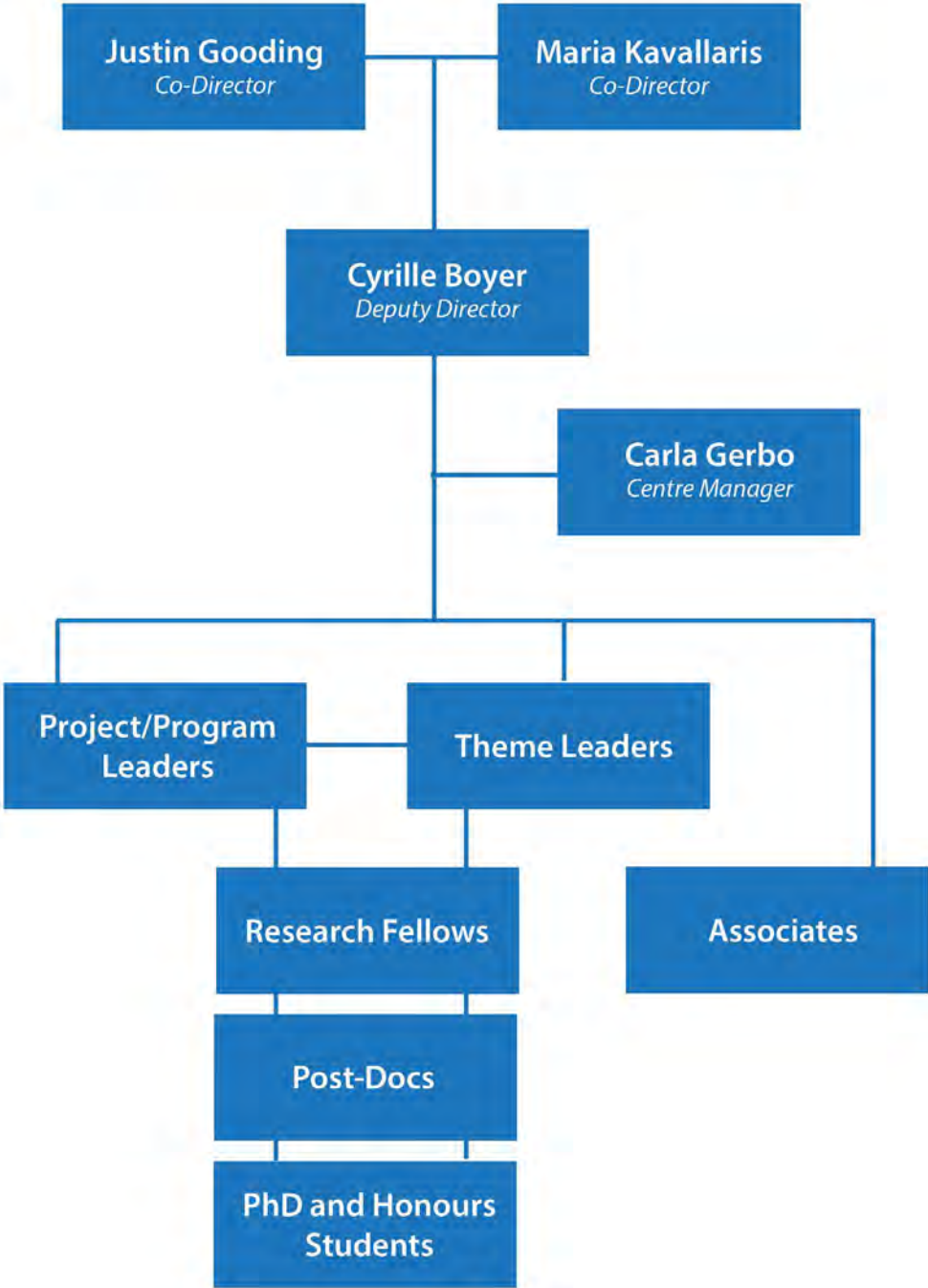
## External Communicable Goals 2014 – 2018

- Make ACN the Australian recognised nanomedicine centre
- Continue building the ACN International NanoMedicine Conference to be the most significant annual nanomedicine conference in the southern hemisphere
- Establish the Australian Society for NanoMedicine (ASNM) which links ACN into international nanomedicine alliances
- Continue building Brand ACN through a range of outreach programs.
- Continue with ACN's visiting professor program linking ACN with key international and Australian research institutes.

## Goal to be achieved by ACN in 2014 – 2018

- ACN to have its own dedicated space (research and administrative) at UNSW

# Organisational Chart



# ACN Team Members

## Directors

Prof Justin Gooding  
Prof Maria Kavallaris

## Deputy Director

A/Prof Cyrille Boyer

## Manager

Ms Carla Gerbo  
(to October 2014)  
Dr Joshua Peterson  
(from January 2015)

## Members

Prof Katharina Gaus  
Prof Naresh Kumar\*  
A/Prof Shelli McAlpine  
Dr Pall Thordarson  
Dr Joshua McCarroll  
Dr Majid Ebrahimi Warkiani\*  
Conjoint Prof Ivan Greguric

## Associate Members

Prof Martina Stenzel\*  
Dr Renee Whan  
Dr May Lim\*

## Research Fellows

Dr Elizabeth Hinde (VC)  
Dr Enrico Klotzsch\*  
Dr Stuart Lowe (VC, left 2014)  
Dr Sharon Sagnella (left 2014)  
Dr Orazio Vittorio (VC)  
Dr S R C Vivekchand (VC)

## Post-docs

Dr Muhammad Alam  
Dr Abbas Barfidokht\*  
Dr Ales Benda (left 2014)  
Dr Kyloon Chuah\*  
Dr Hien Duong (left 2014)  
Dr Bakul Gupta\*  
Dr Bunyamin Karagoz (left 2014)  
Dr Hongxu Lu (Associate)\*  
Dr Jeremie Rossy (left 2014)  
Dr Alex Soeriyadi  
Dr Thibault Tabarin  
Dr Robert Utama\*  
Dr Jason (Jiangtao) Xu

## Post-graduate Students

### PhD Students

Mr Ahmed Abu-Siniyeh (grad 2014)  
Ms Sri Augustina  
Mr Lachlan Carter\*  
Mr Xiaoyu (Jet) Cheng (grad 2014)  
Mr Kyloon Chuah (grad 2014)  
Ms Swahnnnya de Almeida (left 2014)  
Mr Christopher Fife  
Mr Cheng (Johnson) Jiang  
Ms Felicity Kao  
Mr Alexander Kross  
Mr Xun Lu  
Mr Yong (Jerry) Lu  
Ms Gorjana Mitic (grad 2014)  
Ms Mahdie Mollazade  
Ms Khanh Nguyen\*  
Ms Diep Nguyen\*  
Mr Stephen Parker  
Ms Maryam Parviz

### PhD Students (cont'd)

Ms Ranjana Piya\*  
Mr Siva Shanmugam\*  
Mr Vincent Tan\*  
Ms Safura Taufik\*  
Ms Roya Tavallaie (grad 2014)  
Ms Joann Teo  
Mr Jonathan Yeow\*  
Ms Ying Zhu (grad 2014)

### Masters Students

Ms. Genevieve Duche

### Honours Students

Mr Nik Nik Mohd Adnan\* (grad 2014)  
Mr Kenward Jung\* (grad 2014)  
Ms Annie Rajadurai\* (grad 2014)

\*Joined in 2014



# Steering Committee

The ACN Steering Committee is chaired by Prof Graham Davies (Presiding Dean) and is comprised of members from the associate Faculties of Science and Medicine. The 2014 Steering Committee meetings are noted below.

	April 1	July 29	November 20
<b>Prof Graham Davies</b> (Chairman) Dean of Engineering, UNSW	•	•	•
<b>Prof Merlin Crossley</b> Dean of Science, UNSW	•		
<b>Prof Peter Smith</b> Dean of Medicine, UNSW			
<b>Scientia Prof Ian Dawes</b> School of Biotechnology and Biomolecular Sciences, UNSW	•	•	
<b>Prof Peter Gunning</b> School of Medical Sciences, UNSW		•	•
<b>Prof Maria Kavallaris</b> ACN Co-director Head of Program, Tumour Biology and Targeting Program, Children's Cancer Institute Australia	•	•	•
<b>Scientia Prof Justin Gooding</b> ACN Co-director School of Chemistry, UNSW	•	•	•
<b>A/Prof Cyrille Boyer</b> School of Chemical Engineering, UNSW		•	•
<b>Ms Carla Gerbo</b> Centre Manager, Australian Centre for NanoMedicine	•	•	

# Advisory Panels

ACN does not have an Advisory Committee; however ACN has established three advisory panels that assist ACN in its positioning towards the Australian leader in this burgeoning field.

## Strategic Advisory Panel

ACN's Strategic Advisory Panel provides advice on strategic activities including future directions and opportunities, assisting with the clarification and attainment of our vision, creating strategies, implementing actions and measuring results. Strategic panel members include:

- Emeritus Prof Chris Fell (Chairman of the Australian National Fabrication Facility, former Deputy Vice-Chancellor (Research and International) and Dean of Engineering at UNSW)
- Emeritus Prof Mark Wainwright (former Vice-Chancellor and President of UNSW)
- Prof Gabriel Crean (Vice-President for Technology and Director for European Affairs in CEA Technology, CEA)

## Medical Advisory Panel

ACN's Medical Advisory Panel is made up of leading clinicians that provide independent medical advice on specific research projects being undertaken. Medical Advisory Panel members include:

- Prof Glenn Marshall (Paediatric Haematologist and Oncologist, Professor of Paediatrics and Director of the Centre for Children's Cancer and Blood Disorders, Sydney Children's Hospital),
- Prof Jacob George (Professor of Gastroenterology and Hepatic Medicine and Head of Gastroenterology and Hepatology at Westmead Hospital)
- A/Prof Craig Lewis (Director, Medical Oncology at The Prince of Wales Hospital).

## Industry Advisory Panel

ACN's Industry Advisory Panel will assist ACN to adopt leading research and provide advice on translating research to the benefit of health based organisations

- Dr Jason Harcup, Vice President of R&D and Head of Unilever's Research Organisation (China)
- Dr Sridhar Iyengar, Chief Technical Officer and Founder, AgaMatrix (USA)
- Dr Peter French, Chief Executive Officer, Benitec (Australia)

# Performance Against KPIs

Target	Actual 2013	Forecast 2014	Actual 2014
Total Projects commenced in year	2	2	3
Number of DEST "A" Publications	29	22	74
Number of industry/Government partner based projects	7	8	13
Number of media references/mentions	18	15	1
Number of Australian conferences presented	15	10	61
Number of international conferences presented	25	20	18
Number of community/practice presentations	15	16	9
Post doc years	15	17	14
Post graduate students (actuals) – PhD and Researchers	33	35	30
PhD completions	2	6	9
Nanomedicine Conference in Australia	1	1	1
Stakeholder seminar series (off campus)	6	6	17
Other external stakeholder meetings (on campus)	3	3	3
Generate additional external research grant income of at least \$1,200,000 by 2013	\$3,458,634	\$3,3730,000	\$6,360,000

# Research Overview

ACN's research focus is in two distinct themes:

## **Enabling research (80%)** (disease based)

- Theranostics
- Drug and Gene Delivery
- Nano-Materials and Bioimaging

## **Application research (20%)** (capacity building)

- MicroRNA detection for the early detection of cancers
- Detection of circulating tumour cells as an early diagnosis of metastatic cancer progression

## **ACNs Disease Areas include:**

- Lung Cancer
- Neuroblastoma (type of Children's cancer)
- Pancreatic Cancer
- Blood Cancers (Adult and children's lymphoblastic leukaemia)
- Uveitis (eye disease)
- Diabetes Management
- Liver Fibrosis (Completed project)

In terms of the four globally accepted key themes within nanomedicine, ACN will continue to concentrate on three of these themes:

- Theranostics
- Drug and gene delivery
- Nanomaterials and bioimaging

ACNs work in the fourth area, regenerative medicine, will remain as "observer status" although this area is seen as a key area to pursue and the next logical step in the future of the ACN's research profile.

