



THE UNIVERSITY OF  
NEWCASTLE  
AUSTRALIA

FACULTY OF SCIENCE &  
INFORMATION TECHNOLOGY



HONOURS RESEARCH TOPICS

2011

# HONOURS

## **CONTENTS: HONOURS RESEARCH TOPICS (2011)**

---

### **School of Design, Communication & IT**

Communication.....	2
Design .....	4
Natural History Illustration .....	5
Information Technology.....	5

### **School of Environmental & Life Sciences**

Applied Science (Ourimbah Campus).....	10
Biological Sciences.....	15
Chemistry.....	33
Earth Sciences.....	40
Development Studies .....	45
Geography & Environmental Studies .....	48

### **School of Mathematical & Physical Sciences**

Mathematics.....	52
Physics.....	58
Statistics.....	68

### **School of Psychology**

Psychology.....	71
-----------------	----

### COMMUNICATION

---

#### **Public Relations**

Public relations is both a professional practice and a subfield of communication with its own research and theory base. Public relations is relatively young as an academic field, having developed identifiable theory in only the last 30 years. The theoretical debates are far from settled and scholars from across the world, including scholars from this university, are contributing their research findings to further these debates in areas including the construction of meaning in contested spaces and the strategic management of communication. The field of public relations has developed into a theoretically based area of applied communication that has the potential to inform several areas of communication/mass communication and to offer theoretic and conceptual tools in many areas of communication industry practice. The advent of social media and new technologies potentially provides the field of public relations with huge challenges and opportunities, some of which are the focus of research being undertaken at the University of Newcastle. Projects are invited that explore aspects of the management of communication in public relations contexts, including from critical perspectives offered through discourse or semiotic approaches.

*Contact: Ms Melanie James*

*Phone: (02) 4985 4522*

*Email: [Melanie.James@newcastle.edu.au](mailto:Melanie.James@newcastle.edu.au)*

*Contact: Dr. H  l  ne de Burgh-Woodman*

*Phone: (02) 4921 6765*

*Email: [Helene.Deburgh-Woodman@newcastle.edu.au](mailto:Helene.Deburgh-Woodman@newcastle.edu.au)*

*Design, Information & Human Communication Group*

#### **Documentary Production and Creative Practitioner Research**

The research uses a Practitioner-Based Enquiry (PBE) approach in examining how form, format and an aesthetic style develops through the process of writing/directing independent documentary film. The project takes a specific focus on various approaches that Australian documentaries take in regard to effective approaches to the storytelling process. The Tin City project involves the production of a half-hour documentary program, based on the lives of a small, unique community who reside in tin shacks at the Stockton Bight, north of Newcastle.

*Contact: Ms Susan Kerrigan*

*Phone: (02) 4985 4517*

*Email: [Susan.Kerrigan@newcastle.edu.au](mailto:Susan.Kerrigan@newcastle.edu.au)*

*Design, Information & Human Communication Group*

*Contact: Mr Michael Meany*

*Phone: (02) 4985 4525*

*Email: [Michael.Meany@newcastle.edu.au](mailto:Michael.Meany@newcastle.edu.au)*

*Design, Information & Human Communication Group*

#### **Creativity and Innovation in Cultural Production**

Creativity is not, according to the latest research, a process of self-discovery in a freely expressive romantic process. Nor is it simply confined to the arts. In fact the latest research is showing that creativity and innovation involves an agent who necessarily engages with the social and cultural structures that both limit and enable their creative activity. It is a basic human activity that works across both the arts and sciences. It is multifactorial in origin. One of the confluence models developed from the current body of research, the systems model of creativity, is being tested at this University in a number of areas. These include journalism, children's literature, songwriting, video and documentary making, website construction, sound and radio production and so on. Projects are invited that explore similar areas of creative concern via an application of the systems model. Methodologies include quantitative and qualitative forms (experiments, surveys, ethnographies and case studies) as well as practitioner-based enquiry (PBE).

Contact: Dr Phillip McIntyre  
Phone: (02) 4985 4522  
Email: [Phillip.McIntyre@newcastle.edu.au](mailto:Phillip.McIntyre@newcastle.edu.au)

Contact: Dr Judith Sandner  
Phone: (02) 4921 7474  
Email: [Judith.Sandner@newcastle.edu.au](mailto:Judith.Sandner@newcastle.edu.au)

Contact: Mr Michael Meany  
Phone: (02) 4985 4525  
Email: [Michael.Meany@newcastle.edu.au](mailto:Michael.Meany@newcastle.edu.au)  
Design, Information & Human Communication Group

### **Poetics, Aesthetics and Ethics**

Communication practices can be explored through a variety of creative and philosophical approaches. Poetics allows us to understand how we go about doing what it is we do. Poetics allows us to explore the how of what we do as we do it. The outcomes can be creative as well as philosophically novel. Aesthetics allows us to approach communication objects from the perspective of reception. What is the audience response, what do they perceive, how can media artists instruct intentions within objects? Ethics gets us to the why of the what of things. Media objects always raise ethical issues. Media effects is one of the short cuts to this question of why.

Contact: Dr Keith Russell  
Phone: (02) 4985 4533  
Email: [Keith.Russell@newcastle.edu.au](mailto:Keith.Russell@newcastle.edu.au)  
Design, Information & Human Communication Group

### **Journalism**

Research in the field of journalism encompasses a very broad area. For example, research can focus on journalists and their actions or journalism and society. Students can research and engage with texts or journalists or their audiences/readers/listeners. Honours research at UoN in journalism has included creative projects where students have combined an exegesis with a creative work. In 2009, one student undertaking journalism-related research created a radio series on "Coal and the Community", while another examined the impact of Web 2.0 technologies on the communication strategies of the major parties on the Australian political scene. Students interested in journalism related topics have a very open brief to develop a research question that will maintain their interest and academic staff work with them to focus that interest in a manner that will result in Honours research work that is focused, enjoyable and very achievable.

Contact: Mr Paul Scott  
Phone: (02) 4921 8644  
Email: [Paul.Scott@newcastle.edu.au](mailto:Paul.Scott@newcastle.edu.au)

Contact: Ms Christina Koutsoukos  
Phone: (02) 4921 8775  
Email: [Christina.Koutsoukos@newcastle.edu.au](mailto:Christina.Koutsoukos@newcastle.edu.au)

Contact: Ms Felicity Biggins  
Phone: (02) 4921 6781  
Email: [Felicity.Biggins@newcastle.edu.au](mailto:Felicity.Biggins@newcastle.edu.au)  
Design, Information & Human Communication Group

### **How Religion, Media and Culture Intersect**

Projects could take an inter-disciplinary approach in seeking to examine the intersection of these spheres in particular the mediatization of religion and culture.

Contact: Ms Christina Koutsoukos  
Phone: (02) 4921 8775  
Email: [Christina.Koutsoukos@newcastle.edu.au](mailto:Christina.Koutsoukos@newcastle.edu.au)  
Design, Information & Human Communication Group

**Current Honours' student projects include:**

- Environmental activism in Newcastle – 1999 to 2009.
- Communication and coal in the Upper Hunter.
- Facebook Fogies: a uses and gratifications approach to 55-64 year olds on Facebook.
- The HPV school vaccination programme: an examination of the sources and nature of information provided to parents and their constructions of meaning about the product and the programme.
- “Soul Invaders”: an exploration of heavy metal culture in Newcastle and Sydney.
- Disaster Porn.
- The future of news: examining the potential ramifications of online news for credibility.

## DESIGN

---

**Visual Communication Design**

Graphic design is concerned with the visual environment. It is an intellectual, technical and creative activity. It is focused on all aspects of the production of images, from analysis and presentation to distribution and reception. Graphic design creates visual solutions to communication problems. It is an exciting area of research and study because of the increased importance of graphic design in the communication mix of an online world.

Research areas within the discipline include:

- Visual Communication Principles
- Concept Illustration and Visualisation
- Digital Media and Virtual Technologies
- Digital Illustration
- Stop Motion Animation and Animation
- Instructional Design
- Cognitive Load Theory

Contact: Mr Michael Dickinson

Phone: (02) 4921 6397

Email: [michael.dickinson@newcastle.edu.au](mailto:michael.dickinson@newcastle.edu.au)

Design, Information & Human Communication Group

**Current Honours' student projects include:**

- Children and advertising.
- Editorial design.
- The design, construction and marketing processes of designer vinyl toys.
- The use of written and verbal language and its affect on the creation and interpretation of the design brief.
- Creativity, thinking and their application to design.
- How does visual communication influence advertising and marketing of products.
- Why stop motion animation?
- The influence theory has on the creative process and how it shapes the design process.
- The role of imagery in point of purchase positioning.
- Elements of successful modern day album cover design.

# NATURAL HISTORY ILLUSTRATION

---

## Natural History Illustration

Honours students in Natural History Illustration are encouraged to develop their own projects which will be reviewed before students are accepted into the program. In the past students have come from a variety of discipline areas and projects have covered a wide range of topics. Prospective students are encouraged to submit their proposed project outline for consideration to the Natural History Illustration program convenor Dr Trevor Weekes. Applicants for admission must have successfully completed a relevant undergraduate degree or four year diploma in Illustration, Fine Art, Design or equivalent, including science, with a minimum GPA of 5.0 (Credit Grade Average overall) across the entire program.

Contact: *Dr Trevor Weekes*  
Phone: (02) 4921 6371  
Email: [Trevor.Weekes@newcastle.edu.au](mailto:Trevor.Weekes@newcastle.edu.au)

Contact: *Dr Anne Llewellyn*  
Phone: (02) 4925 4544  
Email: [Anne.Llewellyn@newcastle.edu.au](mailto:Anne.Llewellyn@newcastle.edu.au)  
*Wildlife Representation Group*

## Current Honours' student projects include:

- 'The secret life of the Platypus.'
- With the advent of 3D digital imaging has the need for traditional dioramas come to an end?
- Ordinary beauty of flora and fauna found in a specific land site – illustrated creatively and technically.
- Animation and illustration for a series of short stories.
- Evaluation and illustrated folio on plants considered as “weeds”.

# INFORMATION TECHNOLOGY

---

## Data Mining on Health Research Data

Data Mining (DM) provides a means for exploratory analysis of large data sets. A number of IT tools and techniques are available for exploratory data analysis. This project aims to explore health research data collected on pregnancies using Data Mining techniques. The project entails working with both IT and Health researchers to analyse the data with the goal of developing a model to characterise status of a pregnancy based on the different characteristics of the data set. The student will use both statistical and DM IT tools to analyse the data and interact with IT and health researchers in interpreting/visualising them.

Contact: *Dr Rukshan Athauda*  
Phone: (02) 4985 4507  
Email: [Rukshan.Athauda@newcastle.edu.au](mailto:Rukshan.Athauda@newcastle.edu.au)  
*Visual Information Processing (VIP) Group*

## Implementation of Database Privilege Monitor

Eliciting security privilege requirements from users pose a considerable challenge to IT administrators in today's complex IT environments. Further, IT users themselves are typically unaware of the different permissions that are needed to perform their daily activities, thus making it more difficult in determining these privilege requirements. This project aims to develop a tool, called Database Privilege Monitor, for SQL Server database server. The tool will allow IT administrators to determine permission requirements of users by observing the different actions the user performs on a SQL Server database. The student will develop a program to read SQL Server's Profiler trace (i.e. XML file) and determine the permissions needed by a particular user. These permissions will be displayed using a “Privilege Manager Console” to the IT administrator.

Contact: Dr Rukshan Athauda  
Phone: (02) 4985 4507  
Email: [Rukshan.Athauda@newcastle.edu.au](mailto:Rukshan.Athauda@newcastle.edu.au)  
Visual Information Processing (VIP) Group

### **The Utility of RFID Tagging Systems**

This project will explore the use of RFID tags and the limitations that this increasingly popular technology places on applications development. What environments are suitable for RFID applications? How far can the technology be stretched?

Contact: Dr Brian Regan  
Phone: (02) 4954 4530  
Email: [Brian.Regan@newcastle.edu.au](mailto:Brian.Regan@newcastle.edu.au)  
Visual Information Processing (VIP) Group

### **Computer modelling in economics, business and the environment**

This project offers a number of potential topics for study that include:

- a. Visualisation of massive quantities of model output data;
- b. Web interfaces and implementations of models

Contact: Dr Ric Herbert, Ourimbah Campus  
Phone: (02) 4349 4492  
Email: [Ric.Herbert@newcastle.edu.au](mailto:Ric.Herbert@newcastle.edu.au)  
Visual Information Processing (VIP) Group

### **Real time sensor data on websites**

This project offers a number of potential topics for study that include:

- a. How much electricity do solar panels generate: Databases and website display of household solar panel data;
- b. Comparing different sensor data.

Contact: Dr Ric Herbert, Ourimbah Campus  
Phone: (02) 4349 4492  
Email: [Ric.Herbert@newcastle.edu.au](mailto:Ric.Herbert@newcastle.edu.au)  
Visual Information Processing (VIP) Group

### **Reducing e-waste by extending the life of junked computing equipment**

This project offers a number of potential topics for study that include:

- a. Constructing grids of e-waste computers;
- b. Software applications for grids of recycled computers (e.g. data cleaning and mining; database servers);
- c. Business models for making grids of recycled computers financially sustainable;
- d. Web and other applications using junked computing equipment.

Contact: Dr Ric Herbert, Ourimbah Campus  
Phone: (02) 4349 4492  
Email: [Ric.Herbert@newcastle.edu.au](mailto:Ric.Herbert@newcastle.edu.au)  
Visual Information Processing (VIP) Group

### **Applied Techniques in Visual Information Processing**

The project aims to investigate various image processing techniques such as filtering, feature extraction, segmentation, compression and visualization. It will then be applied in solving real problems such as medical imaging, machine vision, robot, scientific visualization. The project requires knowledge of C++ programming, image formatting and image processing.

Contact: Professor Jesse Jin  
Phone: (02) 4985 4505  
Email: [Jesse.Jin@newcastle.edu.au](mailto:Jesse.Jin@newcastle.edu.au)  
Visual Information Processing (VIP) Group

### **Business to Customer Information System**

We have developed a B2C (Business to Customer) system and would like to extend it to include some B2B modules. Various data mining techniques will be used in information management. The project aims to develop a Web-based E-Business system. Various business portals will be investigated. The project requires knowledge of apache, tomcat, J2EE or php programming skills and mysql.

*Contact: Professor Jesse Jin*

*Phone: (02) 4985 4505*

*Email: [Jesse.Jin@newcastle.edu.au](mailto:Jesse.Jin@newcastle.edu.au)*

*Visual Information Processing (VIP) Group*

### **Issues in Multimedia**

The project aims to investigate various multimedia issues such as image retrieval, video cataloguing, 3D modeling, morphing, animation, special video effects, etc. The student will be required to work in one of the selected area and develop a workable system for one of the application. For example, the project on video cataloguing will produce a video database management system which will be capable of archiving and retrieving video streams. The project requires knowledge of C++ or Java programming and INFT3201 (Multimedia Transmission, Storage and Management).

*Contact: Professor Jesse Jin*

*Phone: (02) 4985 4505*

*Email: [Jesse.Jin@newcastle.edu.au](mailto:Jesse.Jin@newcastle.edu.au)*

*Visual Information Processing (VIP) Group*

### **Advanced liver parenchyma segmentation for liver disease diagnosis using texture analysis and machine learning**

This research aims to develop an innovative methodology that can segment liver parenchyma in multi-slice spiral/helical CT images. Automatic segmentation of liver parenchyma is crucial for an advanced computer-aided liver disease diagnosis and liver surgical planning system such as a system for liver transplantation. This research will achieve a breakthrough in non-rigid organ segmentation, a key area of medical image analysis. The segmentation algorithm is novel in that it combines CT image texture analysis with machine learning and adapts to the structures of neighbouring organs and tissues. This research will result in effective liver disease diagnosis, reduced risk for liver patient, higher quality in surgical planning and more effective interventions.

*Contact: Dr Suhuai Luo*

*Phone: (02) 4985 4508*

*Email: [Suhuai.Luo@newcastle.edu.au](mailto:Suhuai.Luo@newcastle.edu.au)*

*Visual Information Processing (VIP) Group*

### **Finding Temporal Patterns in a 3D Visualisation**

In this project the student will develop a generic 3D visualisation of a large data set, such as stock market data or statistics from a football match. The key aspect of this display is that it will involve opposing and complementary forces, such as buyers and sellers in the stock market or two opposing football teams. The aim for the display is to find short temporal patterns in the data that help predict future outcomes, such as the price of the stock market or the winner of the football match.