Nanotoxicology and nanosafety will continue as a central tenant of our research that our research will be tested against.

# Research Project Highlights

Australian Centre for NanoMedicine researchers are currently involved in several research projects based around the themes of drug delivery, diagnostics, development of nanotechnology-enabled therapies and bioimaging. Many of these projects are interdisciplinary and span the three faculties of the ACN – Engineering, Science and Medicine. In addition, there are several projects being undertaken with industry partners and have shown significant progress toward development of clinically available therapies. A selection of highlighted projects is given below. For a complete listing of ACN projects, please refer to Appendix A.

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## **Synthesis of novel flavonoid hybrids and development of their delivery system\***

Min Han Eugene Yee, Orazio Vittorio, Maria Kavallaris, Naresh Kumar

Natural products such as flavonoids have attracted wide interest for the treatment of cancer. These compounds provides potent biological active scaffold that can be hybridized to further improve its overall activity. In this study, the isoflavene phenoxodiol, and flavanol (+)-catechin were selected as the scaffolds for a novel dual action hybridized anti-tumor molecule due to their already potent anti-cancer properties. Given the key role of metals such as copper in the proliferation of cancer cells, it is anticipated that the hybrids will possess superior anti-cancer activities compared to the parent compounds alone. Hence, a copper-chelating motif will be hybridized onto these scaffolds.

Natural products sometimes suffer from low bioavailability in the human body, which reduces their effectiveness as therapeutic agents. In order to overcome this barrier, the attachment of (+)-catechin to the drug carrier  $\beta$ -cyclodextrin will be investigated as a means of developing a novel drug delivery system for flavonoids. A variety of linker groups will be explored, including pH-sensitive linkers that could potentially selectively release (+)-catechin inside the acidic interior of cancer cells. These novel dual action hybrids and its delivery system will be analyzed for its physical properties such as copper chelation and nitric oxide releasing abilities, and biological activity such as anti-proliferative and anti-angiogenic properties.

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\*New project commenced in 2014.

# Research Project Highlights

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## **3D printing of cell cultures\***

*ARC Linkage grant with Inventia Life Science*

Scientia Professor J. Justin Gooding, Professor Maria Kavallaris, Dr. Robert Utama, Dr. Chris Fife, Mr. Vincent Tan

*External collaborators:* Dr. Julio Ribeiro (Inventia Life Science)

Cell culture has for many years been performed in 2 dimensions on cell culture dishes but in recent years it has become more accepted that cells respond differently to drugs in 3D than 2D. Hence there has been a move towards performing drug assays in 3D spheroids. However, preparing spheroids is very time consuming. With Inventia Life Sciences, ACN is developing a 3D printing approach to provide a high throughput way of preparing 3D cell spheroids. Such a technology will provide cell biologists and nanomedicine researchers with rapid ways of testing the efficacy of new nanomedicines.

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## **Targeted delivery of chemotherapeutic drugs for the treatment of neuroblastoma\***

Professor Maria Kavallaris, Dr Sharon Sagnella

*External collaborators:* EnGeneIC, Dr David Ziegler

Neuroblastoma is the most common extra-cranial solid tumour in children, accounting for 6-10% of all childhood cancers. The majority of children are diagnosed with advanced stage disease (metastatic) and despite intensive therapy that includes highly toxic chemotherapy and bone marrow transplantation, neuroblastoma has the lowest overall survival rates of all the common childhood cancers (40-50%). Due to the toxic side effects of chemotherapy, the limited number of long-term survivors have lifelong health issues due to the late effects of treatment. There is an urgent need to develop effective treatments that not only to improve survival, but also minimise the late effects of treatment. The Kavallaris laboratory is collaborating with EnGeneIC and our clinical collaborator Dr David Ziegler to identify the mechanism of action and efficacy of drug loaded minicells in a preclinical model of neuroblastoma. The longer term aim is to obtain proof of concept data for acceleration of the minicells to clinical trial for the treatment of drug refractory neuroblastoma.

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\*New project commenced in 2014.

# Research Project Highlights

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## **Development of a ddRNAi therapeutic for lung cancer**

Prof Maria Kavallaris, Dr Joshua McCarroll

*External collaborators:* Benitec Biopharma

Intellectual property arising from the Kavallaris lab on specific  $\beta$ -tubulin isotypes in lung cancer (Cancer Res 2007, 2008 and 2010) and their diagnostic and therapeutic utility has led to the filing of several patents. The IP has been assigned to New South Innovations (NSi), including a patent that has been licensed to Benitec (Biopharma) for the therapeutic aspects of suppression of specific  $\beta$ -tubulins. We are working in partnership with Benitec Biopharma Ltd to develop a lung cancer therapeutic based on their proprietary dsRNAi technology and our patent on  $\beta$ -tubulin isotype targeting. During the proof-of-concept stage we demonstrated potent *in vivo* silencing of  $\beta$ -tubulin in a clinically relevant model of non-small cell lung cancer developed in our laboratory that chemosensitised tumours and significantly prolonged the lifespan of mice compared with that of control animals. Based on this highly promising proof-of-concept data, Benitec have continued their support of our preclinical studies, and will be advancing this discovery to clinical trial. This transition from discovery (basic research) to preclinical research, to translation, to a therapeutic product highlights our ability to ultimately move discovery to the bedside.

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## **Preclinical development of nanoparticles as RNAi delivery agents for the treatment of cancer**

Prof Maria Kavallaris, Dr Joshua McCarroll, Dr Phoebe Phillips, Ms Joann Teo, Prof. Tom Davis, A/Prof. Cyrille Boyer

Gene silencing is an evolutionarily conserved mechanism of gene control. We are exploiting gene silencing to target abnormally expressed genes driving cancer growth and chemosensitivity in cancer. This cross disciplinary collaboration of chemists and cancer biologists has enabled the development of nanoparticles that can silence genes in cancer cells in both cell line models and preclinical animal models of cancer.

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# Postgraduate Student Projects

In 2014, there were 30 postgraduate students in the ACN – seven in the Faculty of Engineering, seven in the Faculty of Medicine and 16 in Science. Of the 30, 25 were enrolled as PhD students, 1 Masters and 4 Honours students. The project titles for all post graduate students in the ACN are listed below.

Student	Degree	Faculty	Project Title
Mr. Ahmed Abu-Siniyeh	PhD	Medicine	Characterizing and quantifying membrane order of polarized epithelial cells in zebrafish larvae
Ms. Sri Augustina	PhD	Engineering	Morphology control of polymeric nanoparticles using membrane emulsification
Mr. Lachlan Carter	PhD	Science	Super-resolution light microscopy as a single-molecule biosensing tool
Mr. Jet (Xiaoyu) Cheng	PhD	Science	Colloidal Silicon Quantum Dots: From Preparation to the Modifications of Self-Assembled Monolayers for Bio-applications
Mr. Kyloon Chuah	PhD	Science	Nanoparticle-based Nanopore Sensors
Ms. Swahnnya de Almeida	PhD	Science	Detection of microRNA in biological samples
Mr. Christopher Fife	PhD	Medicine	The Delivery of siRNA using Nanoparticles in Pancreatic Cancer
Mr. Cheng (Johnson) Jiang	PhD	Science	Biosensors fabricated using low impedance antifouling surfaces
Ms. Felicity Kao	PhD	Medicine	Investigating the therapeutic potential of microRNAs in glioblastoma
Mr. Alexander Kross	PhD	Medicine	Olfactory signalling elements and membrane organisation of olfactory receptor neurons
Mr. Xun Lu	PhD	Science	Superresolution light microscopy for characterising biointerfaces
Mr. Yong (Jerry) Lu	PhD	Science	The microfabrication of surfaces for cell biology
Ms. Gorjana Mitic	PhD	Medicine	Investigation of the role of $\beta$ III-tubulin in glioblastoma multiforme tumourigenesis and response to therapy
Ms. Mahdie Mollazade	PhD	Medicine	Functionalised nano-structured surfaces for cell adhesion.
Ms. Diep Nguyen	PhD	Engineering	Macromolecular scaffolds for carbon monoxide delivery



# Postgraduate Student Projects (cont'd)

Student	Degree	Faculty	Project Title
Ms. Khanh Nguyen	PhD	Engineering	Polymeric nanoparticles for anti-biofilm application in the treatment of infectious diseases
Mr. Stephen Parker	PhD	Science	Capture-release surfaces for circulating tumour cells
Ms. Maryam Parviz	PhD	Science	Combining fluorescence microscopy with electrochemistry for cell biology
Ms. Ranjana Piya	PhD	Science	Single-cell porous silicon biosensors
Mr. Siva Shanmugam	PhD	Engineering	Development of spatial and temporal control of light mediated RAFT polymerization
Mr. Vincent Tan	PhD	Science	Artificial ECMs for 3D printing of cells
Ms. Safura Taufik	PhD	Science	A biosensor for haemoglobin
Ms. Roya Tavallaie	PhD	Science	Dispersible electrodes for detecting microRNA
Ms. Joann Teo	PhD	Medicine	Discovery of a small molecule TUBB3/beta-tubulin modulator in non-small cell lung cancer
Mr. Jonathan Yeow	PhD	Engineering	Biomedical Applications of Nanoparticles Synthesised Using Polymerization-Induced Self-Assembly (PISA)
Ms. Ying Zhu	PhD	Science	Micropatterned Porous Silicon Photonic Crystals towards Microarray-based Cell Sensing
Ms. Genevieve Duche	Masters	Science	The release of biomacromolecules from self-assembled gels
Mr. Nik Nik Mohd Adnan	Honours	Engineering	Hybrid nanocarrier for controlled delivery of drugs
Mr. Kenward Jung	Honours	Engineering	Photoinitiated radical polymerization in emulsion
Ms. Annie Rajadurai	Honours	Science	Synthesis of Polymer Hydrogels as Mimics of the Extracellular Matrix

# PhD Completions

Target	Actual 2013	Forecast 2014	Actual 2014
PhD completions	2	6	9

**Dr. Ahmed Abu-Siniyeh** (PhD 2014), Faculty of Medicine

*Characterizing and quantifying membrane order of polarized epithelial cells in zebrafish larvae*

**Dr. Xiaoyu (Jet) Cheng** (PhD 2014), Faculty of Science

*Colloidal Silicon Quantum Dots: From Preparation to the Modifications of Self-Assembled Monolayers for Bio-applications*