*Contact: Dr Keith Nesbitt*

*Phone: (02) 4985 4519*

*Email: [Keith.Nesbitt@newcastle.edu.au](mailto:Keith.Nesbitt@newcastle.edu.au)*

*Visual Information Processing (VIP) Group*

### **Information, Perception and Cognition in Multi-sensory Computer Games**

Providing players with “Information” is often a critical consideration in the design of computer games. We may wish to increase or decrease the amount of information depending on the game situation and the player’s performance. This research investigates how we can manipulate the amount of information being displayed using multiple senses (visual, sound, touch). This is a broad topic area but it is only expected that the student will investigate a single relevant issue surrounding perception or cognition in the context of a current computer game.

*Contact: Dr Keith Nesbitt  
Phone: (02) 4985 4519  
Email: [Keith.Nesbitt@newcastle.edu.au](mailto:Keith.Nesbitt@newcastle.edu.au)  
Visual Information Processing (VIP) Group*

### **Navigating Knowledge using a Metro Map Layout**

Metro maps were first introduced on the London Underground and now have become a common place tool for navigating transport routes around the world. Can more abstract knowledge be represented in this way? Would such a layout help novice users navigate through the unfamiliar content. For example, a university subject often contains a number of “tracks” or subject areas that overlap in places. Each track has topics which can be thought of as “stations”. In this project a Metro Map will be developed for a single university subject and then evaluated in a simple experiment.

*Contact: Dr Keith Nesbitt  
Phone: (02) 4985 4519  
Email: [Keith.Nesbitt@newcastle.edu.au](mailto:Keith.Nesbitt@newcastle.edu.au)  
Visual Information Processing (VIP) Group*

### **Simulating Agent-based Emotions**

In this project the student will develop an agent-based simulation to be used in a computer game. A key aspect of these agents is that they will have a simple model of conflicting “emotions” that will influence the game play. The model of emotion may draw on existing ideas from psychology, neuroscience and artificial intelligence. The “emotional” model itself will be relatively simple although complex dynamics may emerge from the interaction of the agents in the game world.

*Contact: Dr Keith Nesbitt  
Phone: (02) 4985 4519  
Email: [Keith.Nesbitt@newcastle.edu.au](mailto:Keith.Nesbitt@newcastle.edu.au)  
Visual Information Processing (VIP) Group*

### **Using Software Design Principles to ‘improve’ Teaching Materials**

This research project investigates the use of software design approaches (object-modelling, processes, patterns, architectures) to improve the quality of instructional materials? The project will focus on existing courses in Bit degree and examine how a software engineering design approach could impact on the reusability, generativity, adaptability, scalability and quality of learning resources?

*Contact: Dr Keith Nesbitt  
Phone: (02) 4985 4519  
Email: [Keith.Nesbitt@newcastle.edu.au](mailto:Keith.Nesbitt@newcastle.edu.au)  
Visual Information Processing (VIP) Group*

### **Facilitating Collaborative Intelligence Analysis Using Computational Methods**

The key question of this research area is: “How can the intelligence analysis process be improved through the utilisation of Digital Collaborative Environment technologies?”. Collaboration within and between allied intelligence organisations is vital for effective national and international security. The review of available literature shows that there is a fundamental lack of collaboration within and between intelligence organisations. This lack of collaboration has been blamed for the failure to prevent of more than one terrorist attack, including the September 11th attacks. This research project aims to address some of these issues by investigating, designing, and developing digital collaborative solutions to facilitate Collaborative Intelligence Analysis.

Contact: Dr Geoff Skinner  
Phone: (02) 498 54512  
Email: [Geoff.Skinner@newcastle.edu.au](mailto:Geoff.Skinner@newcastle.edu.au)  
Visual Information Processing (VIP) Group

**Current Honours' student projects include:**

- Web interfaces to computer-based modelling.
- Predator/Prey model of software development.
- Application of web frameworks and content management systems for large datasets.
- Java applications on computing grids.

### APPLIED SCIENCE (OURIMBAH CAMPUS)

---

#### **Influence of external factors on peripheral blood flow**

Near infrared spectroscopy is a new non-invasive technique that is used to monitor both oxygenated and deoxygenated haemoglobin through muscles. There is little evidence as to the effect that a number of external factors, such as the environment, posture or training has on the validity of its measures. This area of research would target closing.

Contact: *Dr Ben Dascombe*  
Phone: (02) 4348 4150  
Email: [Ben.Dascombe@newcastle.edu.au](mailto:Ben.Dascombe@newcastle.edu.au)  
Exercise & Sport Science Group

#### **Physiology of compression garments**

Compression garments are increasingly popular amongst athletes, though there is very little scientific evidence to support their use. There is an opportunity for students to continue on from several previous studies looking at the benefits and effects of wearing compression garments both during and following exercise.

Contact: *Dr Ben Dascombe*  
Phone: (02) 4348 4150  
Email: [Ben.Dascombe@newcastle.edu.au](mailto:Ben.Dascombe@newcastle.edu.au)  
Exercise & Sport Science Group

#### **Adaptation of resistance training methods to female steroid hormone fluctuations**

The female steroid hormone oestrogen is known for its anabolic effects. It would therefore be expected that conditions for muscle growth are better when oestrogen is elevated. Thus the variability in oestrogen levels due to the menstrual cycle may affect the ability of skeletal muscle to respond to training. The aim of this research is to establish if adaptations of resistance training programs to fluctuations in oestrogen will result in greater strength gains than traditional training programs. Significant improvements with the oestrogen adapted training would revolutionize training regimes for female athletes and assist in improving musculoskeletal rehabilitation programs for females.

Contact: *Dr Xanne Janse de Jonge*  
Phone: (02) 4349 4566  
Email: [x.jansedejonge@newcastle.edu.au](mailto:x.jansedejonge@newcastle.edu.au)  
Exercise & Sport Science Group

#### **Applied Sport Science research in Soccer**

There are opportunities for applied sport science research working with a professional soccer team. Details of the project will be determined in consultation with the soccer team's sport science staff.

Contact: *Dr Xanne Janse de Jonge*  
Phone: (02) 4349 4566  
Email: [x.jansedejonge@newcastle.edu.au](mailto:x.jansedejonge@newcastle.edu.au)  
Exercise & Sport Science Group

#### **The effects of elastic cord towing on sprint kinematics**

The ability to run fast is an important component to many different team sports. A range of training techniques are used in an attempt to improve sprinting ability. Overspeed sprinting is a speed training method whereby an athlete is towed by an external device that allows them to reach a supramaximal running velocity. Elastic cord towing is one such technique. The aim of this research will be to document how elastic cord towing affects the sprint technique of team sport athletes. This information can then be used to design specific speed training programs for these athletes.

Contact: Mr Robert Lockie  
Phone: (02) 4349 4428  
Email: [Robert.Lockie@newcastle.edu.au](mailto:Robert.Lockie@newcastle.edu.au)  
Exercise & Sport Science Group

### **The effects of nutritional supplementation and resistance training on muscle strength and hypertrophy**

There are opportunities for research analysing the effects of resistance training in conjunction with a range of nutritional supplements on muscle strength and hypertrophy in trained and/or untrained individuals. Details of the project will be determined in consultation with sport science academics.

Contact: Mr Robert Lockie  
Phone: (02) 4349 4428  
Email: [Robert.Lockie@newcastle.edu.au](mailto:Robert.Lockie@newcastle.edu.au)  
Exercise & Sport Science Group

### **Role of vitamin B12 polymorphism in hypertension**

Vitamin B12 is crucial for folate dependent one-carbon metabolism and methyl group formation. It is cofactor for methionine synthase which converts homocysteine into methionine. Homocysteine is a vasculotoxic thiol that acts as an independent risk factor for CVD with the same magnitude of effect as cholesterol. This study will see if the transcobalamin II Pro259Arg polymorphism alters homocysteine level and acts as a risk factor for hypertension in an elderly Australian population.

Contact: Dr Mark Lucock  
Phone: (02) 4348 4109  
Email: [mark.lucock@newcastle.edu.au](mailto:mark.lucock@newcastle.edu.au)

Contact: Dr Zoe Yates  
Phone: (02) 4349 4560  
Email: [zoe.yates@newcastle.edu.au](mailto:zoe.yates@newcastle.edu.au)

Contact: Dr Paul Roach  
Phone: (02) 4348 4129  
Email: [paul.roach@newcastle.edu.au](mailto:paul.roach@newcastle.edu.au)

Contact: Dr Martin Veysey  
Phone: (02) 4320 3022  
Email: [mveysey@nscchhs.health.nsw.gov.au](mailto:mveysey@nscchhs.health.nsw.gov.au)  
Nutrition, Food & Health Group

### **Vitamin B12 polymorphism in colonic adenoma formation**

Vitamin B12 is crucial for folate dependent one-carbon metabolism and methyl group formation. It is cofactor for methionine synthase which converts homocysteine into methionine. Methionine contributes methyl groups for epigenetic modifications that modulate gene expression. If the transcobalamin II Pro259Arg polymorphism alters methionine level it may act as a risk factor for early dysplastic changes in the colonic epithelium via altered CpG methylation of DNA. The prevalence of this SNP will be examined in patients with and without colonic polyps.

Contact: Dr Mark Lucock  
Phone: (02) 4348 4109  
Email: [mark.lucock@newcastle.edu.au](mailto:mark.lucock@newcastle.edu.au)

Contact: Dr Zoe Yates  
Phone: (02) 4349 4560  
Email: [zoe.yates@newcastle.edu.au](mailto:zoe.yates@newcastle.edu.au)

Contact: Dr Paul Roach  
Phone: (02) 4348 4129  
Email: [paul.roach@newcastle.edu.au](mailto:paul.roach@newcastle.edu.au)

Contact: *Dr Martin Veysey*  
Phone: (02) 4320 3022  
Email: [mveysey@nscchhs.health.nsw.gov.au](mailto:mveysey@nscchhs.health.nsw.gov.au)  
Nutrition, Food & Health Group

### **Effect of acidity and heat on maca - starch interactions**

Maca is a traditional south American plant extract associated with numerous health benefits. One of its major potential applications is in the baking industry, therefore, the interactions with various starches under a range of pH conditions need to be assessed. The objective of this study is to enhance the understanding of those interactions and evaluate the potential of incorporating maca in a number of applications.

Contact: *Dr Costas Stathopoulos*  
Phone: (02) 4348 4124  
Email: [costas.stathopoulos@newcastle.edu.au](mailto:costas.stathopoulos@newcastle.edu.au)  
Nutrition, Food & Health Group

### **Effects of coagulant type and concentration on the quality attributes of tofu**

The quality of tofu is significantly influenced by the type of coagulant and the process followed. Coagulation of soymilk is the most important step in tofu making and the most difficult to control because it depends on the interrelationships of many variables. The objective of this study is to determine the effect the type and concentration of coagulant has on the yield and the quality characteristics of the final product during small scale tofu manufacture.

Contact: *Dr Costas Stathopoulos*  
Phone: (02) 4348 4124  
Email: [costas.stathopoulos@newcastle.edu.au](mailto:costas.stathopoulos@newcastle.edu.au)  
Nutrition, Food & Health Group

### **Biogeomorphic Processes of Recovery from Historical Channel Incision/ Fluvial geomorphology and Aquatic Ecology**

Many Australian rivers have incised by up to 8 m and widened by up to 100 m since initial European settlement, supplying enormous quantities of sediment to downstream areas. Some rivers have now started to recovery from such incision and the biogeomorphic processes involved need to be determined so that such recovery can be accelerated by river restoration works. This project will determine the biogeomorphic processes of channel recovery on a series of incised channels in the Wollombi Brook catchment, on which Professor Erskine has been researching for the last 30 years. Extensive channel and vegetation surveys need to be repeated for the fourth time in 30 years to help evaluate these processes and will be supplemented by additional sedimentological and botanical research. Alternation between sand-bed channels and chain of ponds has occurred repeatedly in the geologic past and needs to be avoided in the future.

Contact: *Professor Wayne Erskine*  
Phone: (02) 4348 4152  
Email: [Wayne.Erskine@newcastle.edu.au](mailto:Wayne.Erskine@newcastle.edu.au)  
Sustainable Use of Coasts & Catchments Group

*\* Dr Anita Chalmers is also interested in the riparian vegetation component.*

### **Characterisation, Formation, Conservation Significance, and Vegetation and Fish Communities of Chain of Ponds/ Fluvial Geomorphology and Aquatic Ecology**

Chain of ponds were often mentioned by the first European explorers on many Australian rivers. They have supposedly been destroyed by subsequent gully erosion and channel incision on many rivers. The characteristics, modes of formation, conservation significance and associated vegetation and fish communities need to be determined. The purpose of this project is to answer these questions by examining a series of remnant ponds on Wollombi Brook and comparing their characteristics with reaches where ponds have been destroyed.

Contact: Professor Wayne Erskine  
Phone: (02) 4348 4152  
Email: [Wayne.Erskine@newcastle.edu.au](mailto:Wayne.Erskine@newcastle.edu.au)  
Sustainable Use of Coasts & Catchments Group

\* Dr Anita Chalmers and Dr Barbara MacTaggart are also interested in the riparian vegetation component.

### **Floodplain Formation on Laterally Stable, Meandering Streams/ Fluvial Geomorphology**

Meandering rivers usually form floodplains by lateral migration or cutbank erosion on the outside of bends followed by point bar formation on the inside of bends. However, there are many meandering rivers which apparently do not migrate but are flanked by extensive floodplains. The critical questions to be answered by this research are: How did the meandering channel pattern develop? Why did the channel cease meandering? And how did the floodplain form? The interaction of dense, pliable riparian vegetation with high loadings of in-channel, large wood (diameters > 0.1m) and fine-grained channel margin sediments often inhibits lateral migration. In such cases, lateral migration developed the meandering channel before the invasion/colonisation of the riparian vegetation community. However, in other cases, lateral migration is very slow and can develop with the riparian vegetation. The relative contribution of point bar versus overbank deposits to the total floodplain sediment volume remains unknown.

Contact: Professor Wayne Erskine  
Phone: (02) 4348 4152  
Email: [Wayne.Erskine@newcastle.edu.au](mailto:Wayne.Erskine@newcastle.edu.au)  
Sustainable Use of Coasts & Catchments Group

\* Dr Anita Chalmers is also interested in the riparian vegetation component.

### **Role of Large Wood in Forming Pools in Forested Rivers/ Fluvial Geomorphology & Aquatic Ecology**

High loadings of large wood (diameter > 0.1m) induce different types of bed scour (overscour, underscour, constriction scour, lateral scour) that can cause the formation of different types of pools. The type of pool formed depends on the density, orientation, length and elevation of the large wood. The critical questions to be answered by this research are: What is the spacing of pools in rivers with different loadings of large wood? What types of pools form in rivers of different energy and riparian vegetation communities? What is the relationship between pool type and spacing, and different riparian vegetation communities? Does riparian vegetation community influence large wood characteristics and supply to forested rivers? The significance of riparian forests as sources of large wood needs to be determined to plan better river restoration plans based on revegetation. Fish community assemblages in different pool types is also unknown.

Contact: Professor Wayne Erskine  
Phone: (02) 4348 4152  
Email: [Wayne.Erskine@newcastle.edu.au](mailto:Wayne.Erskine@newcastle.edu.au)  
Sustainable Use of Coasts & Catchments Group

\* Dr Anita Chalmers is also interested in the riparian vegetation component.

### **Effect of ration size on gross conversion efficiency of juvenile Port Jackson sharks, *Heterodontus portusjacksoni***

Gross conversion efficiency is a measure of the ability to convert food into body mass. It is an important consideration in the growth and development of individuals, but also has ecosystem-wide importance in terms of energy transfer between different trophic levels. This study will examine gross conversion efficiency under differing levels of energy intake and apply the findings to growth rates of wild and captive *H. portusjacksoni*. The study may also shed light on the 'food vs. protection' debate relating to elasmobranch nursery areas.

Contact: Dr David Powter  
Phone: (02) 4348 4052  
Email: [David.Powter@newcastle.edu.au](mailto:David.Powter@newcastle.edu.au)  
Sustainable Use of Coasts & Catchments Group

**Effects of personal shark deterrent equipment on non-dangerous elasmobranch species**

Operating procedures and legislation have led to an increased emphasis on the use of personal shark deterrent equipment during diving research to minimise the risk of shark attack. However, the impacts of this equipment on non-dangerous sharks and rays may affect the ability to conduct field-based research with these organisms. The project aims to assess these impacts on a range of elasmobranch species, both in the field and in controlled environments.

*Contact: Dr David Powter*

*Phone: (02) 4348 4052*

*Email: [David.Powter@newcastle.edu.au](mailto:David.Powter@newcastle.edu.au)*

*Sustainable Use of Coasts & Catchments Group*

## BIOLOGICAL SCIENCES

---

### **Assisted Reproduction in Amphibians for Conserving Threatened Species**

Many amphibian species are in decline or threatened with extinction across the globe, including Australia. Assisted Reproductive techniques such as IVF and gamete and embryo cryopreservation for genome banking have the potential to improve the management of threatened species. This project is concerned with developing new and improved techniques for cryopreservation of amphibian sperm, eggs and embryos and other reproductive and somatic tissues, and new ways of generating functional embryos from these cells and tissues.

Contact: Dr John Clulow  
Phone: (02) 4921 5721  
Email: [John.Clulow@newcastle.edu.au](mailto:John.Clulow@newcastle.edu.au)

Contact: A/Prof Michael Mahony  
Phone: (02) 4921 5721  
Email: [Michael.Mahony@newcastle.edu.au](mailto:Michael.Mahony@newcastle.edu.au)  
Environmental Biotechnology and Biology Group

### **Assisted Reproduction for Dasyurids**

Native carnivorous marsupials such as quolls and Tasmanian devils are increasingly at risk of extinction. The conservation of such dasyurid species is important for ecosystem maintenance because, as top carnivores, they have essential roles in pest control, carcass removal and subsequent disease control. This project aims to develop both short- and long-term sperm preservation methods for a well studied dasyurid model species, the fat-tailed dunnart, as well as examining their applicability various endangered quoll species and the Tasmanian devil. The isolation, culture and maturation of dasyurid oocytes will also be examined with the long-term aim of establishing intracytoplasmic sperm injection (ICSI) methods for dasyurids. Such assisted reproductive techniques (ART) will provide valuable tools for maximising the genetic diversity in current captive breeding programmes for Eastern quolls and the Tasmanian devil, and for gene banking in the longer-term.

Contact: Dr Merrilee Harris  
Phone: (02) 4921 7784  
Email: [Merrilee.Harris@newcastle.edu.au](mailto:Merrilee.Harris@newcastle.edu.au)

Contact: Prof John Rodger  
Phone: (02) 4921 5700  
Email: [John.Rodger@newcastle.edu.au](mailto:John.Rodger@newcastle.edu.au)  
Environmental Biotechnology and Biology Group

### **Zona Pellucida based Contraceptives for Koalas and Kangaroos**

Marsupials are of fundamental importance to the Australian environment, however some species (e.g. koala and grey kangaroo) have become over abundant within isolated habitat because of environmental changes since European settlement. Such overpopulation has negative impacts on the entire ecosystem, including the abundant species itself. Vaccines based on the zona pellucida, an extracellular matrix surrounding the egg, have been shown to reduce the fertility of a variety of marsupial species however this effect is not species specific. This project will refine zona pellucida based immunocontraceptive vaccines for koalas and kangaroos by testing the contraceptive efficacy of vaccines based on macropod specific immunogenic peptides and koala zona pellucida 2 sequences. It will also identify critical immunological processes correlated with infertility so that they can be more effectively targeted by incorporation of immune modulating molecules or adjuvants.

Contact: Dr Merrilee Harris  
Phone: (02) 4921 7784  
Email: [Merrilee.Harris@newcastle.edu.au](mailto:Merrilee.Harris@newcastle.edu.au)

Contact: Prof John Rodger  
Phone: (02) 4921 5700  
Email: [John.Rodger@newcastle.edu.au](mailto:John.Rodger@newcastle.edu.au)  
Environmental Biotechnology and Biology Group

### **Determinants of survival in the juvenile and adult stages of the life history of the endangered green and golden bell frog**

The green and golden bell frog is endangered and the remaining populations are typically small and occur in isolated habitats. Because amphibians have two stages in their life cycle they are dependent on two different habitats, one aquatic and one terrestrial. The research question is to understand whether the small population numbers of this frog are due to low survival rates during the adult terrestrial stage. The project will be conducted at the Sydney Olympic Park and will be part of a team project with a doctoral scientist and research associate.

Contact: A/Prof Michael Mahony  
Phone: (02) 4921 5721  
Email: [Michael.Mahony@newcastle.edu.au](mailto:Michael.Mahony@newcastle.edu.au)

Contact: Michelle Stockwell, Research Associate  
Email: [Michelle.Stockwell@newcastle.edu.au](mailto:Michelle.Stockwell@newcastle.edu.au)  
Environmental Biotechnology and Biology Group

### **Determinants of survival in the larval stage of the endangered green and golden bell frog**

The green and golden bell frog is endangered and the remaining populations are typically small and occur in isolated habitats. Because amphibians have two stages in their life cycle they are dependent on two different habitats, one aquatic and one terrestrial. The research question is to understand whether the small population numbers of this frog are due to low survival rates during the larval stage. The project will be conducted in a series of ponds where bell frogs are known to breed and will investigate tadpoles survival.

Contact: A/Prof Michael Mahony  
Phone: (02) 4921 5721  
Email: [Michael.Mahony@newcastle.edu.au](mailto:Michael.Mahony@newcastle.edu.au)

Contact: Michelle Stockwell, Research Associate  
Email: [Michelle.Stockwell@newcastle.edu.au](mailto:Michelle.Stockwell@newcastle.edu.au)  
Environmental Biotechnology and Biology Group

### **Toward a Chlamydia Vaccine for the Koala**

The *Chlamydias*, particularly the strains *C. pecorum* and *C. pneumoniae*, are a major cause of disease in koalas. Chlamydial disease in the urogenital tract causes wet bottom, inflammation, lesions and sterility. Infection of the respiratory tract and eyes causes pneumonia, conjunctivitis and blindness. Yet there is currently no preventative treatment for this disease in koalas. This project aims to underpin the development of an effective koala chlamydia vaccine by establishing the fat-tail dunnart as a marsupial model species for *Chlamydia* infection. Longer-term, vaccine formulation and delivery strategies capable of eliciting appropriate protective immune responses in the marsupial reproductive tract will also be investigated.

Contact: Dr Carmen McCartney  
Phone: (02) 4921 7784  
Email: [Carmen.McCartney@newcastle.edu.au](mailto:Carmen.McCartney@newcastle.edu.au)

Contact: Ms Annelie Moberg  
Phone: (02) 4921 7883  
Email: [Annelie.Moberg@newcastle.edu.au](mailto:Annelie.Moberg@newcastle.edu.au)

Contact: Prof John Rodger  
Phone: (02) 4921 5700  
Email: [John.Rodger@newcastle.edu.au](mailto:John.Rodger@newcastle.edu.au)

Contact: Dr Merrilee Harris  
Phone: (02) 4921 7784  
Email: [Merrilee.Harris@newcastle.edu.au](mailto:Merrilee.Harris@newcastle.edu.au)  
Environmental Biotechnology and Biology Group

### **Fertility-based population control for the feral Common (Indian) Myna**

Progress is being made in the US and Europe using various chemical sterilants to control feral birds. One in particular Nicarbazin (an antibacterial drug used in the poultry industry) is registered in the USA for pigeon control and is being tested experimentally for a range of pest species. Ovocontrol acts in birds to reduce egg hatching or egg production. The project will examine the dose effects and delivery strategies of Nicarbazin for the Common Myna.

Contact: Prof John Rodger  
Phone: (02) 4921 5700  
Email: [John.Rodger@newcastle.edu.au](mailto:John.Rodger@newcastle.edu.au)  
Environmental Biotechnology and Biology Group

### **Characterisation and crystallisation of the Xer recombinases from *Pseudomonas aerophilum*.**

The Xer site-specific recombination system has been extensively studied in *E. coli*, where it resolves chromosomal dimers to allow chromosome segregation. It is conserved through almost all bacteria and the archaea. The XerD recombinase is stimulated by direct interaction with a small domain of the FtsK protein, called  $\gamma$ . Structural studies on the *E. coli* proteins have proven difficult and it is hoped that the *P. aerophilum* homologues will be more amenable: the FtsK motor and  $\gamma$  domains from *P. aerophilum* have already been determined. The aim is to produce the Xer proteins and the  $\gamma$  domain separately and as fusions, show that they are active, and produce crystals of these proteins to determine the interaction with  $\gamma$  and/or with the Xer proteins' DNA binding site.

Contact: Dr Ian Grainge  
Phone: (02) 4921 5701  
Email: [ian.Grainge@bioch.ox.ac.uk](mailto:ian.Grainge@bioch.ox.ac.uk)

Contact: A/Prof Peter Lewis  
Phone: (02) 4921 5701  
Email: [Peter.Lewis@newcastle.edu.au](mailto:Peter.Lewis@newcastle.edu.au)  
Genomes Organelles and Development (GOD) Group

### **Characterisation of Xer- $\gamma$ fusion proteins**

The Xer recombinases recombine DNA at a site called *dif* to resolve chromosomal dimers. Recombination requires the physical interaction of XerD with the FtsK protein. However, fusion of the  $\gamma$  domain of FtsK to the C-terminus of XerC or XerD produces catalytically active proteins. This project aims to clone smaller portions of the  $\gamma$  domain, down to a few amino acids, to try to determine the minimal interactions necessary to stimulate recombination.

Contact: Dr Ian Grainge  
Phone: (02) 4921 5701  
Email: [ian.Grainge@bioch.ox.ac.uk](mailto:ian.Grainge@bioch.ox.ac.uk)

Contact: A/Prof Peter Lewis  
Phone: (02) 4921 5701  
Email: [Peter.Lewis@newcastle.edu.au](mailto:Peter.Lewis@newcastle.edu.au)  
Genomes Organelles and Development (GOD) Group

### **Processing of a collapsed replication fork *in vivo*.**

Recovery of replication forks after collapse is a fundamental process that all cells must cope with, and failure to do so can lead to mutation, cell death or cancer. Fluorescent repressor proteins, bound to arrays of operator sequences have been used to visualise chromosomal loci in live cells, both prokaryotic and eukaryotic. Overproduction of the repressor protein can act as a block to replication forks in *E. coli*. Using this system, replication can be blocked at a given location in a population of cells. If a temperature sensitive replication protein is used, then the blocked replication forks can be made to fall apart by a simple temperature shift. The aim of this project is to introduce mutations in proteins suspected to be involved in processing collapsed replication forks to see their effect, and determine the pathways and kinetics of recovery *in vivo*.

Contact: Dr Ian Grainge  
Phone: (02) 4921 5701  
Email: [Ian.Grainge@bioch.ox.ac.uk](mailto:Ian.Grainge@bioch.ox.ac.uk)

Contact: A/Prof Peter Lewis  
Phone: (02) 4921 5701  
Email: [Peter.Lewis@newcastle.edu.au](mailto:Peter.Lewis@newcastle.edu.au)  
Genomes Organelles and Development (GOD) Group

### **Analysis of transcription factor dynamics using ChIP-chip technology/ Bioinformatics**

This project is designed to analyse the assembly and disassembly of transcription complexes on a genome-wide scale using chromatin immunoprecipitation techniques combined with DNA hybridisation to high density tiled microarrays. Using this approach we will be able to determine the order with which transcription factors bind to RNA polymerase, whether there are different classes of transcribing transcription complexes, and how transcription factors influence transcription termination at the end of a gene/operon. The bulk of this project will involve *in silico* analysis and would be ideal for a bioinformaticist/maths-biology major.

Contact: A/Prof Peter Lewis  
Phone: (02) 4921 5701  
Email: [Peter.Lewis@newcastle.edu.au](mailto:Peter.Lewis@newcastle.edu.au)  
Genomes Organelles and Development (GOD) Group

### **Characterisation of the NusA-RNA polymerase binding site/ Molecular Biology**

NusA is a transcription factor that is essential and unique to bacteria. Therefore, preventing NusA interacting with RNA polymerase would lead to cell death, and targeting this interaction represents a promising target for antibiotic development. We have recently determined the structure of NusA in complex with RNA polymerase, and determined at low resolution the regions of RNA polymerase and NusA that interact. This project is designed to carry out mutagenesis on the RNA polymerase binding domain of NusA, followed by mutant purification and binding assays to establish which specific residues of NusA are involved in its interaction. Results from this study can then be used in the rational targeting of this area to design inhibitors of the interaction.

Contact: A/Prof Peter Lewis  
Phone: (02) 4921 5701  
Email: [Peter.Lewis@newcastle.edu.au](mailto:Peter.Lewis@newcastle.edu.au)  
Genomes Organelles and Development (GOD) Group

### **Construction of an inducible RNA polymerase for *in vivo* testing of novel antimicrobials/Molecular Biology**

RNA polymerase is an underutilised target for antibiotics that are urgently needed to combat the increasing incidence of antibiotic-resistant infections. This project will involve the construction of strains of *Bacillus subtilis* (closely related to Golden Staph) and *Acinetobacter baylyi* (closely related to the very serious hospital pathogen *A. baumannii*) in which the production of RNA polymerase can be controlled through the addition/removal of special inducer molecules to the growth medium. These strains will be used to determine the effect of specific mutations on the ability of essential transcription factors to bind to RNA polymerase. Lack of binding will result in cell death, and represent an excellent framework for the development of useful lead antimicrobial compounds.

Contact: A/Prof Peter Lewis  
Phone: (02) 4921 5701  
Email: [Peter.Lewis@newcastle.edu.au](mailto:Peter.Lewis@newcastle.edu.au)  
Genomes Organelles and Development (GOD) Group

### **Identification of competitive inhibitors of NusA interaction with RNA polymerase/Molecular Biology**

Transcription is an essential process in all organisms, and the enzyme, RNA polymerase, that carries out this process is highly conserved across the kingdoms. However, transcription factors, that are often essential, are not conserved across the kingdoms and so the interaction of essential transcription factors with RNA polymerase represents an excellent target for the development of new antibiotics. This project will utilise

phage display technology to identify peptides capable of inhibiting the interaction of the essential transcription factor NusA with RNA polymerase.

Contact: A/Prof Peter Lewis

Phone: (02) 4921 5701

Email: [Peter.Lewis@newcastle.edu.au](mailto:Peter.Lewis@newcastle.edu.au)

Genomes Organelles and Development (GOD) Group

### **Metabolomics of bacterial responses to environmental stresses**

Staphylococci represent a clinically significant group of bacteria that cause serious infections. The coagulase positive *Staphylococcus aureus* or “golden staph” is responsible for many life-threatening hospital-acquired (nosocomial) infections and can have multiple antibiotic resistances. The coagulase negative staphylococci, such as *S. epidermidis* and *S. lugdunensis*, can also cause nosocomial infections and are often associated with chronic infections with prosthetic joint implants and associated drug resistance. These staphylococci are all natural inhabitants of the skin surfaces in healthy individuals. The bacteria can respond to the environment to make the most of infection opportunities and change their mode of existence to a virulent form or survival form as appropriate. The staphylococci can form small colony variants (SCV) in response to exposures to antibiotics, pH, cold and osmotic stresses. These phenotypic variations represent obvious responses to environmental challenge and can invade intra-cellularly. This project will explore the metabolic changes associated with ultra-structural and colony changes in SCV formation. Gas chromatography-mass spectrometry will be used to measure biochemical profiles of cytoplasmic composition before and after stresses to determine how the bacteria adapt to specific environmental challenges. This will be coupled with electron microscope studies relating morphological changes with alterations in metabolic profiles. Several projects are available within this subject area.

Contact: A/Prof Hugh Dunstan

Phone: (02) 4921 5086

Email: [Hugh.Dunstan@newcastle.edu.au](mailto:Hugh.Dunstan@newcastle.edu.au)

Contact: Conjoint Professor Tim Roberts

Phone: (02) 4921 5702

Email: [Tim.Roberts@newcastle.edu.au](mailto:Tim.Roberts@newcastle.edu.au)

Contact: Dr Margaret MacDonald

Phone: (02) 4921 5630

Email: [Margaret.Macdonald@newcastle.edu.au](mailto:Margaret.Macdonald@newcastle.edu.au)

Molecular, Structure & Detection Group

### **Nutrient Allocation**

Both fundamental and applied research is directed at:

- i) **Nutriomics.** Nutrient (especially sugars) transport and metabolism within organs of agronomic significance (e.g. fruit and seed).