**Dr. Kyloon Chuah** (PhD 2014), Faculty of Science

*Nanoparticle-based Nanopore Sensors*

**Dr. Gorjana Mitic** (PhD 2014), Faculty of Medicine

*Investigation of the role of  $\beta$  III-tubulin in glioblastoma multiforme tumourigenesis and response to therapy*

**Dr. Roya Tavallaie** (PhD 2014), Faculty of Science

*Dispersible electrodes for detecting microRNA*

**Dr. Ying Zhu** (PhD 2014), Faculty of Science

*Micropatterned Porous Silicon Photonic Crystals towards Microarray-based Cell Sensing*

**Dr. Bakul Gupta** (PhD 2013), Faculty of Science

*Bioresponsive porous silicon photonic crystals for monitoring protease activity in vivo*

**Dr. Xin Chen** (PhD 2013), Faculty of Science

*Making inorganic oxides stimuli responsive via surface modification*

**Dr. Sema Sevimli** (PhD 2012), Faculty of Engineering

*Cholesterol conjugated polymers as therapeutic delivery vehicles: correlation between physico-chemical and biological properties*

# Collaborating Organisations

Collaborating Institution	Country
Advanced Soft Matter Group – Delft University of Technology	The Netherlands
AgaMatrix, Inc.	USA
ARC Centre of Excellence in Convergent Bio-Nano Science and Technology	Australia
Australian Microscopy & Microanalysis Research facility, The University of Sydney	Australia
Australian Nuclear Science and Technology Organisation (ANSTO)	Australia
Benitec Biopharma	Australia
Biotechnology Institute	Singapore
Children's Cancer Institute Australia	Australia
Clockwerk Pty Ltd (Sydney)	Australia
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Australia
Coral Reef Laboratory / Institute for Life Science (IfLS), University of Southampton	UK
Ian Wark research Institute (Adelaide)	Australia
Imperial College London	UK
Ingham Institute for Biomedical Research (Sydney)	Australia
Institute for Molecular Materials, Radboud University Nijmegen	The Netherlands
Inventia Life Sciences, Australia (Sydney)	Australia
MacDiarmid Institute for Advanced Materials and Nanotechnology, Victoria University of Wellington	New Zealand
Mark Wainwright Analytical Centre, UNSW	Australia
Monash University	Australia
Neptune Bio-Innovations Pty Ltd.	Australia
Princeton University	USA
Qingdao University	China
Ruhr-Universität Bochum	Germany
Single Molecule Laboratory, UNSW	Australia
SMART center	Singapore
Translational Research Institute (Brisbane)	Australia
University of Liverpool	UK
University of Wollongong, ARC Centre of Excellence in Electromaterials	Australia
Victor Chang Cardiac Research Institute (Sydney)	Australia
Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Key Laboratory of Sustainable Development of Marine Fisheries	China

# ACN Member Grants

Whilst the ACN does not directly administer any grant income, its members report the following grants as the funds are used to support ACN related research. The total value of grants associated with ACN research in 2014 was \$ 6,360,000 AUD.

Grant, Value	Title, CIs	2014 Value
ARC Linkage Grant (LPI30101035) 2013 - 2016 \$ 495,000	The development of tuneable materials to allow the three-dimensional printing of cells J.J. Gooding, T.P. Davis, J. Rtbiero, M. Kavallaris	\$ 167,500
ARC Industrial Transformation Training Centres (IC130100021) 2013 - 2016 \$ 2,100,000	Training Centre for Advanced Technologies in Food Manufacture J. Arcot, N. Lee, R. Wills, J.J. Gooding, G. Fleet, R. Amal, M. Stenzel, V. Chen, M. Lim, A. Shrestha, F. Trujillo, P. Spicer, S. Taylor, G. Wright, J. Golding, J. Sellahewa, R. Buckow, D. Frank, D. Zabarar, S. Vishnumohan, F. Curulli, D. Hertford, D. McPherson	\$ 700,000
ARC Linkage Grant (LPI10200610) 2011 - 2015 \$ 774,000	In situ bioremediation solutions for Australia's organochlorine contaminated aquifers M.J. Manefeld, J.J. Gooding, D. Lam	\$ 184,500
ARC Discovery Grant and APF (DPI094564) 2010 - 2014 \$ 980,000	Making Silicon Even More Useful: Functionalising Silicon to Produce Stable Electronic Devices in Aqueous Environments J.J. Gooding	\$ 100,000
NHMRC Development Grant (APPI075628) 2014 - 2016 \$ 567,562	HbA1c biosensor J.J. Gooding	\$ 195,854
NHMRC Project Grant (APPI024723) 2012 - 2014 \$ 439,925	A nanomedicine strategy for detecting and modulating protease activity in vivo J.J. Gooding, Di Girolamo, Wakefield	\$ 149,975
NHMRC Established Career Fellowship Award (APPI058299) 2014 - 2018 \$ 601,420	Regulation and targeting of the cancer cytoskeleton M. Kavallaris, L. Wordeman	\$ 120,284

# ACN Member Grants (Cont'd)

Grant, Value	Title, CIs	2014 Value
NHMRC Project Grant (APPI057805) 2014 - 2016 \$ 617,562	Lamin B1, a new anti-cancer target G. Lessene, N. Kershaw, M. Kavallaris	\$ 205,854
ARC Centre of Excellence (CE140100036) 2014 - 2020 \$ 4,067,000	ARC Centre of Excellence in Convergent Bio-Nano Science and Technology T. Davis, F. Caruso, C. Porter, J.J. Gooding, M. Kendall, N. Voelcker, A. Whittaker, N. Bunnett, M. Kendall, E. Crampin, R. Parton, M. Kavallaris, B. Boyd, M. Kearns, K. Thurecht, A. Johnston, P. Thordarson, T. Nann, S. Corrie, K. Dawson, C. Hawker, D. Haddleton, A. Cameron, M. Stevens, K. McLean, N. Abbott, D. Lee, I. Greguric, J. Lewis	\$ 581,000
ARC Discovery Grant (DPI40103290) 2014 - 2016 \$ 343,000	Structural domains of beta-tubulin and their role in microtubule dynamics and transport M. Kavallaris, L. Wordeman	\$ 121,000
ARC Linkage Infrastructure, Equipment and Facilities (LIEF) Grant (LE140100166) 2014 \$ 370,000	Imaging cell and tissue architecture using confocal and super-resolution microscopy P.W. Gunning, H. Yang, L. Ittner, E. Hardeman, M. Kavallaris, N.J. King, G.E. Grau, J.R. Gamble, W. Wolfgang	\$ 370,000
Cancer Institute NSW Research Equipment Grant (14/REG/1-01) 2014 \$ 350,000	Dual modality photoacoustic/ultrasound imaging system for pre-clinical cancer studies M. Kavallaris, C. Power, P. Gunning, P. Hogg, P. Phillips, L. Wu	\$ 350,000
Australian Cancer Research Foundation – Children's Cancer Research Grant 2014 \$ 1,500,000	ARCF Precision Medicine Centre for Childhood Cancer M. Haber, M. Norris, G. Marshall, M. Kavallaris, R. Lock, P. Ekert	\$ 1,500,000

# ACN Member Grants (Cont'd)

Grant, Value	Title, CIs	2014 Value
ARC Linkage Grant (LP130100774) 2013 - 2016 \$ 306,000	Controlling Light-harvesting with Complex Perylene Arrays P. Thordarson, J.M. Hodgkiss, A. Falber	\$ 102,000
ARC Discovery Grant (DPI30101512) 2013 - 2015 \$ 330,000	How are self-assembled gels formed? From trial-and-error to rational molecular design P. Thordarson	\$ 110,000
ARC Future Fellowship (FT120100101) 2012 - 2016 \$ 824,000	Moving Supramolecular Assembly of Functional Systems into Water P. Thordarson	\$ 206,000
Cancer Institute NSW Early Career Fellowship (13/ECF/01) 2014 - 2017 \$ 599,000	Dextran-catechin conjugation with SPIONs: a potential targeted therapy against glioblastoma multiforme O. Vittorio	\$ 149,750
ARC Centre of Excellence (CE140100011) 2014 - 2020 \$ 2,800,000	ARC Centre of Excellence in Advanced Molecular Imaging J. Whisstock, J. Rossjohn, W. Heath, H. Quiney, K. Nugent, D. Godfrey, B. Abbey, D. Fairlie, K. Gaus, A. Peele, J. Davey, H. Chapman	\$ 400,000
NHMRC Program Grant (APP1037320) 2013 - 2017 \$ 1,750,000	Program in Membrane Interface R. Parton, A. Yap, K. Alexandrov, K. Gaus	\$ 350,000
ARC Future Fellowship (FT120100096) 2012 - 2016 \$ 692,068	Multimodal polymeric nanocarriers designed for the controlled and site specific delivery of nitric oxide C. Boyer	\$ 174,207
ARC Discovery Grant (DPI30100107) 2013 - 2015 \$ 360,000	Design of multimodal polymeric nanoparticles as targeted carriers for the co-delivery of therapeutic molecules C. Boyer, T. Davis	\$ 120,000

# ACN Publication Highlightss

Target	Actual 2013	Forecast 2014	Actual 2014
Number of DEST "A" Publications	29	22	74

ACN researchers published 74 articles in quality journals in 2014 - below is a selection of some of the highlights. For the full list of publications in 2014, please see Appendix B.

Xu, J., Jung, K., Atme, A., Shanmugam, S., and Boyer, C. (2014) A robust and versatile photoinduced living polymerization of conjugated and unconjugated monomers and its oxygen tolerance, *Journal of the American Chemical Society* 136, 5508-5519.

- [Ranked as 'Highly Cited' and 'Research Front' by Web of Science](#)
- [Ranked as 25th most cited paper in JACS for 2014](#)

Barfidokht, A., and Gooding, J. J. (2014) Approaches Toward Allowing Electroanalytical Devices to be Used in Biological Fluids, *Electroanalysis* 26, 1182-1196.

- [11th most accessed article in Electroanalysis in May 2014](#)
- [8th most accessed article in June 2014](#)

Gooding, J. J., Parker, S. G., Lu, Y., and Gaus, K. (2014) Molecularly engineered surfaces for cell biology: From static to dynamic surfaces, *Langmuir* 30, 3290-3302.

- [Front Cover, Invited Feature Article](#)

Zhu, Y., Soeriyadi, A. H., Parker, S. G., Reece, P. J., and Gooding, J. J. (2014) Chemical patterning on pre-formed porous silicon photonic crystals: Towards multiplex detection of protease activity at precise positions, *Journal of Materials Chemistry B* 2, 3582-3588.

- [Front Cover Article](#)

Zong, X., Kong, N., Liu, J., Yang, W., Cao, M., and Gooding, J. J. (2014) The influence of graphene on the electrical communication through organic layers on graphite and gold electrodes, *Electroanalysis* 26, 84-92.

- [10th most accessed paper in Electroanalysis, February 2014](#)
- [13th most accessed paper in Electroanalysis, November 2014](#)
- [18th most accessed paper in Electroanalysis for 2014](#)

# Conference Presentation Highlights

Target	Actual 2013	Forecast 2014	Actual 2014
Number of Australian conferences presented	15	10	61
Number of international conferences presented	25	20	18

ACN researchers gave 8 Plenary and Keynote presentations in 2014, and a further 16 invited talks at Australian and international conferences. Highlighted below are the Plenary and Keynote presentations. For a full list of conference presentations from 2014, please see Appendix C.