#### **Novel membrane transporters**

As membrane transport of sucrose is a key determinant of crop yield, a detailed understanding of genes encoding sucrose transporters provides fundamental knowledge towards increasing crop yield. This project aims to determine the inter- and intracellular localizations of these important proteins.

Contact: Prof Christopher Grof

Phone: (02) 4921 5858

Email: [Chris.Grof@newcastle.edu.au](mailto:Chris.Grof@newcastle.edu.au)

Plant Science Group

### **Control of cell wall biosynthesis for bio-energy and crop yield**

This project will use cotton fibre and transfer cell as models to identify genes for modification of plant cell wall composition to increase efficiency of biofuel production and cotton fibre yield. Contemporary molecular, cellular and biochemical approaches will be utilized to address a set of hypotheses.

Contact: A/Prof Yong-Ling Ruan  
Phone: (02) 4921 7958  
Email: [yong-ling.ruan@newcastle.edu.au](mailto:yong-ling.ruan@newcastle.edu.au)  
Plant Science Group

#### **Improving seed and fruit development using gene technology**

Seed and fruit are organs of major agronomical importance. We recently identified a key regulatory gene, *INVINH1*, which controls tomato seed size and fruit sugar level by repressing activity of invertase (INV) (Jin et al 2009 *Plant Cell*). Further work aims to elucidate the molecular mechanisms and signalling pathways that controls the co-expression and interaction of the *INVINH1* and its target, INV. The questions will be addressed by using contemporary molecular, cellular and biochemical approaches.

Contact: A/Prof Yong-Ling Ruan  
Phone: (02) 4921 7958  
Email: [yong-ling.ruan@newcastle.edu.au](mailto:yong-ling.ruan@newcastle.edu.au)  
Plant Science Group

#### **Manipulating water channel genes for improving drought tolerance of crops**

This project will study water channel genes in the control of water movement in plant cells and design innovative approaches to increase drought tolerance of crops. A combination of molecular, cellular and physiological approaches will be utilized to address relevant questions.

Contact: A/Prof Yong-Ling Ruan  
Phone: (02) 4921 7958  
Email: [yong-ling.ruan@newcastle.edu.au](mailto:yong-ling.ruan@newcastle.edu.au)  
Plant Science Group

#### **Enhancing sugar accumulation in tomato fruit**

Fruit sugar levels are a significant agronomic trait. Sugar transporters have been shown to regulate this trait. The project will screen site-directed mutants of transporters in a functional expression system to select those with enhanced kinetic properties.

Contact: A/Prof David McCurdy  
Phone: (02) 4921 5879  
Email: [David.Mccurdy@newcastle.edu.au](mailto:David.Mccurdy@newcastle.edu.au)  
Plant Science Group

#### **Mechanisms of sugar transfer in AM symbiosis**

AM fungi increase access to essential plant nutrients in exchange for up to 20% of plant sugars. Understanding this nutrient exchange is critical to future efforts to maximise AM benefit in agricultural production systems. The project will involve identification, localisation and expression analyses of key genes involved in sugar transfer.

Contact: Dr Emily Grace  
Phone: (02) 4921 5725  
Email: [Emily.Grace@newcastle.edu.au](mailto:Emily.Grace@newcastle.edu.au)  
Plant Science Group

- ii) **Transfer cell development.** Specialised cells that play a vital role in nutrient allocation.

#### **Building transfer cell wall ingrowths**

Transfer cells have intricately-invaginated wall ingrowth labyrinths that greatly amplify their plasma membranes which in turn contain high densities of nutrient transporters. The wall ingrowths are initially deposited as papillate structures at loci in response to inductive signalling by ethylene, reactive oxygen species (ROS) and  $\text{Ca}^{2+}$ . This project involves isolation of lipid rafts (membrane

aggregation centres for wall building molecules) and visualization of their distribution when transfer cell induction is perturbed using signal cascade inhibitors. The concept of lipid raft involvement in wall deposition is new; outcomes of the project will contribute significantly to our understanding of wall ingrowth formation.

Contact: Conjoint Professor Tina Offler  
Phone: (02) 4921 5704  
Email: [Tina.Offler@newcastle.edu.au](mailto:Tina.Offler@newcastle.edu.au)  
Plant Science Group

#### **Manipulating Transfer Cell Development**

This project will use the model species *Arabidopsis* to investigate genetic control of transfer cell development. Identifying transcriptional cascades involved in this process will provide new avenues for manipulating crop yield. The project involves gene expression analysis, fluorescence microscopy, and mutant analysis.

Contact: A/Prof David McCurdy  
Phone: (02) 4921 5879  
Email: [David.Mccurdy@newcastle.edu.au](mailto:David.Mccurdy@newcastle.edu.au)  
Plant Science Group

- iii) **Cotton fibre development.** A single-cell system, ideal for studying cell growth and cellulose synthesis.

Cotton is the most important textile crop world-wide due to its cellulose-enriched fibres developed from the seed epidermis. Each cotton fibre is a single-cell that elongates up to 3~6 cm long and synthesizes a massive amount of cellulose. This project aims to understand the molecular and cellular basis of rapid fibre cell expansion and cellulose synthesis with the final goal to improve fibre yield, quality and tolerance to drought by manipulating identified key genes and processes.

Contact: A/Prof Yong-Ling Ruan  
Phone: (02) 4921 7958  
Email: [Yong-Ling.Ruan@newcastle.edu.au](mailto:Yong-Ling.Ruan@newcastle.edu.au)  
Plant Science Group

- iv) **Biofuels.** Maximising carbon capture by key crops as a biofuel feedstock.

#### **Sorghum, a biofuel feedstock for arid environments.**

Increasing fuel costs, finite resources and the need to develop more carbon neutral and cleaner fuels have created a need for renewable resources. *Sorghum bicolor* (Sorghum) is a crop plant adapted to the hot water limited environments of northern Australia, both as a grain and forage crop. As a result of its rapid growth rate, sorghum is an ideal crop for biofuel production from grain, sugar and biomass accumulation.

- 1. Identification and characterisation of novel cell wall mutants in Sorghum and Arabidopsis.**
- 2. Identification of regulatory mechanisms important in biomass accumulation.**

These projects will involve:

- Quantitative expression analysis using RT-qPCR from RNA isolated from plant tissues and organs.
- Immunolocalisation of selected proteins.
- Functional characterisation of transporters in heterologous systems including yeast mutants and *Xenopus* oocytes.
- FTIR microscopy and GC-MS analyses.

Contact: Prof Christopher Grof  
Phone: (02) 4921 5858  
Email: [Chris.Grof@newcastle.edu.au](mailto:Chris.Grof@newcastle.edu.au)  
Plant Science Group

## Reconstructing Sustainable Ecosystems

- i) **Rebuilding soils.** Use of plant-microbe associations to re-establish nutrient cycling.

### **Rebuilding soil function**

In badly disturbed ecosystems such as where logging, grazing and mining have occurred, soil function has largely been lost or restricted by erosion, compaction, and physical disturbance. Our principal aims are to capture remaining components of soil biota, determine their role in functional soil, culture them, and return them to reconstructed forest and woodland using experimental methods. Manipulation of the physical characteristics of a site can promote these interactions. The effect of site amelioration, including decompaction, scarification, adding organic materials and inoculation on plant and microbe survival and health, is also being investigated.

Contact: Conjoint Lecturer Mike Cole, CSER Director

Phone: (02) 4921 5575

Email: [Mike.Cole@newcastle.edu.au](mailto:Mike.Cole@newcastle.edu.au)

Plant Science Group / Centre for Sustainable Ecosystem Restoration (CSER)

- ii) **Reconstructing Ecologically Endangered Communities (EECs).** Finding the best methods of restoring endangered ecological communities.

A number of vegetation communities are particularly threatened by development and have therefore been classified EECs. These are of particular interest when it comes to reconstructing communities on disturbed land. Experimental testing of techniques such as scalping or ripping the land prior to seeding and planting with a wide range of species are being investigated to determine the best methods of restoring these communities. The cost-benefit relationship of particular reconstruction strategies is also being undertaken. Some species may be difficult to re-establish and research into factors contributing to this including mycorrhizal associations, seed dormancy and site conditions is being developed.

Contact: Conjoint Lecturer Mike Cole, CSER Director

Phone: (02) 4921 5575

Email: [Mike.Cole@newcastle.edu.au](mailto:Mike.Cole@newcastle.edu.au)

Plant Science Research Group / Centre for Sustainable Ecosystem Restoration (CSER)

- iii) **Restoration Potential.** Addressing ecological bottlenecks by modifying, monitoring and modelling native vegetation communities.

### **Restoration Potential, Dispersal, Sustainability and Resilience**

Ecosystems that have suffered loss of structure and function due to disturbances such as logging and grazing can have bottlenecks preventing pollination, dispersal and the development of regeneration potential. As part of this research we are building and calibrating models of sustainability and resilience. The ecological conductance model seeks to explain the ease or difficulty that organisms confront in completing their life cycles and building restoration potential. Current research is focussed on quantifying the resistances to life cycle completion, including pollination success; seed production and viability; the ability to be recruited into a sustainable population; to form associations with soil microbes; and the development of both spatial and temporal dispersal vectors.

Contact: Conjoint Lecturer Mike Cole, CSER Director

Phone: (02) 4921 5575

Email: [Mike.Cole@newcastle.edu.au](mailto:Mike.Cole@newcastle.edu.au)

Plant Science Research Group / Centre for Sustainable Ecosystem Restoration (CSER)

**The roles of cytoskeletal proteins on the fertilisation and embryonic development in a marine invertebrate, *Galeolaria caespitose*.**

The project aims to produce a high definition Blue-Ray DVD movie to in-real-time show how a single fertilised egg of *Galeolaria* develops through the cleavage and gastrulation stages into a larva using our Zeiss physiological microscopic digital recording system. We shall image those events in 2D fluorescent and stereo phase-contrast formats, which allow us to understand the roles of the dynamic changes of actin filaments and tubulin microtubule during the fertilisation and early development. Some critical moments of those reproductive and developmental events will be backed up by electron microscopic pictures.

The results should improve our understanding of the reproductive physiology of this Australian marine species. The project will provide information on evaluation of whether the *Galeolaria* has potential to be a bio-monitor species for our ocean environment, as this species is so widely distributed along the east coast from Queensland to Victoria; and easy to be handled in the laboratory conditions.

An Honours student is invited to join this project. He/She will be involved in all activities in this project. Thus, the student will receive training on gamete and embryo culture, video imaging and tracking embryonic development, cell identification by immunofluorescent markers, and operations of fluorescent and electron microscopes.

Contact: Dr Minjie Lin  
Phone: (02) 4921 5707  
Email: [Minjie.Lin@newcastle.edu.au](mailto:Minjie.Lin@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

**Btbd12 – role in spermatogenesis**

Proteins with a bric-a-brac, tramtrack, broad-complex (BTB) domain are implicated in a broad variety of biological processes, including DNA binding, regulation of gene transcription and organization of macromolecular structures. We have generated a unique Btbd12 null (knockout) mouse, which has a male sterility phenotype. Pilot experiments confirm that this gene is highly expressed in meiotic germ cells. The aims of this project are to characterise the expression of Btbd12 mRNA and protein in the mouse testes and to investigate the use of protein:DNA binding experiments to elucidate genes under the transcriptional control of Btbd12.

Contact: Prof Eileen McLaughlin  
Phone: (02) 4921 5708  
Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)  
ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

**Characterisation of FZR1 in spermatogenesis**

We have created a tissue-specific FZR1 knockout in oocytes and spermatogonia by cross-breeding the floxed FZR1 mice with a mouse that contains a Cre-recombinase driven by the driven by the Ddx4 (DeadBox 4) promoter. Mice will therefore be derived in which male germ cells have been depleted of FZR1.

The role of FZR1 in spermatogenesis is unknown – however our preliminary analysis suggests that FZR1 gene and protein expression is highly upregulated in the early stages of spermatogenesis in the testes. Indicating that FZR1 is likely to play a key role in meiotic segregation in spermatocytes. The aims of this project are to characterise the expression of FZR1 mRNA and protein in the mouse testes and to investigate the use of shRNA experiments to elucidate signalling pathways controlled by FZR1.

Contact: Prof Eileen McLaughlin  
Phone: (02) 4921 5708  
Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)  
ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Chemokines and spermatogenesis: roles of SDF-1 and CXCR-4/7**

In the mammalian testes, numerous spermatozoa are continuously produced throughout adult reproductive life. This process, known as spermatogenesis, is dependent on the establishment early in neonatal development, of a population of self renewing germ line stem cells known as GSC's, from which the highly differentiated haploid spermatozoa are produced. Little is known about the molecular and cellular mechanisms underlying the creation of GSC's from their immediate progenitors, the gonocytes, and how the stem cell niche in which they reside in the testes is defined. Recent evidence from our laboratory suggests that a chemokine SDF-1 and its receptors CXCR-4 and CXCR-7 are intimately involved in the processes of gonocyte survival and differentiation in the fetal testes and the eventual migration of the GSC population to the stem cell "niche" located in the basement membrane in the post natal testes. The aims of this proposal are: to elucidate the mechanism of maintenance and migration of male germ cells in the developing testis and the role of SDF-1/CXCR-4/7 interaction in the establishment of stem cell populations in the germ cell niche, to characterize the signalling pathways activated by CXCR-4/7 and their role in germ cell differentiation and to investigate the use of knockdown and overexpression technologies in vivo and in vitro to manipulate germ cell survival and differentiation.

*Contact: Prof Eileen McLaughlin*

*Phone: (02) 4921 5708*

*Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)*

*ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science*

### **Cytokines and ovarian folliculogenesis**

Female germ cells or oocytes are sequestered in primordial follicles before birth and remain quiescent in the ovary until recruited into the growing pool throughout the reproductive years. Programmed follicular cell death continues throughout a woman's reproductive lifetime and ultimately 99.9% of all oocytes are lost prior to ovulation with no opportunity to be fertilised. Very little is known about what triggers follicle activation, nor the intracellular mechanism by which the coordinated differentiation of somatic cells is harmonized with oocyte growth yet this holds the key to female germ cell maintenance as well as optimising oocyte cell health and development.

Studies of pleiotrophic cytokines have suggested that the mechanisms behind follicle activation involve a complex network of bidirectional signalling between cellular components of the ovarian follicle. However little is known about the intracellular signaling pathways activated by these pleiotrophic cytokines.

In our pilot microarray gene expression surveys and confirmed by our protein localisation studies, we have identified that two key intracellular signaling molecules Signal Transducers and Activators of Transcription 3 (STAT3) and Suppressor of Cytokine Signalling 4 (SOCS-4) are induced on activation of the murine primordial follicle. The overall goal of our proposed project is to characterise the intracellular cytokine signalling pathways regulating activation and maintenance of mammalian ovarian primordial follicles.

*Contact: Prof Eileen McLaughlin*

*Phone: (02) 4921 5708*

*Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)*

*ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science*

### **Environmental impacts on female fertility**

All female mammalian ovaries contain a limited supply of primordial follicles which are present from birth. Recently it has become apparent that xenobiotics, such as organochlorine pesticides, polychlorinated biphenyls, dioxins, alkyl phenolic chemicals, phthalates and synthetic oestrogens are capable of interfering with normal female reproductive function in both humans and animals. Some xenobiotics that are prevalent in the environment including 4-vinylcyclohexane and benzo[a]pyrene, have been shown to target primordial follicles and trigger atretic oocyte depletion of the ovary leading to premature menopause. Our recent studies of the effects of xenobiotic exposure in the ovary have demonstrated that environmental agents can cause significant primordial follicle loss and oocyte damage through oxidative stress. Our proposed model is based on preliminary findings which indicate that xenobiotic exposure has direct consequences on ovarian function. The aims of this project are: To elucidate the action of xenobiotics in the developing ovary and in particular the role of the Phase I enzymes (Cytochrome p450's) in the generation of reactive oxygen species. To quantify the role of xenobiotic derived oxidative stress on mitochondrial function, plasma membrane fluidity

and oocyte dysfunction. To characterize the ovarian follicle signalling pathways activated by xenobiotics and their role in oocyte growth, follicle differentiation and survival. Insight into these processes will illuminate the origins of primordial follicle loss and oocyte dysfunction leading to subsequent ovarian failure and infertility in human females.

Contact: Prof Eileen McLaughlin

Phone: (02) 4921 5708

Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Meiosis: role of Msi2 in male germ cell development**

Gametogenesis is whereby primordial germ cells differentiate into gonocytes the precursors of physically mature viable gametes. This process needs strict control over translational regulation and is achieved through RNA binding proteins (RBPs) which have been implicated in the regulation of spatial temporal and functional dynamics of mRNAs. The RBPs bind and regulate the translation of mRNA by attaching to specific target sites in the 3' untranslated region (UTR).

The Musashi family of RNA binding proteins are important translational regulators in gamete formation and are evolutionarily conserved across species. Recent evidence has revealed that both Musashi family homologues Msi1 and Msi2 are involved during early and late stages of gametogenesis. Msi1 is expressed in the germ line stem cells and spermatogonia and involved in proliferation, where as Msi2 expression is localised to the progenitor cells and is active in meiosis.

The aims of this project are to identify mRNA and proteins which interact with Msi2 – this is intended to identify mRNA targets of translational regulation in gametogenesis using Msi2 protein:RNA and Msi2 protein:protein pull downs.

Contact: Prof Eileen McLaughlin

Phone: (02) 4921 5708

Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **miRNAs and spermatogenesis**

MicroRNA are a recently discovered class of noncoding RNA molecules of about 20-22 nucleotides long. These miRNA molecules specifically target the 3' untranslated region of mRNA molecules to repress their translation and thus control their expression. MicroRNAs are involved in many developmental processes such as spermatogenesis and regulate more than 30% of human genes. MicroRNA expression is disrupted in several diseases such diabetes, Alzheimer's and cancer including testicular germ cell cancer. The aims of this project are to obtain detailed information as to the causes of testicular cancer by examining the gene expression and miRNA expression within mouse gonocytes and spermatogonia, and comparing to that obtained in normal human testes and testicular tumours. The changes in miRNA expression will be examined using a microarray and confirmed with real time PCR. The target gene expression pattern will be examined using real time PCR. The role of miRNA within spermatogenic stem cells as well as testicular germ cell tumours will be examined using shRNA knockdown within spermatogonia and the T-Cam2 cell line which was derived from a seminoma tumour.

Contact: Prof Eileen McLaughlin

Phone: (02) 4921 5708

Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Non surgical sterilization for the control of fertility in domesticated animals and feral pests**

The intention of this study is to develop a humane, safe and effective method of sterilising female domestic animals without surgical intervention. This study intends to target the supply of dormant eggs in the ovaries of female mammals. Every female mammal is born with a finite supply of eggs, once this supply is exhausted, reproduction ceases. Our study intends to isolate and characterise pharmaceutical agents which can specifically destroy the dormant egg population resulting in irreversible sterilisation.

Using a technique known as phage display we have isolated several small proteins, known as peptides, which are capable of specifically binding eggs (oocytes) in vitro. Binding in some cases results in a substantial loss of oocytes, with no significant damage being done to any of the surrounding tissue. This study intends to increase the virulence of these peptides by attaching to biological agents which facilitate the destruction of the oocytes cellular membrane. Ultimately resulting in a sterilisation agent which is effective at low concentrations, providing a low cost alternative to surgical sterilisation.

Contact: Prof Eileen McLaughlin

Phone: (02) 4921 5708

Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Retention of Spermatogonial Stem cell phenotype**

Crucial to spermatogenesis are a number of RNA binding proteins, which are expressed in germ cells. These proteins are responsible for the control of post-transcriptional regulation of the multitude of mRNAs coding for proteins essential for latter stages of germ cell and spermatozoal development. Musashi (Msi) is an RNA binding protein family and we recently investigated the role of Musashi family in the *Drosophila* and mouse testes and showed that *Drosophila* Msi is both expressed and required in spermatogonial stem cells for maintenance of stem cell fate. We also found that cell-autonomous loss of Msi in the *Drosophila* testis results in the premature differentiation of spermatogonial stem cells, indicating an intrinsic requirement for Msi for regulation of stem cell maintenance – we have produced a transgenic *msi1* mouse for overexpression studies and this project aims to characterise this mouse.

Contact: Prof Eileen McLaughlin

Phone: (02) 4921 5708

Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Translational control of folliculogenesis and oocyte development: role of the RNA binding protein Musashi-1**

Coordinated post-transcriptional regulation of the oocyte mRNA pool is critical for the control of the finite pool of primordial follicles, normal progression of chromatin condensation and ultimately healthy oocyte production. Using our mouse and *Drosophila* model systems, we have recently identified the Musashi family of RNA binding proteins as key regulators of folliculogenesis and oocyte development. Historically, Musashi proteins have been identified in both neural and epithelial stem cells where they function as translational repressors. We have recently identified a novel member of the Musashi family in *Drosophila* ovary, which also functions as a translational repressor of key regulators of oocyte nuclear maturation and meiotic progression and have characterised the expression of the mammalian homologue Musashi-1 in the mouse ovary. In this project we aim to characterise the signalling pathways of Musashi-1 oocyte specific overexpression and knockout in transgenic and null mice using gene and protein expression profiling.

Contact: Prof Eileen McLaughlin

Phone: (02) 4921 5708

Email: [Eileen.McLaughlin@newcastle.edu.au](mailto:Eileen.McLaughlin@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **An assessment of DNA packaging in human sperm.**

Human sperm package DNA with protamines to protect it from damage. However, a significant proportion of the genome remains poorly packaged and accessible to DNA damaging agents. We have developed an assay to assess packaging in human sperm. The project will use the assay to determine the extent of variation in packaging between humans.

Contact: Dr Shaun Roman

Phone: (02) 4921 6818

Email: [shaun.roman@newcastle.edu.au](mailto:shaun.roman@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Evaluating the effect chronic exposure has in generating DNA damage in the paternal germline.**

DNA damage in the male germline is postulated to lead to detrimental effects such as cancer in the offspring. We are developing mouse models of chronic exposure to assess the genotoxic effect of chemicals. The project involves examining gene and protein expression in testis from exposed animals. We will also investigate the nature of the DNA damage generated.

Contact: Dr Shaun Roman

Phone: (02) 4921 6818

Email: [shaun.roman@newcastle.edu.au](mailto:shaun.roman@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Molecular Pathways of Germ Cell Differentiation 1: regulation of gene expression in spermatogonia**

Using array technology we have previously identified a number of genes regulated by retinoids in spermatogonia. We have identified a pathway of genes that responds to retinoids via a transcription factor not previously implicated in retinoid signalling. The project involves assessing regulation of a target of this transcription factor at the promoter level via a reporter construct. We will use gene knockdown to evaluate the role of the transcription factor in the pathway.

Contact: Dr Shaun Roman

Phone: (02) 4921 6818

Email: [shaun.roman@newcastle.edu.au](mailto:shaun.roman@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

### **Molecular Pathways of Germ Cell Differentiation 2: regulation of BMP4 gene expression**

We are seeking to understand the transition from spermatogonia to spermatocyte at the molecular level. We have identified 2 signalling pathways that interact during spermatogonial differentiation: the BMP4 and retinoid pathways. Previously, we have found that the metabolites of vitamin A, known as retinoids, regulate BMP4 gene expression. The major metabolite of vitamin A is not the active molecule in this case. This challenges a dogma. Testis and germ cells will be examined for vitamin A metabolites. Retinoids, both extracted and commercially available, will be tested by assessing their affects on BMP4 gene expression in isolated cells.

Contact: Dr Shaun Roman

Phone: (02) 4921 6818

Email: [shaun.roman@newcastle.edu.au](mailto:shaun.roman@newcastle.edu.au)

ARC Centre of Excellence in Biotechnology & Development / Priority Research Centre in Reproductive Science

## Advanced proteomic research – application of molecular imprinting

### i) **Recognition of Different Conformations of Protein Secondary Structure by Molecular Imprinting**

Turner et al have performed proof of concept studies of using molecular imprinting to recognise different isoforms of the same protein. This study suggests that direct discrimination of isoforms via an artificial receptor is possible, however this initial work needs validating with further examples.

This honours project will aim to provide this, by studying alternate model systems (Lysozyme and  $\alpha$ -lactalbumin) to verify the validity of this technique. As well as using the techniques developed in the pilot study, this project will look at modifying the imprint matrix to improve sensitivity and affinity.

This project would suit a biochemist, with interests in structural biology, molecular recognition, and/or chemistry at the biological interface.

*Contact: Dr Nicholas Turner, Dr Mark Baker, Laureate Professor John Aitken*

*Phone: (02) 4921 6143*

*Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)*

*Priority Research Centre for Reproductive Science*

### ii) **Removal of Interfering Proteins from Blood Serum**

Human Serum Albumin (HSA) makes up approximately 50-60% of blood serum protein, and as such can be a problem when screening serum for biomarkers, which tend to be short peptides. A matrix that could specifically filter out this abundant protein, leaving other components behind would be highly beneficial.

Molecular imprinting is a technique which creates artificial recognition sites (binding pockets) in polymeric materials, and has demonstrated the potential to specifically bind proteins. This project will focus on creating a gel filter matrix that by size exclusion and molecular imprinting will be able to specifically remove albumin from serum, without removing any markers of interest. Success will create a material which will improve screening processes for molecular biological applications.

This project would suit a biochemist, with interests in protein chemistry, molecular recognition, and/or chemistry at the biological interface.

*Contact: Dr Nicholas Turner, Dr Mark Baker, Laureate Professor John Aitken*

*Phone: (02) 4921 6143*

*Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)*

*Priority Research Centre for Reproductive Science*

## **Analysis of the mechanisms generating DNA damage in human spermatozoa**

This project involves examining the nature of the environmental factors that might induce DNA damage in human spermatozoa. Current emphasis is on the identification of an endonuclease which we believe to be activated by a variety of stressors (temperature/oxidative stress/electromagnetic radiation/age) and be responsible for the induction of much of the DNA damage we see in infertile patients. The results of this research will have a bearing on assisted conception therapy and public awareness of the impact of environmental factors on reproductive health.

*Contact: Laureate Professor John Aitken, Dr Mark Baker, Dr Ari Pujianto, Dr Geoff De Iulius*

*Phone: (02) 4921 6143*

*Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)*

*Priority Research Centre for Reproductive Science*

## **Assessment of oocyte and embryo quality**

A major task in the assisted conception industry is to develop non-invasive methods for the evaluation of oocyte and embryo quality. We have patented an approach to this problem and now wish to refine the assay technique, using conditioned embryo culture media from Hunter IVF and samples of follicular fluid. The same fundamental chemistry will be used to develop a diagnostic test for male infertility.

Contact: Laureate Professor John Aitken, Dr Mark Baker, Dr Geoff De Iuliis  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

### **Assisted Conception and Early Development**

The overall purpose of the studies grouped under this heading is to improve the management of human infertility by evaluating the causes of diminished gamete quality and resolving the impact of this damage on the developmental potential of the embryo.

#### **i) Proteomic and Metabolomic Analyses of Gamete and Embryo Quality**

This clinically-orientated project research project involves the development of a close interface with collaborators in assisted conception clinics to refine our understanding of gamete and embryo quality. This project will use state-of-the-art techniques in metabolomics and proteomics to define the molecular basis of impaired gamete function and to identify markers for the assessment of embryo quality. Current emphasis is on resolving the molecular basis of impaired gamete interaction at fertilization and the role of oxidative stress in the disruption of fertilization and impaired embryonic development. This project would provide training in advanced mass spectrometry as well as insights into the assisted conception industry.

Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)

Contact: Dr Brett Nixon  
Phone: (02) 4921 6977  
Email: [Brett.Nixon@newcastle.edu.au](mailto:Brett.Nixon@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

#### **ii) Epigenetic Defects**

Preliminary clinical data is available to suggest that infertile males generate gametes that possess methylation defects that might have an impact on the developmental potential of the embryo and the health and well being of the subsequent offspring. These defects are characterized by hypomethylation of key sites, which we have hypothesised is due to oxidative damage to the corresponding CpG islands. High-throughput DNA methylation profiling will be used to screen for genome wide methylation defects in the gametes of infertile men. These profiles will subsequently be correlated with presence of oxidative base damage to the sperm DNA. In addition we shall correlate any defects seen in the methylation profiles with the developmental potential of the embryo and the normality of DNA methylation in the offspring.

Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

### **Cell Biology of Spermatozoa**

#### **i) Epididymal Transit and Maturation**

Upon leaving the testis, spermatozoa are incapable of progressive movement or the cascade of cellular events that result in fertilization of the oocyte. These functional characteristics are only acquired as spermatozoa undergo maturation during epididymal transit. Given the absolute importance of epididymal maturation for the generation of fertile spermatozoa, it is clearly important that the molecular mechanisms supporting this functional transformation be elucidated. Success in this area will have implications both for development of reversible male contraceptive agents and the aetiology of male infertility. This project aims to characterise changes in tyrosine phosphorylation and mitochondrial activation which appear to be particularly important parts of epididymal maturation.

Contact: Dr Brett Nixon  
Phone: (02) 4921 6977  
Email: [Brett.Nixon@newcastle.edu.au](mailto:Brett.Nixon@newcastle.edu.au)

Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

ii) **Capacitation and Development of Fertilizing Ability**

Transcriptionally inactive spermatozoa rely heavily on post-translational modifications in order to acquire functional competence. These processes occur in two distinct phases as spermatozoa pass through the epididymal lumen and then ascend the female reproductive tract. It is well established that both events are essential for fertility, however the biochemical mechanisms behind the maturation of these cells remains unclear. This project aims to characterise the entire complement of proteins present in spermatozoa. It will also decipher which proteins are up/down regulated, acquired and/or completely lost during both maturation procedures.

Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

iii) **Mitochondrial Function and Reactive Oxygen Species**

Reactive oxygen species (ROS) are conventionally considered as detrimental by-products of cellular metabolism, which generate a state of oxidative stress in susceptible cells. Despite the pathophysiological significance of ROS generation in the male germ line, neither the sub-cellular origin nor the biochemical basis for this activity has been established. The major source of ROS generation in somatic cells is postulated to involve electron leakage from the mitochondrial electron transport chain during cellular respiration. In view of our poor understanding of mitochondrial function in spermatozoa, and the potential importance of these organelles as a potential source of oxidative stress in the male germ line in particular, this project is an analysis of the potential competence of human sperm mitochondria to generate ROS and to characterise the significance of this activity in the aetiology of defective sperm function.

Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

iv) **Monotreme Sperm Biology**

As iconic symbols of Australia's unique fauna the platypus and echidna generate considerable interest from tourists and the Australian public, thus ensuring that their display in zoos is of significant commercial value. Nevertheless, the record of breeding the 3 extant monotremes in captivity is poor, and the New Guinea echidna faces extinction in the wild. Consequently, knowledge of monotreme reproductive biology is important for conservation practices. This project focuses on elucidation of the molecular processes leading to fertilization in monotremes, including: the proteins which form sperm into bundles to greatly enhance their motility (a unique sperm competition strategy) and the mechanisms involved in sperm bundle formation. The work will provide an understanding of the biological significance of adaptations unique to mammals, the need for maturation of sperm in the epididymis and a subsequent period of capacitation before they are capable of fertilizing an ovum.

Contact: Dr Brett Nixon  
Phone: (02) 4921 6977  
Email: [Brett.Nixon@newcastle.edu.au](mailto:Brett.Nixon@newcastle.edu.au)  
Priority Research Centre for Reproductive Science

## Fertilisation and Contraception

### i) Formation of Sperm Zona Receptor Complex

Mammalian sperm-egg interaction is arguably one of the most remarkable processes in biological science. This exquisitely specific cell recognition event depends upon a complex cascade of interactions between free-swimming sperm and ovulated eggs. Elucidating the nature of these interactions has been the subject of intense investigation by many laboratories. Although this has led to extensive characterization of the respective gametes, such studies have failed to elucidate the molecular basis of this event. In our considered judgement this lack of success stems from the incorrect assumption that the sperm receptor is a single molecular entity that is constitutively expressed on the cell surface.

In contrast, recent research from our laboratory has provided support for a novel hypothesis that sperm-egg interaction is mediated by a multimeric sperm receptor complex. Furthermore, we have compelling evidence that this complex is assembled on the sperm surface through the concerted action of a family of molecular chaperone proteins that reside within specialised membrane domains, known as lipid rafts. In this project we aim to confirm the validity of this model, establish the molecular composition of the sperm surface receptor complexes and characterise the downstream signalling cascades that culminate in fertilisation.