1. M. Kavallaris, Nanoparticle Targeting of Drug Resistance in Cancer, American Association for Pharmaceutical Sciences (AAPS) Workshop, Shanghai, China, 25-26 April 2014.
2. J.J. Gooding, Nanomaterial Based Biosensors for Diagnostics and Personalised Medicine, Biosensors 2014, 24th Anniversary World Congress on Biosensors, Melbourne, Australia, 27-30 May 2014.
3. J.J. Gooding, G.Z. Liu, A. Barfidokht, S. Ciampi, C.C.A. Ng, M. Chockalingham, X. Lu, Designing and Characterising Bioaffinity Surfaces for Biosensing, Analysdagarna 2014, Djurönäset, Sweden, 9-11 June 2014.
4. J.J. Gooding, L.M.H. Lai, I.Y. Goon, K. Chuah, E. Murago, R. Tavallaie, D.B. Hibbert, Gold coated magnetic nanoparticles as dispersible electrodes, ESEAC 2014, Malmo, Sweden, 11-15 June 2014.
5. Y. Zhu, B. Gupta, A. Soeriyadi, B. Guan, P.J. Reece, K. Gaus, J.J. Gooding, Porous silicon for monitoring the levels of matrix metalloproteases released from just a few cells and in vivo, NanoBio Australia 2014, Brisbane, Australia, 6-10 July 2014.
6. K. Gaus, Molecular insights into the regulation of T cell signalling with single molecule localisation microscopy, 2014 IUPAB Congress, Brisbane, Australia, 3-7 August 2014.
7. J.J. Gooding, S. Ciampi, Y. Zhu, B. Gupta, X. Cheng, M.H. Choudhury, B. Guan, P.J. Reece, K. Gaus, Making Silicon a Responsive Materials for Biosensing and Biolabelling Applications, Taishan Academic Forum on Graphene Nanomaterials and Biomedicine, Qingdao, China, 9-11 October 2014.
8. J.J. Gooding, S. Ciampi, Y. Zhu, B. Gupta, X. Cheng, M.H. Choudhury, B. Guan, P.J. Reece, K. Gaus, Making Silicon a Responsive Materials for Biosensing and Biolabelling Applications, 2nd International Conference on Bioinspired and Biobased Chemistry and Materials, Nice, France, 15-17 Oct 2014.



# ACN Seminars

Target	Actual 2013	Forecast 2014	Actual 2014
Stakeholder seminar series (off campus)	6	6	17

1. J.J. Gooding, "Bioresponsive Materials for Diagnostics, Personalised Medicine and Drug Delivery", Jinan University, China, 11 October 2014.
2. J.J. Gooding, "Bioresponsive Materials for Diagnostics, Personalised Medicine and Drug Delivery", Centenary Institute, University of Sydney, 30 September 2014.
3. J.J. Gooding, "Making Silicon Water Friendly for Electrochemical, Cell Biology and Molecular Electronic Applications", School of Chemical Engineering, University of Adelaide, 1 August 2014.
4. J.J. Gooding, "Nanotechnology: What is it? Is it new? Is it important?", Royal Australian Chemical Institute, NSW Education Branch, University of Sydney, 22 July 2014.
5. M. Kavallaris, "Microtubules: Tumourigenesis, Metastasis & Therapeutics", Research Leaders Lecture Series, Garvan Institute for Medical Research, Sydney, 8 December 2014.
6. M. Kavallaris, "Microtubules in Cancer Biology & Therapeutics", Monash Institute for Pharmaceutical Sciences, Melbourne, 20 August 2014.
7. M. Kavallaris, "Microtubules in Tumourigenesis and Metastasis", Peter MacCallum Cancer Institute, Melbourne, 24 July 2014.
8. M. Kavallaris, "Cancer Nanomedicine: Challenges and Opportunities", Therapeutic Goods Administration, Australia, 19 March 2014.
9. M. Kavallaris, "Cancer Nanomedicine: Drug and RNAi therapeutics for drug resistant tumors", Nanotechnology Characterization Lab, National Cancer Institute, Washington, USA, 9-10 April 2014.
10. M. Kavallaris, "Microtubules: Multifunctional proteins in Cancer", Sanford|Burnham Medical Research Institute, California, USA, 4 April 2014.
11. M.E. Warkiani, "Inertial microfluidics for diagnostic and therapeutic applications", Macquarie University, Australia, 2014.
12. M.E. Warkiani, "Inertial microfluidics for diagnostic and therapeutic applications", University of South Australia (Ian Wark centre), Australia, 2014.
13. M.E. Warkiani, "Ultra-fast isolation of CTCs using spiral microfluidics", Ingham Institute, Sydney, Australia, 2014.
14. M.E. Warkiani, "High-throughput cell sorting using inertial microfluidics", 21st NSW Stem Cell Network Workshop: Bioengineering and Stem Cells, Sydney, Australia, 23 September 2014.
15. M.E. Warkiani, "Ultra-fast isolation of CTCs using spiral microfluidics", Translational Research Institute, Queensland UT, Brisbane, Australia, 2014.
16. M.E. Warkiani, "The emerging role of inertial microfluidics for cell sorting", RMIT University, Australia, 2014.
17. M.E. Warkiani, "High-throughput cell sorting using inertial microfluidics", A\*STAR's Bioprocessing Technology Institute (BTI), Singapore, 3 December 2014.

# ACN Seminars

Target	Actual 2013	Forecast 2014	Actual 2014
Other external stakeholder meetings (on campus)	3	3	3



**Professor Mark Davis**  
*California Institute of Technology*  
7 July 2014

**Fighting Cancer with Nanoparticle Medicines:  
The Nanoscale Matters!**

**Professor Robert K. Prud'homme**  
*Princeton University*  
4 August 2014

**Scaleable Polymeric Nanoparticle Formation for  
Multifunctional Drug Delivery and Imaging**



**Jatin Kumar & Connie Liu**  
*Institute of Materials Research & Engineering (IMRE)*  
12 September 2014

**Future Materials in Singapore – Polymers, Surfactants and Porous Structures,**

# ACN Community/Practice Presentations

Target	Actual 2013	Forecast 2014	Actual 2014
Number of community/practice presentations	15	16	9

ACN members are asked to present their research to the wider group as part of an internal seminar program. There were nine such presentations in 2014 as indicated below.

**Dr Bunyamin Karagoz** 21 February  
Faculty of Engineering

**Ms Bakul Gupta** 21 March  
Faculty of Science

**Dr Sharon Sagnella** 17 April  
Faculty of Medicine

**Dr Muhammad Alam** 16 May  
Faculty of Science

**Dr Liz Hinde** 20 June  
Faculty of Medicine

**Ms Roya Tavallaie** 18 July  
Faculty of Science

**Ms Swahnnya de Almeida** 15 August  
Faculty of Science

**Dr Majid Ebrahimi Warkiani** 19 September  
Faculty of Engineering

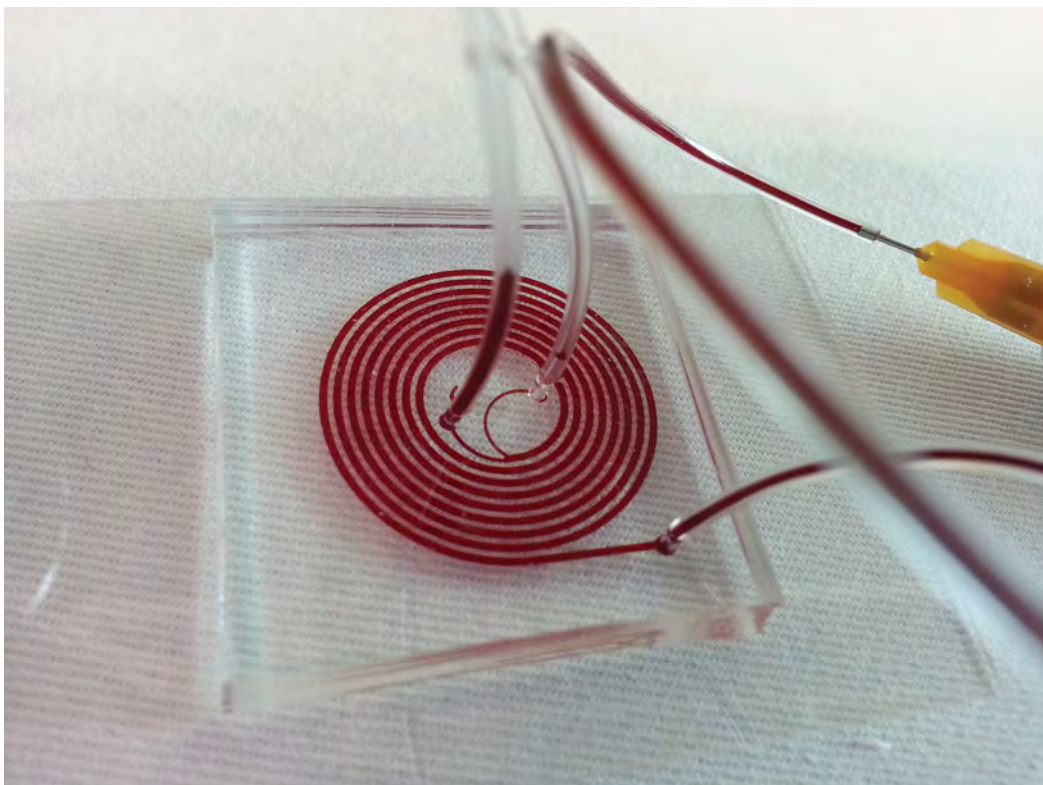
**Mr Vincent Tan** 17 October  
Faculty of Science

# Media References



Dr. Majid Ebrahimi Warkiani's spiral microfluidic device for CTC sorting is highlighted in the segment of CBS news show (60 minutes) "Disrupting Cancer" on 7-December 2014.

<http://www.cbsnews.com/news/billionaire-doctor-fights-cancer-in-unconventional-way/>



Dr. Majid Ebrahimi Warkiani's spiral microfluidic device for sorting circulating tumor cells (CTCs).



# Nanomedicine Conference



The 5th International Nanomedicine Conference was held 30 June - 2 July, 2014 at the Crowne Plaza Coogee Beach in Sydney, Australia. The conference attracted more than 200 attendees from 23 countries and featured:

- 5 Plenary presentations
- 34 Invited talks
- 24 Oral presentations
- 46 Poster presentations

## Plenary Speakers



**Prof Mark Davis**  
*California Institute of Technology*



**Prof Shana Kelley**  
*University of Toronto*



**Prof Jason S. Lewis**  
*Memorial Sloan-Kettering Cancer Center*



**Prof Tanya Monro**  
*The University of Adelaide*



**Prof Andrew Whittaker**  
*University of Queensland*



Prof Justin Gooding poses with high school students from Moriah College in Sydney. The students attended day 2 of the conference and were judges of the 3 minute poster competition.