Contact: *Dr Brett Nixon*  
Phone: (02) 4921 6977  
Email: [Brett.Nixon@newcastle.edu.au](mailto:Brett.Nixon@newcastle.edu.au)

Contact: *Laureate Professor John Aitken*  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)

Contact: *Prof Eileen McLaughlin*  
Phone: (02) 4921 5708  
Email: [Eileen.Mclaughlin@newcastle.edu.au](mailto:Eileen.Mclaughlin@newcastle.edu.au)  
*Priority Research Centre for Reproductive Science*

### ii) Oolemma sperm receptors

Post-coitus, sperm encounter the ovulated oocyte within the fallopian tube, which serves as the site of fertilisation. By the time sperm reach the site of fertilisation they have undergone the prerequisite series of capacitation-associated changes necessary for ultimately achieving fertilisation. Upon penetrating the Zona pellucida, sperm must then recognise and bind to the oocyte plasma membrane. Together, the molecular machinery present in both cell membranes must then interact in a precise manner necessary to facilitate the energetically costly event that is the merger of sperm and egg membranes.

This research aims to identify and characterise egg surface proteins implicated in sperm-egg interaction, by identifying the important GPI-anchored protein(s) as well characterising the role of the tetraspanins and their interacting web partners. In vitro binding and fusion experiments will be used as functional bioassays and mass spectrometry (MS)-based proteomics and bioinformatics-based analyses will be employed to compile oocyte protein databases and to identify candidate proteins responsible for mediating sperm-egg interaction, such as newly identified candidate GPI-anchored proteins.

Contact: *Prof Eileen McLaughlin*  
Phone: (02) 4921 5708  
Email: [Eileen.Mclaughlin@newcastle.edu.au](mailto:Eileen.Mclaughlin@newcastle.edu.au)

Contact: *Dr Shaun Roman*  
Phone: (02) 4921 6818  
Email: [Shaun.Roman@newcastle.edu.au](mailto:Shaun.Roman@newcastle.edu.au)

Contact: *Dr Brett Nixon*  
Phone: (02) 4921 6977  
Email: [Brett.Nixon@newcastle.edu.au](mailto:Brett.Nixon@newcastle.edu.au)  
*Priority Research Centre for Reproductive Science*

**iii) Spermicides and microbicides**

There is an urgent clinical need to research novel methods of fertility control that are also protective against sexually transmitted diseases (STDs) such as the human immunodeficiency virus (HIV) or Chlamydia. The most obvious way to generate such a dual-purpose contraceptive method would be to develop safe, effective spermicides that were also active against a wide range of pathogenic organisms. The currently available formulations such as nonoxynol-9, gramicidin and benzalkonium chloride are effective spermicides but are toxic to the vaginal epithelium and do not provide protection against STDs. Over 60 agents are in clinical trials as potentially safer topical spermicides and/or microbicides. Compounds that have reached this stage of development include acid buffers, detergents, dendrimers, non-nucleoside reverse transcriptase inhibitors and anionic polymers.

In addition, a number of potential spermicides/microbicides are the subject of preclinical investigation, including beta-cyclodextrin, cyanovirin, porphyrins, cyclotriazadisulfonamides, dermasепtins, short-interfering RNA (siRNA) and HIV antibodies. This project aims using to characterise the biological activities and mode of action of newly developed target specific compounds as novel dual spermicides/microbicides.

*Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science*

**vi) Identification and validation of targets for fertility regulation**

There have been no significant advances in planned fertility regulation since the introduction of the oral contraceptive pill in the 1960s. The purpose of this project is to use our advanced proteomics platform to identify targets for male and female fertility regulation on the basis of their specificity, functional significance and drugability. The current focus is on the identification of phosphoproteins that are critical to the process of fertilization and then through a knowledge of the kinases and phosphatases that regulate their phosphorylation status, to select contraceptive targets that can then be validated by functional genomics in vivo and in vitro.

*Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science*

## **Spermatogenesis and Stem Cells**

**i) DNA damage in the Germline**

DNA damage in the male germline is associated with poor fertilization rates following IVF, defective preimplantation embryonic development, and high rates of miscarriage and morbidity in the offspring, including childhood cancer. This damage is poorly characterized, but is known to involve hypomethylation of key genes, oxidative base damage, endonuclease mediated cleavage and the formation of adducts with xenobiotics and the products of lipid peroxidation. There are many possible causes of such DNA damage, including abortive apoptosis, the oxidative stress associated with male genital tract infection, exposure to redox cycling chemicals, and defects of spermiogenesis associated with the retention of excess residual cytoplasm. Physical factors such as exposure to radiofrequency electromagnetic radiation or mild scrotal heating can also induce DNA damage in mammalian spermatozoa, although the underlying mechanisms are unclear. Ultimately, resolving the precise nature of the DNA lesions present in the spermatozoa of infertile men will be an important step towards uncovering the aetiology of this damage and developing strategies for its clinical management.

*Contact: Laureate Professor John Aitken  
Phone: (02) 4921 6143  
Email: [John.Aitken@newcastle.edu.au](mailto:John.Aitken@newcastle.edu.au)  
Priority Research Centre for Reproductive Science*

## CHEMISTRY

---

### **Characterisation of Solid – Liquid Interfaces in Dye Solar Cells (DSC).**

It is clear that burning fossil fuels is not sustainable in the long term. The DSC is a cheap and versatile technology for large scale production of solar cells. The basic element of a DSC is an assembly of titanium dioxide nanoparticles about 20 nm diameter, well connected to their neighbours. As TiO<sub>2</sub> only absorbs a small fraction of the solar energy, dye molecules are attached to the TiO<sub>2</sub> surface to harvest a greater portion of solar light. This project will characterise the structure of the solid – liquid interfaces within the DSC, which will lead to the new DSC designs with increased energy conversion efficiencies.

Contact: Dr Rob Atkin  
Phone: (02) 49217107  
Email: [Rob.Atkin@newcastle.edu.au](mailto:Rob.Atkin@newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Effect of Electrode potential on Ionic Liquid Interfacial Structure**

Interest in ionic liquid (IL) based electrochemistry increased markedly around the year 2000, primarily as a consequence of ILs often wide electrochemical windows. Until now atomic force microscope (AFM) experiments have only been conducted at the open circuit potential (OCP), but we have recently modified our AFM cell to allow force curves to be obtained as a function of potential. As the magnitude of the potential is increased the strength with which IL ions are bound to the surface also increases, which will affect a variety of electrochemical processes, including electrodeposition, batteries and capacitors. Experiments planned for this topic will examine interfacial forces as a function of potential across the whole electrochemical window, which will reveal how IL interfacial structure evolves with potential. The effect of dissolved solutes (particularly ions) on interfacial properties will also be examined, allowing mechanisms for tuning interfacial structure to optimise electrochemical performance to be determined.

Contact: Dr Rob Atkin  
Phone: (02) 49217107  
Email: [Rob.Atkin@newcastle.edu.au](mailto:Rob.Atkin@newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Ionic Liquid Lubricants**

The use of ILs as lubricants was first proposed in 2001 and since then about 80 articles have appeared on the topic, the majority describing macroscopic measurements. Strong ion adsorption at solid surfaces and robust physicochemical properties, in particular negligible vapour pressure, could lead to high end lubrication applications, such as in electronics or high vacuum environments where ILs could be used without significant product loss. The tendency for ILs to adsorb and spontaneously arrange into interfacial layers results in a coating of ions at the solid interface. In an article published last year we reported that particles suspended in a protic IL were stable to aggregation but settled six times faster than predicted by the Stokes equation, and suggested that the same interfacial IL structure that imparts stability could have a lubricating effect. This project will measure friction as a function of cation alkyl chain length, after which the cation and anion species will be varied.

Contact: Dr Rob Atkin  
Phone: (02) 49217107  
Email: [Rob.Atkin@newcastle.edu.au](mailto:Rob.Atkin@newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Nanostructures in Ionic Liquids**

Ionic liquids are molten salts, which means they are salts in a liquid phase, not simply salts dissolved in water. Surfactant molecules dissolve in ionic liquids and can self assemble into nanostructures like micelles, liquid crystals and microemulsions, just like they do in water. This project will examine various surfactant structures in ionic liquids. Our aim is to use surfactant templating of glass-forming ionic liquids as a way of designing and creating permanent high surface area structures from microemulsions and liquid crystals. These materials could be used in catalytic or separation technologies.

Contact: Dr Rob Atkin  
Phone: (02) 49217107  
Email: [Rob.Atkin@newcastle.edu.au](mailto:Rob.Atkin@newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Advanced Supercapacitors**

Modern electronic devices (e.g., consumer electronics and electric/hybrid vehicles) place considerable demands on their respective power sources, to the point where device efficiency is compromised. The inclusion of a supercapacitor has the potential to improve the specific power density and also cycle efficiency of all types of power source. We have recently made considerable advances in improving supercapacitor performance (e.g., 800 F/g for existing systems compared to >2000 F/g in our advanced materials). Projects in this area will be focus on both understanding the origin of this improved performance, as well as implementing these materials into prototype supercapacitors. This work is funded by CSIRO Division of Energy Technology and CAP-XX, and is also in collaboration with the Ecole Polytechnique de la Universitie de Nantes and National Taiwan University.

Contact: A/Prof Scott Donne  
Phone: (02) 4921 5477  
Email: [Scott.Donne@newcastle.edu.au](mailto:Scott.Donne@newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Catalysts for Fuel Cells**

Energy can be stored in many chemical forms, and hence used in many different ways. One way is in a fuel cell, of which there are numerous varieties. The cathodic reaction in all though involves reduction of O<sub>2</sub> to H<sub>2</sub>O on the surface of a suitable catalyst. This is currently the limiting performance feature of all fuel cell technologies because of its slow reaction kinetics. This focus of projects in this area is to examine the factors that cause slow O<sub>2</sub> reduction kinetics, and to then address these limitations with novel solutions. One particularly important aspect is to examine the role that adsorption plays in determining O<sub>2</sub> reduction kinetics. This work is in collaboration with the Massachusetts Institute of Technology.

Contact: A/Prof Scott Donne  
Phone: (02) 4921 5477  
Email: [Scott.Donne@newcastle.edu.au](mailto:Scott.Donne@newcastle.edu.au)  
Priority Research Centre for Energy

### **Corrosion Phenomena in Electrode Materials**

Corrosion is an electrochemical phenomenon that can have a devastating effect on all forms of infrastructure if it is not properly monitored and controlled. Projects in this area are focussed on understanding the corrosion phenomena that metals such as titanium and copper undergo, and then developing strategies to minimize their corrosion. Titanium, for example is used as the anode substrate in many modern high volume electrolysis processes, yet it is subject to corrosion and passivation which effectively destroys its performance. Similarly, copper is used as an earthing electrode in modern power infrastructure, in which case its corrosion and failure lessens the safety of such a network. Support for these projects comes from Energy Australia.

Contact: A/Prof Scott Donne  
Phone: (02) 4921 5477  
Email: [Scott.Donne@newcastle.edu.au](mailto:Scott.Donne@newcastle.edu.au)  
Priority Research Centre for Energy

### **High Performance Battery Systems**

The backbone of energy storage in modern society is the battery. Of course many systems are commercially available, each having been developed to power a specific type of electronic device. The importance and extent of efficient energy storage will increase in the future due to the required move away from fossil fuel powered energy. Projects in this area will focus on the development of advanced materials, and improving our fundamental understanding of the charge storage mechanisms various materials possess. Funding in this area comes from the CSIRO Division of Energy Technology (Li-ion systems), Duracell (advanced MnO<sub>2</sub>),

Pure Energy Battery Systems (rechargeable MnO<sub>2</sub>), and Litronik Batterietechnologie (battery systems for implantable pacemakers).

Contact: A/Prof Scott Donne

Phone: (02) 4921 5477

Email: [Scott.Donne@newcastle.edu.au](mailto:Scott.Donne@newcastle.edu.au)

Priority Research Centre for Energy

### Hydrogen Production

Hydrogen has been variously described as the perfect fuel. It is abundant, chemically non-toxic, and it burns to produce non-toxic species. However, its main limitation to commercial uptake is its synthesis, since it requires more energy to produce hydrogen than what is returned upon its combustion. Projects in this area revolve around the use of the Hybrid Sulfur (HyS) Cycle for the large scale production of hydrogen. Using renewable energy inputs water can be split into its components through the use of a sulphur-based intermediate. Part of the HyS cycle involves an electrolysis step (SO<sub>2</sub> oxidation to H<sub>2</sub>SO<sub>4</sub>), the efficiency of which is a significant limitation to the overall process. Therefore, our focus will be on developing an understanding of the oxidation mechanism, and developing new catalysts to facilitate its improvement. This work is in collaboration with the CSIRO Division of Energy technology.

Contact: A/Prof Scott Donne

Phone: (02) 4921 5477

Email: [Scott.Donne@newcastle.edu.au](mailto:Scott.Donne@newcastle.edu.au)

Priority Research Centre for Energy

### Molecularly Imprinted Polymers (MIPs)

Molecular imprinting is an effective method of imparting highly specific and selective recognition sites in synthetic polymers. First, a molecule of interest (target) is used as the template and allowed to pre-associate with polymerisable (a molecule with a double bond) molecules (*in situ* imprinting) called the functional monomers. The degree of association between the monomer and the template (T) depends on their functionalities but mostly based on simple molecular interactions such as hydrogen-bonding. Secondly, the association between the template and monomer can be fixed in place by polymerisation in the presence of a huge amount non-interacting monomer (e.g. crosslinker), which can impart the robustness required for the polymer. Thirdly, the template is extracted from the monolithic or particulate polymer to leave behind a cavity containing binding sites that are oriented to compliment the functional groups of the template molecule and capable of rebinding the target. Molecular imprinting can also be achieved by *post*-polymerisation imprinting on a pre-prepared polymer. This technique is very useful for the preparation of MIP films.

Contact: Dr Clovia Holdsworth

Phone: (02) 4921 5481

Email: [Clovia.Holdsworth@newcastle.edu.au](mailto:Clovia.Holdsworth@newcastle.edu.au)

Advanced Synthetic Materials Group / Priority Research Centre for Organic Electronics

### PNIPAAm-Based Molecularly Imprinted Polymers

Poly(N-isopropylacrylamide) (PNIPAAm) is a thermoresponsive polymer and is characterised by a lower critical solution temperature (LCST). Below its LCST, PNIPAAm is water-soluble; above its LCST, it is water-insoluble. The LCST of PNIPAAm can be tuned by copolymerisation. For example, its LCST can be lowered to 10°C in the presence of the hydrophobic monomer styrene. Thus, by choosing co-monomers that can interact with a target molecule of interest, it is possible to use PNIPAAm copolymers to create molecular moulds. Simply by using the target molecule as template at temperatures below the LCST and preserving the target imprints at temperatures higher than the LCST, PNIPAAm copolymers can be imparted with molecular recognition sites which can be capable of selectively binding the target molecule in the presence of other analytes. This project will focus on the evaluation of the molecular imprinting capability of PNIPAAm copolymers and will involve (a) synthesis of NIPAAm polymers, (b) preparation of PNIPAAm MIPs (c) evaluation of PNIPAAm MIP binding capability (d) characterisation of PNIPAAm polymers and MIPs.

Contact: Dr Clovia Holdsworth

Phone: (02) 4921 5481

Email: [Clovia.Holdsworth@newcastle.edu.au](mailto:Clovia.Holdsworth@newcastle.edu.au)

Advanced Synthetic Materials Group / Priority Research Centre for Organic Electronics

### **MIP as Reaction Catalyst**

The ability of a MIP to recognise and trap a template/target molecule makes it an attractive alternative catalytic system. Considering the hypothetical synthetic reaction,  $R1 + R2 \rightarrow DP + BP$ , this project will involve (a) the generation of a MIP selective to either DP or BP, (b) evaluation of the selectivity of the MIP with respect to the other substances involved in the reaction – R1, R2 and DP or BP (c) testing the catalytic effect of the MIP by evaluating reaction yields.

Contact: Dr Clovia Holdsworth

Phone: (02) 4921 5481

Email: [Clovia.Holdsworth@newcastle.edu.au](mailto:Clovia.Holdsworth@newcastle.edu.au)

Advanced Synthetic Materials Group / Priority Research Centre for Organic Electronics

### **Investigation of the Mechanism of Imprinting: Kinetics of the Formation of Imprints**

Recent studies have shown that the formation of molecular imprints is affected by temperature, solvents and polymer composition, and that the imprinting effect can sometimes be missed due to the high binding capacity (though superficial) of its non-imprinted equivalent (NIP). Most of the reported evidence deals with the beginning - presynthetic studies (i.e. molecular modelling and spectroscopic studies) and the end - binding performance of the MIPs and NIPs, but no evidence has been gathered during the early stages of the formation of imprints (i.e. within 12 hours of polymerisation). This study proposes to investigate the early stages of MIP formation with the aim to understand the effect of the template on the polymer structure and the kinetics of template-monomer association and will involve (a) molecular modelling using Spartan (b) NMR experiments (c) free radical polymerisation (d) quantitation and species identification by GC or LC MS.