# Patents

1. J. Xu, C. Boyer (2014), Process for preparing a polymer, Application No's. 2014900300 & 2014901259 filed on 31<sup>st</sup> January 2014.
2. O. Vittorio, H. Duong, C. Boyer, M. Kavallaris (2014), Copper and Iron nanoparticles functionalized with antioxidant for cancer therapy, Application No. 2014904854, filed 15<sup>th</sup> November 2014
3. N. Barraud, H. Duong, C. Boyer (2014), Polymer, Application No. 2014902080, filed on 15th March 2014.
4. J.J. Gooding, S. Ciampi, M.H. Choudhury, S.G. Parker, Y. Yang, Light Activated Electrochemistry, Australian Provisional Patent Application No. 2014903596, filed 11th September 2014

# Book Chapters

1. Gooding, J. J., and Zhu, Y. (2014) Modifying porous silicon with self-assembled monolayers for biomedical applications, In *Porous Silicon for Biomedical Applications*, pp 81-103.
2. Truong, W. T., Lewis, L., and Thordarson, P. (2014) CHAPTER 6 Biomedical Applications of Molecular Gels, In *Functional Molecular Gels*, pp 157-194, The Royal Society of Chemistry.
3. Pasquier, E., Kavallaris, M., and Andre, N. (2014) Metronomic Chemotherapy Regimens Using Microtubule-Targeting Agents: Mechanisms of Action, Preclinical Activity and Future Developments, In *Metronomic Chemotherapy: pharmacology and clinical applications* (Bocci, G., and Francia, G., Eds.) 1 ed., pp 69-90, Springer-Verlag Berlin Heidelberg.
4. Dunn, A. E., Dunn, D. J., Lim, M., Boyer, C., and Thanh, N. n. T. K. (2014) Chapter 8 Recent developments in the design of nanomaterials for photothermal and magnetic hyperthermia induced controllable drug delivery, In *Nanoscience: Volume 2*, pp 225-254, The Royal Society of Chemistry.

# ACN Awards and Honours

Name	Award / Honour	Date
Amelia Parker	UNSW PRSS - Conference Travel Fund to present poster at <i>AACR Annual Meeting, San Diego USA, April 5-9 2014</i>	25 February
Christopher Fife	UNSW PRSS - Conference Travel Fund to present poster at <i>AACR Annual Meeting, San Diego USA, April 5-9 2014</i>	25 February
Stephen Parker	winner oral presentation prize, 5th International Nanomedicine Conference	2 July
Swahnnya de Almeida	winner poster prize, 5th International Nanomedicine Conference	2 July
Annie Rajadurai	winner poster prize, 5th International Nanomedicine Conference	2 July
Joann Teo	International Nanomedicine Conference, July 2014, Best Oral Presentation Awarded	2 July
Alistair Laos	Winner poster prize, 18th International Union of Pure and Applied Biophysics (IUPAB) International Biophysics Congress	7 August
Swahnnya de Almeida	winner UNSW Science Postgraduate Research Competition (one minute thesis)	8 August
Alexander Soeriyadi	NHMRC Peter Doherty Early Career Fellowship	17 October
Ethan Howe	Winner poster prize, Mark Wainwright Analytical Centre Symposium, UNSW, Sydney.	24 October
Amelia Parker	Lonza Award for Best Overall Presentation, Children's Cancer Institute PhD Student Mini Symposium	29 October
Walter Muskovic	Sigma-Aldrich Best 1st Year PhD Presentation, Children's Cancer Institute PhD Student Mini Symposium	29 October
Kristel Tjandra	Winner poster prize, 35th Royal Australian Chemical Institute NSW Organic Group Annual One Day Symposium, Australian National University, Canberra.	3 December
Maryam Parviz	poster prize winner in "UNSW Nanomaterial and Electrochemistry symposium"	5 December
Bakul Gupta	poster prize winner, SEALS (South Eastern Area Laboratory Services) research symposium entitled "Improving health care and safety through better research, diagnostic tests and communication"	8 December

# ACN Awards and Honours (cont'd)

Name	Award / Honour	Date
Maria Kavallaris	Awarded Life Membership to the Australian Society for Medical Research (ASMR) for exceptional service and promotion of health and medical research	2014
Maria Kavallaris	Editorial Board – Cancer Research	2014
Maria Kavallaris	Assessment Committee Member, Sydney vital Fellowship for Flagship 1	2014
Maria Kavallaris	Inaugural President, Australian Society for Nanomedicine	2014
Maria Kavallaris	Appointed to the Editorial Board, Nanomedicine: Nanotechnology, biology and medicine	2014
Maria Kavallaris	NHMRC Established Career Development Award Panel Member	2014
Maria Kavallaris	NHMRC Established Career Fellowship. Highly competitive national award	2014-2018
Maria Kavallaris	Scientific Program Convenor, Lowy Symposium, Drug Discovery & Personalised Medicine, Sydney, May 2015	January
Maria Kavallaris	NHMRC Research Fellowship Peer Review Panel	May
Maria Kavallaris	Judge, 3M Eureka Prize for Emerging Leader in Science, Australian Museum	June
Pall Thordarson	Associate and Handling Editor, Australian Journal of Chemistry	1 July to present
Pall Thordarson	Editorial Board member, "Gels" (publisher, MDPI).	5 September to present
Pall Thordarson	Editorial Board member "Frontiers in Materials Science – Colloidal Materials and Interfaces"	28 July to present
Pall Thordarson	Chair, Supramolecular Symposia, RACI Congress 2014 - Adelaide	7 December
Justin Gooding	ARC Australian Professorial Fellow	2010-2014
Justin Gooding	Elected member of the editorial board of Bioconjugate Chemistry (ACS) and Chemistry – a European Journal (Wiley-VCH)	2014
Justin Gooding	Symposium chair, 11 <sup>th</sup> Annual World Congress of the Society of Brain Mapping and Therapeutics	17 March
Justin Gooding	Elected Fellow of the Royal Society of New South Wales	20 March
Justin Gooding	Local chair of the 24 <sup>th</sup> World Biosensor Congress, Melbourne	May
Justin Gooding	Listed in ISI Highly Cited Researcher list for 2014	June
Justin Gooding	Symposium chair, Royal Australian Chemical Institute Congress	7 December



# Appendix A

## Research Projects

# Appendix A - Research Projects

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## **Synthesis of novel flavonoid hybrids and development of their delivery system\***

Min Han Eugene Yee, Orazio Vittorio, Maria Kavallaris, Naresh Kumar

Natural products such as flavonoids have attracted wide interest for the treatment of cancer. These compounds provides potent biological active scaffold that can be hybridized to further improve its overall activity. In this study, the isoflavene phenoxodiol, and flavanol (+)-catechin were selected as the scaffolds for a novel dual action hybridized anti-tumor molecule due to their already potent anti-cancer properties. Given the key role of metals such as copper in the proliferation of cancer cells, it is anticipated that the hybrids will possess superior anti-cancer activities compared to the parent compounds alone. Hence, a copper-chelating motif will be hybridized onto these scaffolds.

Natural products sometimes suffer from low bioavailability in the human body, which reduces their effectiveness as therapeutic agents. In order to overcome this barrier, the attachment of (+)-catechin to the drug carrier  $\beta$ -cyclodextrin will be investigated as a means of developing a novel drug delivery system for flavonoids. A variety of linker groups will be explored, including pH-sensitive linkers that could potentially selectively release (+)-catechin inside the acidic interior of cancer cells. These novel dual action hybrids and its delivery system will be analyzed for its physical properties such as copper chelation and nitric oxide releasing abilities, and biological activity such as anti-proliferative and anti-angiogenic properties.

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## **3D printing of cell cultures\***

*ARC Linkage grant with Inventia Life Science*

Scientia Professor J. Justin Gooding, Professor Maria Kavallaris, Dr. Robert Utama, Dr. Chris Fife, Mr. Vincent Tan

*External collaborators: Dr. Julio Ribeiro (Inventia Life Science)*

Cell culture has for many years been performed in 2 dimensions on cell culture dishes but in recent years it has become more accepted that cells respond differently to drugs in 3D than 2D. Hence there has been a move towards performing drug assays in 3D spheroids. However, preparing spheroids is very time consuming. With Inventia Life Sciences, ACN is developing a 3D printing approach to provide a high throughput way of preparing 3D cell spheroids. Such a technology will provide cell biologists and nanomedicine researchers with rapid ways of testing the efficacy of new nanomedicines.

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\*New project commenced in 2014.

# Appendix A - Research Projects

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## **Targeted delivery of chemotherapeutic drugs for the treatment of neuroblastoma\***

Professor Maria Kavallaris, Dr Sharon Sagnella

*External collaborators:* EnGeneIC, Dr David Ziegler

Neuroblastoma is the most common extra-cranial solid tumour in children, accounting for 6-10% of all childhood cancers. The majority of children are diagnosed with advanced stage disease (metastatic) and despite intensive therapy that includes highly toxic chemotherapy and bone marrow transplantation, neuroblastoma has the lowest overall survival rates of all the common childhood cancers (40-50%). Due to the toxic side effects of chemotherapy, the limited number of long-term survivors have lifelong health issues due to the late effects of treatment. There is an urgent need to develop effective treatments that not only to improve survival, but also minimise the late effects of treatment. The Kavallaris laboratory is collaborating with EnGeneIC and our clinical collaborator Dr David Ziegler to identify the mechanism of action and efficacy of drug loaded minicells in a preclinical model of neuroblastoma. The longer term aim is to obtain proof of concept data for acceleration of the minicells to clinical trial for the treatment of drug refractory neuroblastoma.

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## **A home-use biosensor for glycosylated haemoglobin (HbA1c)**

*National Health and Medical Council (NHMRC)*

Scientia Professor J. Justin Gooding, Dr. Abbas Barfidokht, Dr. Muhammad Alam, Ms. Safura Taufik, Mr. Cheng Jiang

*External collaborators:* AgaMatrix Inc.

The percentage of glycosylated haemoglobin (HbA1c) in the blood of a diabetics patient is an important 3 month biomarker of the effectiveness of the blood glucose management regime of the patient. A 1% drop in HbA1c levels can result is a 20% drop in the chronic effect of diabetes. To measure the percentage of HbA1c requires a sensor that can detect both the levels of HbA1c and the levels of haemoglobin. ACN has developed a patented electrochemical immunosensor technology that is the first electrochemical immunosensor that can operate in whole blood. With ACN's industrial partners the ACN is developing the first ever HbA1c biosensor that can interface with existing blood glucose meters.

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\*New project commenced in 2014.

# Appendix A - Research Projects

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## **MicroRNA detection using magnetic nanoparticles**

*ARC Centre of Excellence*

Scientia Professor J. Justin Gooding, Professor Maria Kavallaris, Dr. Roya Tavallaie, Mr. Saimon Silva

MicroRNA (miRNA) is small pieces of RNA, about 20 base pairs long, that have recently been discovered as important gene expression regulators within the body. From a diagnostics perspective they are particularly important new class of biomarker for disease diagnosis, including cancer, because the levels of different miRNA sequences changes with a pathology and because they are readily available because they circulate in the blood stream. The challenge is the levels of the miRNAs can range between from 10 fmol/L and 1.0 pmol/L and hence ultrasensitive diagnostic devices are required. This project uses the gold coated magnetic nanoparticle electrochemical sensor technology developed by the ACN which has been shown to be ultrasensitive but with very rapid response times. These new sensors are applied to miRNAs for the first time where the levels of miRNAs through different tissues as well as the blood will be determined such that a robust analytical method can be developed.