Contact: Dr Clovia Holdsworth

Phone: (02) 4921 5481

Email: [Clovia.Holdsworth@newcastle.edu.au](mailto:Clovia.Holdsworth@newcastle.edu.au)

Advanced Synthetic Materials Group / Priority Research Centre for Organic Electronics

### **Preparation of Molecularly Imprinted Nanoparticles by Phase Inversion**

Phase inversion, that is the immersion of a polymer solution, in a solvent, is one of the techniques utilised for the preparation of molecularly imprinted polymeric films. Molecularly imprinted polymers (MIPs) are molecular moulds generated by templating with the target analyte and can be introduced *in-situ* or post-polymerisation as in the phase inversion technique. This project aims to prepare phase-inversed MIP nanoparticles, not films, by ultrasonication of the polymer solution in the presence of a non-solvent. The MIP nanoparticles can be used as extractant and as recognition element for sensing devices.

Contact: Dr Clovia Holdsworth

Phone: (02) 4921 5481

Email: [Clovia.Holdsworth@newcastle.edu.au](mailto:Clovia.Holdsworth@newcastle.edu.au)

Priority Research Centre for Organic Electronics

### **Aqueous chemistry of CO<sub>2</sub>, as relevant for greenhouse abatement**

A significant reduction in CO<sub>2</sub> output is crucial for the climate and long-term stability of the planet. In the Australian context an eminently promising method is post-combustion capture (PCC) of carbon dioxide in fossil fuel power plants. While the technology is not new, the process needs to occur on such a scale that it demands significant improvement in overall efficiency. In collaboration with CSIRO our research is directed at developing a complete understanding for the first time of the fundamental chemistry of carbon dioxide removal by amine solutions. Detailed examination of the speed (kinetics), extent (thermodynamics) and energy requirements (calorimetry) of all reactions for a range of amines will produce a model to guide technological improvements. This project is well funded and there is a good prospect of being able to continue working in this field after the Honours year.

Contact: Prof Marcel Maeder

Phone: (02) 4921 5478

Email: [marcel.maeder@newcastle.edu.au](mailto:marcel.maeder@newcastle.edu.au)

Contact: Dr Robert Burns

Phone: (02) 4921 5479

Email: [robert.burns@newcastle.edu.au](mailto:robert.burns@newcastle.edu.au)

Priority Research Centre for Energy

### **Flow Chemistry / Medicinal Chemistry / Organic Chemistry**

Traditional organic synthesis is conducted in a batch manner, i.e. small quantities of materials are mixed and heated for a standard period of time, and the product extracted and purified. Recent advances in flow technologies allow continuous production of novel materials. This technology has been introduced to the medicinal chemistry group at the University; it is currently the best-equipped flow chemistry laboratory in Australia. Reactions are conducted at higher temperatures and pressures, which has the effect of increasing reaction yield and compound purity, largely removing the more tedious aspects of compound purification. Students working in this area will develop new approaches to drugs spanning three research programs: anti-epileptic, anti-cancer and anti-parasitic drugs. This new technology requires subtle optimisation and students will be exposed to cutting edge equipment and ultimately be responsible for the development of new drugs and biological tools to a considerable number of our national and international collaborators.

*Contact: Prof Adam McCluskey*

*Phone: (02) 4921 6486*

*Email: [Adam.McCluskey@newcastle.edu.au](mailto:Adam.McCluskey@newcastle.edu.au)*

*Priority Research Centre for Organic Electronics*

### **Medicinal Chemistry / Drug Design**

Today 1% of the worlds' population suffer from epilepsy, of these 30% fail to respond to existing anti-epileptic drugs. Current anti-epileptic drugs were discovered in the 1960s. We have identified a protein called dynamin as a new ant-epileptic drug target and have advanced compounds that only target epilepsy at seizure onset, a significant advance on existing treatments. This is a major collaborative drug discovery and development effort drawing medicinal chemistry experience at the University of Newcastle (McCluskey), neurobiology and neurochemistry at the Children's Medical Research Institute Westmead Hospital (Prof Phillip Robinson), epilepsy (medical aspects) at the Royal Melbourne Hospital / Melbourne University (Prof Terry O'Brien), and the National Institute of Health (USA) (Captain Jim Stables). Students working in this area will experience the full drug development cycle through synthesis and biological evaluation of new drugs. You will advance these drugs to the next stage of evaluation and potentially to animal studies in both Melbourne and USA. During the course of your studies you will be trained in the latest technologies associated with drug design and chemical synthesis (see Flow Chemistry below).

*Contact: Prof Adam McCluskey*

*Phone: (02) 4921 6486*

*Email: [Adam.McCluskey@newcastle.edu.au](mailto:Adam.McCluskey@newcastle.edu.au)*

*Advanced Synthetic Materials Group / Priority Research Centre for Organic Electronics*

### **Medicinal Chemistry / Drug Design / Smart Devices**

Current anti-epileptic drugs act by reducing chemical signalling in the brain, **and are always 'on'**. This means that patients have reduced functional capacity, at best it has been compared to being drunk, at worst patients are physically incapacitated and physically ill. Huge numbers of patients are left unable to perform simple day-to-day tasks. This project represents a major advance in the 'on-demand' administration of drugs with the epileptic seizure triggering the release of an anti-epileptic drug at seizure onset. It will develop implantable organic electronic devices with the ability to specifically absorb and release anti-epileptic drugs 'on-demand'. This project is at the interface of chemistry, biology, physics and medicine, a unique opportunity to advance drug delivery in the 21<sup>st</sup> century.

*Contact: Prof Adam McCluskey*

*Phone: (02) 4921 6486*

*Email: [Adam.McCluskey@newcastle.edu.au](mailto:Adam.McCluskey@newcastle.edu.au)*

*Advanced Synthetic Materials Group / Priority Research Centre for Organic Electronics*

### **Nanomaterials / Organic Electronics**

Amyloid fibrils are linked to some of mankind's most crippling diseases, such as Cystic Fibrosis, Alzheimer's and type II diabetes, BUT they are emerging as exciting biocompatible, biodegradable, high strength (environmentally friendly), nano-materials, for use in a range of electronic devices. Amyloid fibres have excellent potential as electrically conducting nano-wires. This project will investigate the influence changing the rate of fibre growth has on the physical and chemical properties of the resulting nano-wires. This work will open the door to the next generation of electronic devices.

Contact: Prof Adam McCluskey

Phone: (02) 4921 6486

Email: [Adam.McCluskey@newcastle.edu.au](mailto:Adam.McCluskey@newcastle.edu.au)

Priority Research Centre for Organic Electronics

### **Chemical Taxonomy of Brown Alga *Cystophora* spp.**

In 1995 two significant papers appeared regarding the chemical taxonomy of alga from the *Sargassaceae* (formerly *Cystoseiraceae*) family. Chemical taxonomy uses the secondary metabolites present in an organism to elaborate their evolutionary and taxonomic relationships; Algae that produce similar compounds are closer to each other on the 'family tree' than those that have no compound types in common. Algae from the *Cystophora* genus belong to the *Sargassaceae* and since they are not well studied and are, by and large, only found in temperate Australasian waters, it seemed to us that we could make a significant contribution in this area. This study is a mixture of interpretation of our previous results and those of others, and investigating the metabolites of the remaining unstudied algae in the genus. Work in this area will also lead into the study of marine chemical ecology.

Contact: Dr Ian van Altena

Phone: (02) 4921 5480

Email: [ian.vanAltena@newcastle.edu.au](mailto:ian.vanAltena@newcastle.edu.au)

Advanced Synthetics Materials Group

### **Searching for New Lead Compounds as Dynammin Inhibitors**

Dynammin is an important enzyme in the process of vesicle formation which is one of the mechanisms used to transport chemicals and small particles across membrane walls or as a way of insulating an organism from endogenous or exogenous toxic compounds. In this project we are looking to the marine environment as source for compounds that can act as leads to new classes of dynammin inhibitors. In the initial stages new active compounds will be used to probe the, as yet poorly understood, mechanism of action of this enzyme. In the future this may lead to drugs useful in the treatment of diseases associated with dynammin kinetics, e.g. some common neurological disorders.

Contact: Dr Ian van Altena

Phone: (02) 4921 5480

Email: [ian.vanAltena@newcastle.edu.au](mailto:ian.vanAltena@newcastle.edu.au)

Advanced Synthetics Materials Group

### **Surfactant and polymer adsorption**

Surfactant and/or polymer coated interfaces are present in the use of everyday formulations from shampoo to paint. A new quartz crystal microbalance instrument will be used to investigate the adsorption of surfactant and polymer molecules at the solid/liquid interface in an effort to develop a sophisticated understanding of the adsorption mechanism and subsequent interfacial behaviour in a variety of solvents (aqueous, non-aqueous, ionic liquids). This project will be cosupervised by Dr Rob Atkin.

Contact: A/Prof Erica Wanless

Phone: (02) 4921 8846

Email: [erica.wanless@newcastle.edu.au](mailto:erica.wanless@newcastle.edu.au)

Advanced Synthetic Materials Group

### **Direct observation of bubble coalescence using high-speed video imaging**

Colloidal particles can be used to stabilise foams in the absence of any surfactant by adsorbing in close-packed particulate monolayers at the air-water interface. We are investigating the mechanism of bubble coalescence at up to 3500 frames per second in order to understand the role of particles at the interfaces of coalescing bubbles. Such coalescence processes are important wherever there are bubbles from champagne to mineral separation by froth flotation. In late 2010 we will install an important new instrument capable of complementary simultaneous measurement of interfacial elasticity and surface tension. This will greatly increase our knowledge of bubble-bubble interactions for a range of industries from 2011 onwards.

*Contact: A/Prof Erica Wanless  
Phone: (02) 4921 8846  
Email: [erica.wanless@newcastle.edu.au](mailto:erica.wanless@newcastle.edu.au)  
Priority Research Centre for Advanced Particle Processing*

### **Mineral processing using minimal water**

There is a need to develop methods to process minerals that will reduce the need to use the large unsustainable quantity of water that is currently used. An important characteristic of any new method is that it must be selective to differences in the physical or chemical properties of the valuable mineral, which is often a sulfide, as distinct from the host rock in the ore, which is usually a silicate. The aim of this project is to attempt to separate various minerals using triboelectric (surface charging) separation, thus obviating the need for water intensive processes such as flotation.

*Contact: A/Prof Erica Wanless  
Phone: (02) 4921 8846  
Email: [erica.wanless@newcastle.edu.au](mailto:erica.wanless@newcastle.edu.au)  
Priority Research Centre for Advanced Particle Processing*

### **Smart polymeric coatings**

Polymer films can radically change the surface of a material while leaving the bulk properties of the material intact. The polymer surface coating controls the interaction with other objects through nanoscale forces. We will construct the next-generation of polymer films that contain an inbuilt molecular-scale switch from attractive to repulsive interactions, offering a means for dictating macroscopic character such as the adhesion or friction of a surface. Academic and industrial interest in these coatings is increasing rapidly, for potential application as low-friction coatings for confined parts or rheology modifiers. This project can have either a polymer synthesis, characterisation (atomic force microscopy, optical reflectometry etc), or materials engineering focus.

*Contact: A/Prof Erica Wanless  
Phone: (02) 4921 8846  
Email: [erica.wanless@newcastle.edu.au](mailto:erica.wanless@newcastle.edu.au)  
Priority Research Centre for Advanced Particle Processing*

### **Nature-inspired silicate nanomaterials for biosensor and biocatalysis applications**

Biosensors are used to detect disease markers and toxins and biocatalysis is increasingly used for manufacturing high yield chemical products with low waste production. Silicate nanostructured materials fabricated based on nature-inspired processes offer major advantages over existing materials. For example, high surface area silicate nanoparticles can be used to immobilise and stabilise a wide range of enzymes under neutral conditions and with high efficiency. The project will create innovative advanced processes for the coentrapment and stabilisation of active enzymes within silicate nanostructured materials, for new biocatalytic chemistry and biosensing applications. The project will be cosupervised by research fellow, Dr Frances Neville.

*Contact: A/Prof Erica Wanless  
Phone: (02) 4921 8846  
Email: [erica.wanless@newcastle.edu.au](mailto:erica.wanless@newcastle.edu.au)  
Priority Research Centre for Organic Electronics*

### **Surface chemistry for improved organic solar cells**

One problem with current plastic photovoltaic cells is phase separation of the polymer blends used during device construction. We have excellent recent results that indicate an improvement by including polymeric nanoparticles in the solar cells. With a combined focus on the polymer chemistry, the surface chemistry and the device fabrication, advances in solar cell efficiency are being made at Newcastle. This project concerns the manufacture, surface organisation and incorporation of conducting polymer nanoparticles into polymeric photovoltaic devices. The project may be cosupervised by either Dr Clovia Holdsworth or Dr Warwick Belcher depending on the desired level of polymer synthesis or device construction respectively.

Contact: A/Prof Erica Wanless  
Phone: (02) 4921 8846  
Email: [erica.wanless@newcastle.edu.au](mailto:erica.wanless@newcastle.edu.au)  
Priority Research Centre for Organic Electronics

## **EARTH SCIENCES**

---

### **Acid Mine Drainage**

The project is at a derelict mine site and trials are proposed for the remediation of contaminated water at the site.

Contact: A/Prof Phillip Geary\*  
Phone: (02) 4921 6726  
Email: [Phil.Geary@newcastle.edu.au](mailto:Phil.Geary@newcastle.edu.au)  
Molecular Structure & Detection Group

### **Comparative Evaluation of Different Small Scale Waste Treatment Systems**

This project is to compare the performance of different wastewater treatment systems, particularly a sand mound system in treating domestic wastewater.

Contact: A/Prof Phillip Geary\*  
Phone: (02) 4921 6726  
Email: [Phil.Geary@newcastle.edu.au](mailto:Phil.Geary@newcastle.edu.au)  
Molecular Structure & Detection Research Group

\*A/Prof Phillip Geary also has research interests in:

- Environmental impacts associated with the on-site treatment and disposal of domestic and agricultural wastewaters, and stormwaters
- Movement and fate of contaminants in soils and groundwaters
- Design and performance of small-scale treatment systems such as sand filters and constructed wetland systems
- Effluent transport through vadose zone and tracer applications using fluorescein, bromide and lithium
- Microbial and pathogen source tracking in catchments, use of fluorescent whitening agents and other tools to track contaminant pathways

### **Monitoring of cave systems: CO<sub>2</sub> fluxes at Wombeyan.**

Understanding CO<sub>2</sub> fluxes in caves is of primary importance to understand calcium carbonate deposition with implication for palaeoenvironmental reconstructions. The work includes monthly visits to Wombeyan caves. Collection of drip rate data on selected drips, continuous pCO<sub>2</sub> monitoring with Vaisala probe, pH measurements of drip waters monthly resolution, temperature measurement within and outside caves. Rainfall data from meteorological stations.

Contact: Dr Silvia Frisia  
Phone: (02) 4921 5402  
Email: [Silvia.Frisia@newcastle.edu.au](mailto:Silvia.Frisia@newcastle.edu.au)

Contact: Dr Janece McDonald  
Phone: (02) 4921 5509  
Email: [Janece.McDonald@newcastle.edu.au](mailto:Janece.McDonald@newcastle.edu.au)  
Environmental & Climate Change Group

### **Petrography and diagenesis of climate-sensitive continental carbonates**

The work observations in thin sections (optical microscope) of cave carbonates, including lamina counting, and on freshly cut pieces (Scanning Electron Microscope). XRD analyses to determine phases, fluorescence and back-scattered electron analyses (at Newcastle) to determine and map compositional changes. Recognition of fabrics and phases is of primary importance. Focus is to determine if diagenetic processes altered the original fabrics and, consequently, the geochemical signals. Work will be carried out on specimens from Nullarbor (Australia), 1 to 3 million years old.

A second thesis could be on specimens from the Dolomites (N Italy), probably 1 million year old. Affected by glacial and interglacial climate and hydrology for the past at least 800,000 years.