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## **Nanopores for single molecule sensors**

*ARC Centre of Excellence*

Scientia Professor J. Justin Gooding, Dr. Kyloon Chuah

*External collaborators: A/Prof Adam Micolich (UNSW School of Physics)*

Diagnostic tools for early warning of a pathology typically must be able to detect concentrations of 1 fM or lower of a biomarker. The ultimate detection limit for a sensor is a single molecule. Although there are devices that can detect a single molecule they typically lack analytical utility due to slow response times. The ACN is addressing the challenge of rapidly responding single molecule sensors using nanopore sensors where magnetic nanoparticles bring the analyte to the pore. This new type of sensor would represent the ultimate diagnostic device.

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# Appendix A - Research Projects

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## **Single molecule sensing using super-resolution light microscopy**

*ARC Centre of Excellence*

Scientia Professor J. Justin Gooding, Professor Katharina Gaus, Mr. Xun Lu, Mr. Lachlan Carter, Ms. Manchen Zhao

*External collaborators:* Dr. Philip Nicovich (Centre for Vascular Research)

Single molecule sensors that could detect many single molecule binding events simultaneously would then provide better quality, more analytically robust diagnostic devices that can overcome issues of interference. To do this requires the device to be able to detect single molecule events over a broad area. Until recently we have not had instrumentation to do this but the invention of super-resolution microscopy, and in particular stochastic microscopy, provides this capability but such tools have never been used for sensing. The ACN is making the first strides towards using these new tools for molecular counting for diagnostic devices by developing the first ever single molecule pull-down assays that do not require any wildtype cells.

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## **Porous silicon photonic crystals for cell chips**

*ARC Centre of Excellence*

Scientia Professor J. Justin Gooding, Professor Katharina Gaus, Dr. Alexander Soeriyadi, Dr. Bakul Gupta, Ms. Ranjana Piya

*External collaborators:* Dr. Peter Reece (UNSW School of Physics)

Cell chips are invaluable for evaluating how cells respond to stimuli such as drugs and toxins in a high throughput manner. Traditionally cell chips are simply surfaces in which cells are immobilised in a well-controlled manner and then their response to stimuli is monitored using fluorescence microscopy. The ACN is developing surfaces that are not only platforms for cell immobilisation but also report on the response of the cells. This is achieved using porous silicon photonic crystals that are combined with enzyme responsive biogels. Immobilised cells that respond to the stimuli, it releases enzymes that degrade the enzyme responsive biogel and the photonic signature changes. The first generation of device detects protease activity released from immune cells. These devices are being developed for in vivo detection of protease activity and towards developing cell chips that can detect the response of arrays of single cells. Such devices are not only valuable tools for personalised medicine and nanotoxicology but also will provide a valuable tool for providing cell biologists with information on cell heterogeneity.

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# Appendix A - Research Projects

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## **Capture and release of single rare cells**

*ARC Centre of Excellence, ARC Discovery grant*

Scientia Professor J. Justin Gooding, Stephen Parker, Leila Zarei

*External collaborators:* Dr. Simone Ciampi (University of Wollongong), Ying Yang (UNSW School of Chemistry)

Rare cells circulating in the blood stream are of prime important in the establishment of metastatic cancers (so called circulating tumour cells or CTCs) and other pathologies. The enumeration of CTCs is of major interest for diagnostics. Most enumeration technologies involve the capture of cells on a surface. Furthermore, being able to studies these cells further in functional assays which requires their release from capture surfaces. ACN has developed technology that allows the electrochemical release of individual cells from anywhere on a surface upon which they are captured. This is a new capability that provided biomedical researchers with a valuable tool to study the heterogeneity in rare cells such as CTCs.

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## **Self-assembled gels for drug release**

Associate Professor Pall Thordarson, Dr. Adam Martin, Dr. Celine Heu, Dr. Warren Truong, Andrew Robinson, Md Musfzur Hassan, Jonathan Wojciechowski, Jennifer Khonasty, Geneviève Duché and Kristel Tjandra  
Children's Cancer Institute

*External collaborators:* ARC CoE in Convergent Bio-Nano Science and Technology, CSIRO, ANSTO, Advanced Soft Materials group - Delft University, University of Liverpool, the University of Wollongong - ARC Centre of Excellence in Electromaterials and the Australian Microscopy & Microanalysis Research facility, The University of Sydney

This project is concerned with developing a new class of materials for drug release and localised delivery, namely self-assembled gels. These materials are formed from small molecules that self-assemble into macroscopic structures yet chemically well-defined structure. Key research questions include issues such as stability, drug release properties, ease of synthesis and biological compatibility.

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# Appendix A - Research Projects

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## **Self-assembled gels for 3D cell cultures and tissue engineering**

Associate Professor Pall Thordarson, Dr. Adam Martin, Dr. Celine Heu, Andrew Robinson, Jonathan Wojciechowski, Garry Tan, Eric Du and Hilary Huynh  
Children's Cancer Institute

Related to the self-assembled gels for drug release project above, we are also investigating the use self-assembled gels for 3D cell cultures and tissue engineering but self-assembled gels appear to be excellent mimics of the Extra-Cellular Matrix (ECM).

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## **Novel light-activated materials for molecular tracking and biosensors**

Associate Professor Pall Thordarson, Dr. James Webb, Dr. Ethan Howe, Ekaterina Nam, Alex Mason, Alistair Laos, Chin Ken Wong  
Mark Wainwright Analytical Centre - UNSW

*External collaborators:* The Centre for Advanced Macromolecular Design, Recombinant Products Facility – UNSW, Coral Reef Laboratory / Institute for Life Science (IfLS), University of Southampton, Institute for Molecular Materials, Radboud University Nijmegen, The Netherlands, Clockwerk Pty Ltd, Sydney, Australia. MacDiarmid Institute for Advanced Materials and Nanotechnology, Victoria University of Wellington, New Zealand.

The main object of this work is developing functional systems that are controlled by light. This includes both redox protein systems that could be used for biosensors, novel approach for tracking the various component in nanoparticle assemblies and new dyes that could be used for cancer research and molecular imaging. Part of this work is also concerned with developing better polymersomes that include light-activated component for applications such as intra-cellular drug trafficking and release.

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# Appendix A - Research Projects

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## **Understanding and controlling protein interaction, assembly and ligand (drug) binding**

Associate Professor Pall Thordarson, Ekaterina Nam, Robert Healey, Alistair Laos, Alex Mason, Susan Ireland and Kristel Tjandra  
Children's Cancer Institute

*External collaborators:* Neptune Bio-Innovation Pty Ltd, Recombinant Products Facility – UNSW, the ARC CoE in Convergent Bio-Nano Science and Technology, Coral Reef Laboratory / Institute for Life Science (IfLS), University of Southampton, Institute for Molecular Materials, Radboud University Nijmegen, The Netherlands and Princeton University

Using approaches from small-molecule-based supramolecular chemistry this project aims to shed a new light on how we can control how proteins interact with each other and other ligands but these interactions underpin various signal processes including those that play a major role in cancers. Additionally, this work could also allow for the development of novel system for drug delivery targeting particular over-expressed protein (receptors) in cancer cells.

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## **Design of multimodal polymeric nanoparticles as targeted carriers for the co-delivery of therapeutic molecules**

*ARC Future Fellowship*

Associate Professor Cyrille Boyer, Professor Tom Davis

Nitric oxide (NO) plays a key role in the development of different diseases. The chronic deficiency of NO results in severe problems such as cardiovascular diseases, liver fibrosis, diabetes, cancer, Alzheimer's diseases, etc. This project will describe a new method to deliver specifically nitric oxide using macromolecules. This project will greatly enhance the tools available to oncologists by providing new treatment options, minimising side-effects to conventional chemotherapy approaches. In this project, the design of next generation of drug delivery will be developed using the most recent advances in materials sciences.

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# Appendix A - Research Projects

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## **Design and development of novel microfluidic co-culture systems**

Dr. Majid Ebrahimi Warkaini, Dr. Jonathan Shemesh

*External collaborators:* Dr. Robert Nordon (UNSW), A/P Guan Yeoh

Glial cells direct neurons in their early stages of development and regulate their normal firing activity. The communication between these two cell types plays a key role in their cellular functions. Conventional *in vitro* techniques are often inadequate to obtain enough information from this complex network. Recent advances in microfluidic technologies have opened doors for creating more realistic *in vitro* cell culture methods that mimic many aspects of the *in vivo* microenvironment such as cellular communication. In this project, we will develop a new microfluidic device for rapid patterning of cells into arbitrary substrates with an interlaced configuration for electrophysiological characterization of neuron-Schwann cell activity.

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## **High throughput microfluidic systems for biomedical applications**

Dr. Majid Ebrahimi Warkiani

Cell sorting is critical for many applications ranging from stem cell research to cancer therapy. Isolation and fractionation of cells using microfluidic platforms have been flourishing areas of development in recent years. The need for efficient and high-throughput cell enrichment, which is an essential preparatory step in many chemical and biological assays, has led to the recent development of numerous microscale separation techniques.

The proposed research is to develop a novel multiplexed microfluidic platform for ultra-high throughput (~ 1-1000 mL/min), label/clog-free separation of targeted cells (e.g., CTCs, MSCs, parasites and yeast) from various biological samples.

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# Appendix A - Research Projects

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## **Fetal cell sorting using inertial microfluidics**

Dr. Majid Ebrahimi Warkiani

*External collaborators:* A/P Benjamin Thierry (UniSA)

Fetal cells from the maternal circulation have the potential to replace cells from amniotic fluid or chorionic villi in a diagnosis of common chromosomal aneuploidies; however, reliable markers for enrichment and identification are still missing. In this study, for the first time, we plan to demonstrate the usability of inertial microfluidics for ultra-fast, label-free isolation of circulating fetal cells found in maternal blood from 5 weeks gestation.

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## **Isolation and characterization of CTCs using inertial microfluidics for early-stage breast cancer patients**

Dr. Majid Ebrahimi Warkiani

*External collaborators:* A/P Benjamin Thierry (UniSA) and Prof. Rik Thompson (QUT)

The potential utility of circulating tumor cells (CTCs) to guide clinical care and understand the biology of metastasis has gained momentum over the past decade evidence by numerous publications and over 270 registered clinical trials. Yet, the clinical utility of CTCs has been hampered due to inherent limitations of conventional approaches for CTC isolation/identification and also scarcity and the lack of reliable markers to enrich these cells. We have recently developed a novel microfluidic system which can isolate and retrieve viable CTCs from blood based on size and deformability of cells, surmounting the shortcomings of traditional affinity-based separation techniques. The main aim of this project is to utilize this system for isolation and identification of CTCs from early-stage breast cancer patients and utilize them as a marker for early cancer diagnosis.

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## **Cell-cycle sorting using spiral microfluidics**

Dr. Majid Ebrahimi Warkiani

The ability to efficiently synchronize and select mammalian cells into different stages of their cell cycle is an important technique for the precise studies of various cellular properties, biological processes, and genetic mechanisms involved in cell cycle phase prior to division. Current chemical-based synchronization methods are unfavourable as these can disrupt cell physiology and metabolism. In this project, I am planning to develop a high-throughput microfluidic system for large-scale cell cycle synchronization suitable for industrial applications. By exploiting the relationship between cell size and its phase in the cell cycle, large numbers of synchronized cells can be obtained by size fractionation.

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# Appendix A - Research Projects

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## **Preclinical development of nanoparticles as RNAi delivery agents for the treatment of cancer**

Prof Maria Kavallaris, Dr Joshua McCarroll, Dr Phoebe Phillips, Ms Joann Teo, Prof. Tom Davis, A/Prof. Cyrille Boyer

Gene silencing is an evolutionarily conserved mechanism of gene control. We are exploiting gene silencing to target abnormally expressed genes driving cancer growth and chemosensitivity in cancer. This cross disciplinary collaboration of chemists and cancer biologists has enabled the development of nanoparticles that can silence genes in cancer cells in both cell line models and preclinical animal models of cancer.

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## **Development of a ddRNAi therapeutic for lung cancer**

Prof Maria Kavallaris, Dr Joshua McCarroll

*External collaborators:* Benitec Biopharma

Intellectual property arising from the Kavallaris lab on specific  $\beta$ -tubulin isotypes in lung cancer (Cancer Res 2007, 2008 and 2010) and their diagnostic and therapeutic utility has led to the filing of several patents. The IP has been assigned to New South Innovations (NSi), including a patent that has been licensed to Benitec (Biopharma) for the therapeutic aspects of suppression of specific  $\beta$ -tubulins. We are working in partnership with Benitec Biopharma Ltd to develop a lung cancer therapeutic based on their proprietary dsRNAi technology and our patent on  $\beta$ -tubulin isotype targeting. During the proof-of-concept stage we demonstrated potent *in vivo* silencing of  $\beta$ -tubulin in a clinically relevant model of non-small cell lung cancer developed in our laboratory that chemosensitised tumours and significantly prolonged the lifespan of mice compared with that of control animals. Based on this highly promising proof-of-concept data, Benitec have continued their support of our preclinical studies, and will be advancing this discovery to clinical trial. This transition from discovery (basic research) to preclinical research, to translation, to a therapeutic product highlights our ability to ultimately move discovery to the bedside.

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# Appendix B

## Publications

# Appendix B - Publications

Target	Actual 2013	Forecast 2014	Actual 2014
Number of DEST "A" Publications	29	22	74

1. Barfidokht, A., and Gooding, J. J. (2014) Approaches Toward Allowing Electroanalytical Devices to be Used in Biological Fluids, *Electroanalysis* 26, 1182-1196.

11th most accessed article in *Electroanalysis* in May 2014  
8th most accessed article in June 2014

- Basuki, J. S., Esser, L., Duong, H. T. T., Zhang, Q., Wilson, P., Whittaker, M. R., Haddleton, D. M., Boyer, C., and Davis, T. P. (2014) Magnetic nanoparticles with diblock glycopolymers shells give lectin concentration-dependent MRI signals and selective cell uptake, *Chemical Science* 5, 715-726.
- Basuki, J. S., Jacquemin, A., Esser, L., Li, Y., Boyer, C., and Davis, T. P. (2014) A block copolymer-stabilized co-precipitation approach to magnetic iron oxide nanoparticles for potential use as MRI contrast agents, *Polymer Chemistry* 5, 2611-2620.
- Benda, A., Kapusta, P., Hof, M., and Gaus, K. (2014) Fluorescence spectral correlation spectroscopy (FSCS) for probes with highly overlapping emission spectra, *Optics Express* 22, 2973-2988.
- Bleach, R., Karagoz, B., Prakash, S. M., Davis, T. P., and Boyer, C. (2014) In situ formation of polymer-gold composite nanoparticles with tunable morphologies, *ACS Macro Letters* 3, 591-596.
- Boyer, C., and Davis, T. P. (2014) Themed issue: Synthesis of polymeric nanomaterials for medicine, *Polymer Chemistry* 5, 1501-1502.
- Brandl, M. B., Pasquier, E., Li, F., Beck, D., Zhang, S., Zhao, H., Kavallaris, M., and Wong, S. T. C. (2014) Computational analysis of image-based drug profiling predicts synergistic drug combinations: Applications in triple-negative breast cancer, *Molecular Oncology* 8, 1548-1560.
- Byrne, F. L., Yang, L., Phillips, P. A., Hansford, L. M., Fletcher, J. I., Ormandy, C. J., McCarroll, J. A., and Kavallaris, M. (2014) RNAi-mediated stathmin suppression reduces lung metastasis in an orthotopic neuroblastoma mouse model, *Oncogene* 33, 882-890.
- Caldwell, B. J., Lucas, C., Kee, A. J., Gaus, K., Gunning, P. W., Hardeman, E. C., Yap, A. S., and Gomez, G. A. (2014) Tropomyosin isoforms support actomyosin biogenesis to generate contractile tension at the epithelial zonula adherens, *Cytoskeleton* 71, 663-676.
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- Chaudhary, N., Gomez, G. A., Howes, M. T., Lo, H. P., McMahon, K. A., Rae, J. A., Schieber, N. L., Hill, M. M., Gaus, K., Yap, A. S., and Parton, R. G. (2014) Endocytic Crosstalk: Cavins, Caveolins, and Caveolae Regulate Clathrin-Independent Endocytosis, *PLoS Biology* 12.
- Chen, X., Cheng, X., Soeriyadi, A. H., Sagnella, S. M., Lu, X., Scott, J. A., Lowe, S. B., Kavallaris, M., and Gooding, J. J. (2014) Stimuli-responsive functionalized mesoporous silica nanoparticles for drug release in response to various biological stimuli, *Biomaterials Science* 2, 121-130.

# Appendix B - Publications

13. Chen, X., Soeriyadi, A. H., Lu, X., Sagnella, S. M., Kavallaris, M., and Gooding, J. J. (2014) Dual biore-sponsive mesoporous silica nanocarrier as an "AND" logic gate for targeted drug delivery cancer cells, *Advanced Functional Materials* 24, 6999-7006.
14. Cheng, X., Lowe, S. B., Ciampi, S., Magenau, A., Gaus, K., Reece, P. J., and Gooding, J. J. (2014) Versatile "click chemistry" Approach to functionalizing silicon quantum dots: Applications toward fluorescent cellular imaging, *Langmuir* 30, 5209-5216.
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16. Chockalingam, M., Magenau, A., Parker, S. G., Parviz, M., Vivekchand, S. R. C., Gaus, K., and Gooding, J. J. (2014) Biointerfaces on indium-tin oxide prepared from organophosphonic acid self-assembled monolayers, *Langmuir* 30, 8509-8515.
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18. Ciampi, S., Luais, E., James, M., Choudhury, M. H., Darwish, N. A., and Gooding, J. J. (2014) The rapid formation of functional monolayers on silicon under mild conditions, *Physical Chemistry Chemical Physics* 16, 8003-8011.
19. Cirillo, G., Mauro, M. V., Spizzirri, U. G., Cavalcanti, P., Puoci, F., Giraldo, C., Vittorio, O., Picci, N., and Iemma, F. (2014) Synthesis, characterization and antimicrobial activity of conjugates based on fluoro-quinolon-type antibiotics and gelatin, *Journal of Materials Science: Materials in Medicine* 25, 67-77.
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23. Duong, H. T. T., Jung, K., Kutty, S. K., Agustina, S., Adnan, N. N. M., Basuki, J. S., Kumar, N., Davis, T. P., Barraud, N., and Boyer, C. (2014) Nanoparticle (star polymer) delivery of nitric oxide effectively ne-gates *Pseudomonas aeruginosa* biofilm formation, *Biomacromolecules* 15, 2583-2589.
24. Eakins, G. L., Gallaher, J. K., Keyzers, R. A., Falber, A., Webb, J. E. A., Laos, A., Tidhar, Y., Weissman, H., Rybtchinski, B., Thordarson, P., and Hodgkiss, J. M. (2014) Thermodynamic factors impacting the peptide-driven self-assembly of perylene diimide nanofibers, *Journal of Physical Chemistry B* 118, 8642-8651.
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# Appendix B - Publications

26. Fife, C. M., McCarroll, J. A., and Kavallaris, M. (2014) Movers and shakers: cell cytoskeleton in cancer metastasis, *British Journal of Pharmacology* 171, 5507-5523.
27. Fu, C., Xu, J., Tao, L., and Boyer, C. (2014) Combining enzymatic monomer transformation with photoinduced electron transfer - Reversible addition-fragmentation chain transfer for the synthesis of complex multiblock copolymers, *ACS Macro Letters* 3, 633-638.
28. Gambin, Y., Ariotti, N., McMahon, K. A., Bastiani, M., Sierrecki, E., Kovtun, O., Polinkovsky, M. E., Magenau, A., Jung, W., Okano, S., Zhou, Y., Leneva, N., Mureev, S., Johnston, W., Gaus, K., Hancock, J. F., Collins, B. M., Alexandrov, K., and Parton, R. G. (2014) Single-molecule analysis reveals self assembly and nanoscale segregation of two distinct cavin subcomplexes on caveolae, *eLife* 2014.
29. Gooding, J., Alam, M. T., Barfidokht, A., and Carter, L. (2014) Nanoparticle mediated electron transfer across organic layers: From current understanding to applications, *Journal of the Brazilian Chemical Society* 25, 418-426.
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31. Guan, B., Magenau, A., Ciampi, S., Gaus, K., Reece, P. J., and Gooding, J. J. (2014) Antibody modified porous silicon microparticles for the selective capture of cells, *Bioconjugate Chemistry* 25, 1282-1289.
32. Hinde, E., Yokomori, K., Gaus, K., Hahn, K. M., and Gratton, E. (2014) Fluctuation-based imaging of nuclear Rac1 activation by protein oligomerisation, *Sci. Rep.* 4.
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34. Hvasanov, D., Nam, E. V., Peterson, J. R., Pornsaksit, D., Wiedenmann, J., Marquis, C. P., and Thordarson, P. (2014) One-pot synthesis of high molecular weight synthetic heteroprotein dimers driven by charge complementarity electrostatic interactions, *Journal of Organic Chemistry* 79, 9594-9602.
35. Jamieson, S. A., Tong, K. W. K., Hamilton, W. A., He, L., James, M., and Thordarson, P. (2014) Small angle neutron scattering (SANS) studies on the structural evolution of pyromellitimide self-assembled gels, *Langmuir* 30, 13987-13993.
36. Karagoz, B., Boyer, C., and Davis, T. P. (2014) Simultaneous polymerization-induced self-assembly (PISA) and guest molecule encapsulation, *Macromolecular Rapid Communications* 35, 417-421.
37. Karagoz, B., Esser, L., Duong, H. T., Basuki, J. S., Boyer, C., and Davis, T. P. (2014) Polymerization-Induced Self-Assembly (PISA)-control over the morphology of nanoparticles for drug delivery applications, *Polymer Chemistry* 5, 350-355.
38. Karagoz, B., Yeow, J., Esser, L., Prakash, S. M., Kuchel, R. P., Davis, T. P., and Boyer, C. (2014) An efficient and highly versatile synthetic route to prepare iron oxide nanoparticles/nanocomposites with tunable morphologies, *Langmuir* 30, 10493-10502.



# Appendix B - Publications

39. Kong, N., Gooding, J. J., and Liu, J. (2014) Protein sensors based on reversible  $\pi$ - $\pi$  stacking on basal plane HOPG electrodes, *Journal of Solid State Electrochemistry* 18, 3379-3386.
40. Kwiatek, J. M., Hinde, E., and Gaus, K. (2014) Microscopy approaches to investigate protein dynamics and lipid organization, *Molecular Membrane Biology* 31, 141-151.
41. Lakshminarayan, R., Wunder, C., Becken, U., Howes, M. T., Benzing, C., Arumugam, S., Sales, S., Ariotti, N., Chambon, V., Lamaze, C., Loew, D., Shevchenko, A., Gaus, K., Parton, R. G., and Johannes, L. (2014) Galectin-3 drives glycosphingolipid-dependent biogenesis of clathrin-independent carriers, *Nature Cell Biology* 16, 592-603.
42. Laos, A. J., Curmi, P. M. G., and Thordarson, P. (2014) Quantum coherence and its impact on biometric light-harvesting, *Australian Journal of Chemistry* 67, 729-739.
43. Li, Y., Laurent, S., Esser, L., Elst, L. V., Muller, R. N., Lowe, A. B., Boyer, C., and Davis, T. P. (2014) The precise molecular location of gadolinium atoms has a significant influence on the efficacy of nanoparticulate MRI positive contrast agents, *Polymer Chemistry* 5, 2592-2601.
44. Liu, P. Y., Erriquez, D., Marshall, G. M., Tee, A. E., Polly, P., Wong, M., Liu, B., Bell, J. L., Zhang, X. D., Milazzo, G., Cheung, B. B., Fox, A., Swarbrick, A., Hüttelmaier, S., Kavallaris, M., Perini, G., Mattick, J. S., Dinger, M. E., and Liu, T. (2014) Effects of a novel long noncoding RNA, lncUSMycN, on N-Myc expression and neuroblastoma progression, *Journal of the National Cancer Institute* 106.
45. Lowe, S. B., Tan, V. T. G., Soeriyadi, A. H., Davis, T. P., and Gooding, J. J. (2014) Synthesis and High-Throughput Processing of Polymeric Hydrogels for 3D Cell Culture, *Bioconjugate Chemistry* 25, 1581-1601.
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50. Michaels, P., Alam, M. T., Ciampi, S., Rouesnel, W., Parker, S. G., Choudhury, M. H., and Gooding, J. J. (2014) A robust DNA interface on a silicon electrode, *Chemical Communications* 50, 7878-7880.
51. Parchi, P. D., Cecchini, M., Antonini, S., Piolanti, N., Andreani, L., Poggetti, A., Lisanti, M., and Vittorio, O. (2014) NANOSTRUCTURED MATERIALS: A NEW APPROACH TO DESIGN INNOVATIVE SCAFFOLDS FOR THE TREATMENT OF BONE DEFECTS, *Bone & Joint Journal Orthopaedic Proceedings Supplement* 96-B, 244-244.
52. Parker, A. L., Kavallaris, M., and McCarroll, J. A. (2014) Microtubules and their role in cellular stress in cancer, *Frontiers in Oncology* 4, 1-19.



# Appendix B - Publications

53. Parviz, M., Darwish, N., Alam, M. T., Parker, S. G., Ciampi, S., and Gooding, J. J. (2014) Investigation of the Antifouling Properties of Phenyl Phosphorylcholine-Based Modified Gold Surfaces, *Electroanalysis* 26, 1471-1480.
54. Rossy, J., Cohen, E., Gaus, K., and Owen, D. M. (2014) Method for co-cluster analysis in multichannel single-molecule localisation data, *Histochemistry and Cell Biology* 141, 605-612.
55. Rossy, J., Ma, Y., and Gaus, K. (2014) The organisation of the cell membrane: Do proteins rule lipids?, *Current Opinion in Chemical Biology* 20, 54-59.
56. Sagnella, S. M., Duong, H., Macmillan, A., Boyer, C., Whan, R., McCarroll, J. A., Davis, T. P., and Kavallaris, M. (2014) Dextran-based doxorubicin nanocarriers with improved tumor penetration, *Biomacromolecules* 15, 262-275.
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58. Shanmugam, S., Xu, J., and Boyer, C. (2014) Photoinduced electron transfer-reversible addition-fragmentation chain transfer (PET-RAFT) polymerization of vinyl acetate and N-vinylpyrrolidinone: Kinetic and oxygen tolerance study, *Macromolecules* 47, 4930-4942.
59. Shanmugam, S., Xu, J., and Boyer, C. (2015) Utilizing the electron transfer mechanism of chlorophyll a under light for controlled radical polymerization, *Chemical Science* 6, 1341-1349.
60. Soeriyadi, A. H., Gupta, B., Reece, P. J., and Gooding, J. J. (2014) Optimising the enzyme response of a porous silicon photonic crystal via the modular design of enzyme sensitive polymers, *Polymer Chemistry* 5, 2333-2341.
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63. Tavallaie, R., De Almeida, S. R. M., and Gooding, J. J. (2014) Toward biosensors for the detection of circulating microRNA as a cancer biomarker: an overview of the challenges and successes, *Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology*.
64. Vittorio, O., Brandl, M., Cirillo, G., Spizzirri, U. G., Picci, N., Kavallaris, M., Iemma, F., and Hampel, S. (2014) Novel functional cisplatin carrier based on carbon nanotubes-quercetin nanohybrid induces synergistic anticancer activity against neuroblastoma in vitro, *RSC Advances* 4, 31378-31384.
65. Vittorio, O., Voliani, V., Faraci, P., Karmakar, B., Iemma, F., Hampel, S., Kavallaris, M., and Cirillo, G. (2014) Magnetic catechin-dextran conjugate as targeted therapeutic for pancreatic tumour cells, *Journal of Drug Targeting* 22, 408-415.
66. Warkiani, M., Wicaksana, F., Fane, A., and Gong, H.-Q. (2014) Investigation of membrane fouling at the microscale using isopore filters, *Microfluid Nanofluid*, 1-9.
67. Xu, J., Atme, A., Marques Martins, A. F., Jung, K., and Boyer, C. (2014) Photoredox catalyst-mediated atom transfer radical addition for polymer functionalization under visible light, *Polymer Chemistry* 5, 3321-3325.

# Appendix B - Publications

68. Xu, J., Jung, K., Atme, A., Shanmugam, S., and Boyer, C. (2014) A robust and versatile photoinduced living polymerization of conjugated and unconjugated monomers and its oxygen tolerance, *Journal of the American Chemical Society* 136, 5508-5519.

Ranked as 'Highly Cited' and 'Research Front' by Web of Science  
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69. Xu, J., Jung, K., and Boyer, C. (2014) Oxygen tolerance study of photoinduced electron transfer-reversible addition-fragmentation chain transfer (PET-RAFT) polymerization mediated by Ru(bpy)<sub>3</sub>Cl<sub>2</sub>, *Macromolecules* 47, 4217-4229.

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73. Zhu, Y., Soeriyadi, A. H., Parker, S. G., Reece, P. J., and Gooding, J. J. (2014) Chemical patterning on preformed porous silicon photonic crystals: Towards multiplex detection of protease activity at precise positions, *Journal of Materials Chemistry B* 2, 3582-3588.

Front Cover Article

74. Zong, X., Kong, N., Liu, J., Yang, W., Cao, M., and Gooding, J. J. (2014) The influence of graphene on the electrical communication through organic layers on graphite and gold electrodes, *Electroanalysis* 26, 84-92.

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# Appendix C

## Conference Presentations

# Appendix C - Conference Presentations

Target	Actual 2013	Forecast 2014	Actual 2014
Number of Australian conferences presented	15	10	61
Number of international conferences presented	25	20	18

## P - Plenary      K - Keynote      I - Invited

- I 1. J.J. Gooding, A.L. Gui, G. Liu, A. Barfidokht, Electrodes that resist protein fouling when used in biological fluids: Applications for biosensing, cell biology and implantable electrodes, 11th Annual World Congress of the Society for Brain Mapping and Therapeutics, Sydney, Australia, 17-19 March 2014.
- I 2. J.J. Gooding, S. Ciampi, G. Liu, A. Barfidokht, Nanobioelectronic Interfaces that Facilitate Efficient Electron Transfer to Biomolecules, 11th Annual World Congress of the Society for Brain Mapping and Therapeutics, Sydney, Australia, 17-19 March 2014.
- I 3. M. Kavallaris, Targeting the Tumor Cytoskeleton, 14th Hunter Cellular Biology Meeting, Pokolbin, Australia, 25-28 March 2014.
- I 4. M. Kavallaris,  $\beta$ III-tubulin is required for the tumorigenic phenotype and resistance to anoikis via the PTEN/AKT signaling axis in non-small cell lung cancer, AACR Annual Meeting, San Diego, USA, 5-9 April 2014.
- I 5. A. Parker, M. Kavallaris,  $\beta$ III-Tubulin and cell survival: Novel role in endoplasmic reticulum stress and autophagy in non-small cell lung cancer, AACR Annual Meeting, San Diego, USA, 5-9 April 2014.
- I 6. C. Fife, M. Kavallaris, Stathmin regulates cell migration, invasion and transendothelial migration via RhoA activation in neuroblastoma, AACR Annual Meeting, San Diego, USA, 5-9 April 2014.
- K 7. M. Kavallaris, Nanoparticle Targeting of Drug Resistance in Cancer, American Association for Pharmaceutical Sciences (AAPS) Workshop, Shanghai, China, 25-26 April 2014.
- I 8. C. Boyer, Photoinduced Electron Transfer: A Robust and Versatile Technique for the Synthesis of Well-defined Polymers under Air and their Post-Modifications, 3rd International Symposium on Controlled/Living Polymerization: From Synthesis to Applications, CLP'14, Antalya, Turkey, 1-4 May 2014.
- I 9. K. Gaus, Molecular insights into T cell signalling with single molecule localisation microscopy, EMBO Conference: Lymphocyte signalling, Bertinoro, Italy, 17-21 May 2014.
- P 10. J.J. Gooding, Nanomaterial Based Biosensors for Diagnostics and Personalised Medicine, Biosensors 2014, 24th Anniversary World Congress on Biosensors, Melbourne, Australia, 27-30 May 2014.
- I 11. R. Tavalalaie, S. De Almeida, N. Darwish, D.B. Hibbert, J.J. Gooding, Ultrasensitive nanosensors offer a new way to detect serum circulating microRNA, Biosensors 2014, 24th Anniversary World Congress on Biosensors, Melbourne, Australia, 27-30 May 2014.
- I 12. Y. Zhu, A. Soeriyadi, P. Reece, K. Gaus, J.J. Gooding, Micropatterned porous silicon photonic crystal and multiplexing enzyme detection, Biosensors 2014, 24th Anniversary World Congress on Biosensors, Melbourne, Australia, 27-30 May 2014.

# Appendix C - Conference Presentations

13. P. Thordarson, Is my binding model correct? A case study from an ion-pair receptor, 9th International Conference on Macrocyclic and Supramolecular Chemistry (ICMSC-9), Shanghai, China, 7-11 June 2014.

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58. M. Kavallaris, Nanotechnology: The next best thing in medicine, Australian Health & Medical Research Congress, Melbourne, Australia, 16-19 November 2014.
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