Contact: Dr Silvia Frisia  
Phone: (02) 4921 5402  
Email: [Silvia.Frisia@newcastle.edu.au](mailto:Silvia.Frisia@newcastle.edu.au)  
Environmental & Climate Change Group

### **Petrography and diagenesis of marine carbonates in karst areas**

The work includes fieldwork at Wombeyan caves to characterize the karst rock hosting the cave system. Geologic survey, collection of rock samples, observations in thin sections (optical microscope) and on freshly cut pieces (Scanning Electron Microscope). XRD analyses to determine phases, fluorescence and back-scattered electron analyses (at Newcastle) to determine and map compositional changes. A bit of geochemistry to understand diagenetic alterations and present-day dissolution.

Contact: Dr Silvia Frisia  
Phone: (02) 4921 5402  
Email: [Silvia.Frisia@newcastle.edu.au](mailto:Silvia.Frisia@newcastle.edu.au)

Contact: Dr Janece McDonald  
Phone: (02) 4921 5509  
Email: [Janece.McDonald@newcastle.edu.au](mailto:Janece.McDonald@newcastle.edu.au)  
Environmental & Climate Change Group

### **Assessment of General Circulation Model's (GCMs) ability to realistically simulate local and large-scale drivers of natural climate variability in southeast Australia**

Since the release of the IPCC 4th Assessment Report research has been directed at evaluating the ability of GCMs to simulate the present/historical climate in an attempt to identify the GCMs that are best for the region/application of interest. At present, most metrics used to assess the ability of GCMs to simulate climate variables (such as rainfall, temperate etc.) are based on seasonal and annual time scales. However monthly, seasonal, or longer averages can hide biases or systematic errors. This project aims to investigate the potential of an alternate GCM assessment technique which seeks to identify the GCMs that successfully simulate the major local and large-scale climate drivers known to be important for southeast Australia. We already know which GCMs do a particularly poor job at simulating El Niño-Southern Oscillation (ENSO), but what about the other drivers known to influence southeast Australia (e.g. Indian Ocean Dipole, Southern Annular Mode, Interdecadal Pacific Oscillation, Sub-Tropical Ridge, ENSO Modoki etc)?

Contact: Dr Anthony Kiem  
Phone: (02) 4921 8656  
Email: [anthony.kiem@newcastle.edu.au](mailto:anthony.kiem@newcastle.edu.au)  
Environmental & Climate Change Group

### **Characterising southern hemisphere dry epochs and their causal processes**

This project aims to firstly catalogue the location, duration and severity of dry epochs in the Southern Hemisphere. This will involve a literature review and analysis of both instrumental and pre-instrumental (paleo) records. Secondly, the climatic drivers of the identified dry epochs will be investigated with the ultimate objective being to put the current southeast Australian drought into context and to more realistically quantify drought risk so more robust adaptation strategies can be developed.

*Contact: Dr Anthony Kiem*

*Phone: (02) 4921 8656*

*Email: [anthony.kiem@newcastle.edu.au](mailto:anthony.kiem@newcastle.edu.au)*

*Environmental & Climate Change Group*

### **Characterising southern hemisphere wet epochs and their causal processes**

This project aims to firstly catalogue the location, duration and severity of wet epochs in the Southern Hemisphere. This will involve a literature review and analysis of both instrumental and pre-instrumental (paleo) records. Secondly, the climatic drivers of the identified wet epochs will be investigated with the ultimate objective being to put recent flood events in QLD and NSW into context and to more realistically quantify flood risk so more robust adaptation strategies can be developed.

*Contact: Dr Anthony Kiem*

*Phone: (02) 4921 8656*

*Email: [anthony.kiem@newcastle.edu.au](mailto:anthony.kiem@newcastle.edu.au)*

*Environmental & Climate Change Group*

### **Characterising Victorian bushfire risk and its causal processes**

This project aims to firstly catalogue the location, duration and severity of bushfires in southeast Australia, specifically Victoria. This will involve a literature review and analysis of both instrumental and pre-instrumental (paleo) records. Secondly, the climatic drivers of the identified bushfires will be investigated with the ultimate objective being to put the recent "Black Saturday" Victorian bushfires into context and to more realistically quantify bushfire risk so more robust adaptation strategies can be developed.

*Contact: Dr Anthony Kiem*

*Phone: (02) 4921 8656*

*Email: [anthony.kiem@newcastle.edu.au](mailto:anthony.kiem@newcastle.edu.au)*

*Environmental & Climate Change Group*

### **East Coast Lows and the Newcastle Pasha Bulker Storm**

The June 2007 Pasha Bulker storm was one of the most significant meteorological events in Australia's history. It was the 4th largest general insurance loss since insurance records were started in 1968. The storm consisted of three distinct impacts (1) flash flooding in the urban area of Newcastle on the 8 June (about 1 in 100 year return period) (2) more general flooding on the Hunter River 3 days later and (3) high winds and wave heights, the worst in the Newcastle-Sydney region since the "Sygna" storm in 1974. Both the Pasha Bulker and Sygna storms were the result of an East Coast Low (ECL). ECLs are the cause of most major flood events on the East Australian Coastal strip. The context for the June 2007 ECL and the resulting storm will be provided. How big was it historically? Where and when have similar ECL occurred before, and how frequently? What are the "typical" impacts associated with ECLs and was the June 2007 ECL "typical"? What is the likely trend of ECL intensity and frequency with climate change? What is the likelihood of similar events occurring elsewhere in Australia?

*Contact: Dr Anthony Kiem*

*Phone: (02) 4921 8656*

*Email: [anthony.kiem@newcastle.edu.au](mailto:anthony.kiem@newcastle.edu.au)*

*Environmental & Climate Change Group*

### **Establish the long-term (1000 years) natural variability of East Coast Lows**

East Coast Lows (ECL) are complex weather systems that travel parallel to the east coast of Australia from south-east Queensland to Victoria. They can cause significant storm damage to both the natural system and human infrastructure (e.g. the Pasha Bulker storm). The historical records over the past century show that the magnitude and frequency of ECLs is linked to decadal-scale variability in the climate system. This project will use insights into the mechanisms that drive climate variability in Australia to produce a time-series of ECL frequency and intensity over (a) the last century using instrumental records and (b) the last 1000 years using proxy data based on palaeo reconstructions. The project will provide the basis for risk assessment of extreme ECL events both under natural and anthropogenic climate change.

*Contact: Dr Anthony Kiem  
Phone: (02) 4921 8656  
Email: [anthony.kiem@newcastle.edu.au](mailto:anthony.kiem@newcastle.edu.au)  
Environmental & Climate Change Group*

### **Defining 'east coast' climate**

The area of land between the tablelands and the coast of NSW and southern Queensland is home to more than nine million people. A variety of high impact weather events occur in this area, generating damaging winds, flooding, hail, heavy seas and swell. Rainfall during these weather events also plays a critical role in our State's water supply, filling dams and supplying base flows for inland river systems and groundwater recharge. However, the climatic processes in this part of Australia are the least well-understood in terms of climate change and its impacts. This project will identify the drivers of climatic variability in the 'east coast' region and highlight differences between the 'east coast' and other areas of Australia. The project will form the basis for addressing the gaps in our knowledge relating to the impacts of climate variability and change along the 'east coast'. This is necessary to develop informed and robust planning and adaptation strategies to ensure the sustainability of this heavily populated region.

*Contact: Dr Anthony Kiem  
Phone: (02) 4921 8656  
Email: [anthony.kiem@newcastle.edu.au](mailto:anthony.kiem@newcastle.edu.au)  
Environmental & Climate Change Group*

### **Exhumation of eclogites and blueschists – a tectonic ambiguity?**

The exhumation of deep crustal depths is an enigmatic process not comprehensively explained by tectonic theory. In the New England Orogen, eclogite and blueschist facies rocks (from depths of 20-60 km) are exposed and generally enveloped by highly deformed serpentinite. This project will use information deciphered from detailed analysis of tectonic fabrics formed in serpentinite and tectonic melanges to provide inferences on structural processes associated with exhumation of deep crustal rocks. The results of this project will provide important information on a long-standing tectonic ambiguity that has puzzled tectonicists for years.

*Contact: Dr Glen Phillips  
Phone: (02) 4921 5410  
Email: [Glen.Phillips@newcastle.edu.au](mailto:Glen.Phillips@newcastle.edu.au)  
Tectonics and Earth Resources Group*

### **Formation of eclogites and blueschists – what can they tell us about plate tectonics?**

Eclogite and blueschist facies rocks form under high-pressure tectonic conditions and are generally associated with processes occurring along plate margins. This project will use detailed petrography and thermodynamic modelling to provide constraints on the evolution of eclogite to blueschist facies rocks exposed in the New England Orogen, NSW. Thermodynamic modelling will be carried out using the computer software THERMOCALC and will involve the calculation of phase diagrams with the aim of constructing pressure-temperature paths. The primary aim of this project is to provide robust physical constraints on the processes that occur in subduction zones.

*Contact: Dr Glen Phillips  
Phone: (02) 4921 5410  
Email: [Glen.Phillips@newcastle.edu.au](mailto:Glen.Phillips@newcastle.edu.au)  
Tectonics and Earth Resources Group*

### **Identifying contraction and extension cycles in orogenic belts**

The geological record of the New England Orogen preserves evidence of successive periods of contraction and extension. The role of these contraction and extension cycles on controlling crustal growth and genesis of base metal deposits is still poorly understood. In this project, the student will unravel the deposition and then deformation history of Permian-Triassic basins exposed throughout the New England Orogen. To tighten up timing constraints on basin forming and closing events, geochronology will be an integral part of the project. This project will deliver improved timing and kinematic constraints on the evolution of an advancing-retreating orogenic system, which can be integrated into crustal growth or ore genesis models of Australia.

*Contact: Dr Glen Phillips*

*Phone: (02) 4921 5410*

*Email: [Glen.Phillips@newcastle.edu.au](mailto:Glen.Phillips@newcastle.edu.au)*

*Tectonics and Earth Resources Group*

### **Is crustal growth controlled by tectonic setting?**

The New England Orogen provides an ideal location to study the potential relationships between crustal growth and tectonic setting. During its 200 million year history, the New England Orogen was characterised by periods of advancing and retreating subduction as well as high and low geothermal gradients. As result, granite genesis during these periods can be studied to evaluate the contribution of crustal vs. mantle material - which can be achieved by carrying out U-Pb and Hf zircon studies. A recent reconnaissance study has revealed a link between periods of lithospheric thinning and direct mantle contributions to granites (in turn encouraging crustal growth). The aim of this project is to carry out U-Pb and Hf zircon studies on granites that were emplaced during periods of crustal thickening vs. crust thinning. This will test the hypothesis that tectonic setting is strongly linked to crustal growth.

*Contact: Dr Glen Phillips*

*Phone: (02) 4921 5410*

*Email: [Glen.Phillips@newcastle.edu.au](mailto:Glen.Phillips@newcastle.edu.au)*

*Tectonics and Earth Resources Group*

### **Unravelling the structural characteristics of accretionary wedges**

This project will involve combining field mapping with geophysics to interpret the internal structure and kinematic evolution of an accretionary wedge, located as part of the New England Orogen, eastern Australia. The aim of this project will be to compare the structural evolution of this accretionary wedge with analogue (sandbox modelling) and numerical models. This work will significantly add to our understanding of how accretionary wedges and fold and thrust belts evolve.

*Contact: Dr Glen Phillips*

*Phone: (02) 4921 5410*

*Email: [Glen.Phillips@newcastle.edu.au](mailto:Glen.Phillips@newcastle.edu.au)*

*Tectonics and Earth Resources Research Group*

## DEVELOPMENT STUDIES

---

### **Geographies of urban regeneration**

The regeneration of our cities in the face of growing environmental, social and population pressures will be a major challenge facing urban Australia over the coming decades. Both national and comparative research is needed on how we can imagine, govern and operationalise successful regeneration to have environmentally and socially acceptable outcomes. Research topics might include case study investigations of regeneration processes and outcomes, studies of community involvement in regeneration, studies of the politics of regeneration governance.

Contact: Professor Pauline M<sup>c</sup>Guirk or Dr Kathy Mee  
Phone: (02) 4921 5097  
Email: [Pauline.McGuirk@newcastle.edu.au](mailto:Pauline.McGuirk@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Urban Carbon Governance**

Effective responses to climate change hinge on the capacity to govern carbon, especially in our growing cities. Australia's urban carbon governance framework has proved ineffective, and there is no systematic knowledge of it to inform improvement. This research project would contribute to a wider project aimed to document and analyse the 'who', 'how' and 'where' of urban carbon governance, and the related politics and spatiality. The project will provide empirical and theoretical knowledge to advance the capacity to govern carbon and enhance Australia's environmental

Contact: Professor Pauline M<sup>c</sup>Guirk  
Phone: (02) 4921 5097  
Email: [Pauline.McGuirk@newcastle.edu.au](mailto:Pauline.McGuirk@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Urban social inclusion**

Cities have long been sites where the uneven distribution of resources and recognition is expressed. Recent policy initiatives have been framed around the notion of 'social excluded' places and people and the challenge of attaining 'social inclusion'. Yet we have relatively poor understandings of how social inclusion is both understood and experienced differentially across diverse communities and neighbourhoods with diverse levels of mobility and connectivity. Research topics in this field could address both urban spatial variations in the availability of resources and opportunities and the diverse understanding and experience of social inclusion.

For these or other urban-related topics, please contact:

Contact: Professor Pauline M<sup>c</sup>Guirk  
Phone: (02) 4921 5097  
Email: [Pauline.McGuirk@newcastle.edu.au](mailto:Pauline.McGuirk@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Geographies of home and home making**

Recent research in geography has investigated the homemaking as a dynamic process. Research in the field has investigated the home making practices of newly arrived migrants, new suburban residents, people living in medium density developments, public housing tenants, gay men, people with an intellectual impairment and the experiences of people living with animals as pets and pests. Other research has looked at practices of home-making that occur in gardens and neighbourhoods. This honours research topic would further our knowledge of home making practices by examining one of the following:

- Home making on the Newcastle suburban fringe
- Home making in a retirement village
- Home making in share households
- The adoption of green domestic technologies and home making practices
- The role of food and cooking in homemaking

Contact: *Dr Kathy Mee*  
Phone: (02) 4921 6451  
Email: [Kathy.Mee@newcastle.edu.au](mailto:Kathy.Mee@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Understanding Neighbourhood Dynamics**

Recent research on neighbourhood has emphasised that neighbourhoods cannot merely be understood as a set of socio-economic characteristics, but rather are brought into being through the actions of neighbourhood residents and other people who use the neighbourhood. At the cutting edge of urban research, this notion that neighbourhoods are performed, requires further investigation. Students could choose to investigate the role of social interactions in creating the neighbourhoods, the role of new developments or threatened developments in provoking the mobilisation of neighbourhood resources or the role of particular sorts of community assets such as schools and green spaces in developing neighbourhood. Potential topics include:

- Neighbourly relations and social capital in neighbourhoods
- Protest movements and neighbourhood development
- Schools as neighbourhood resources
- Green spaces as a neighbourhood resources

Contact: *Dr Kathy Mee*  
Phone: (02) 4921 6451  
Email: [Kathy.Mee@newcastle.edu.au](mailto:Kathy.Mee@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Geographies of mobility**

Issues of mobility and transport access are crucial to developing more sustainable cities. Recent geographical research has emphasised the importance of understanding flows of people around cities. While research on mobility in geography is growing, there is considerable scope to contribute to our understanding of mobility in Australia. Some potential research projects include:

- Cycling as a form of commuting in Newcastle
- Cycling activism as a form of urban intervention in Australian cities
- Public transport and mobility
- Transport access and neighbourhood development on the urban fringe
- Managing multiple demands in daily commuting
- The journey to university: transport choices amongst workers and students

Contact: *Dr Kathy Mee*  
Phone: (02) 4921 6451  
Email: [Kathy.Mee@newcastle.edu.au](mailto:Kathy.Mee@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Case Studies of community/mining company relations**

The minerals sector remains one of Australia's most important corporate players today influencing governmental decision-making at all scales. Its relations with communities, however, are not always as transparent as they could be and this can often lead to contestation over access to land and resources as well as concerns over possible environmental damage. These issues remain compelling ones for all sectors of society.

Contact: *Dr Meg Sherval*  
Phone: (02) 4921 6809  
Email: [Meg.sherval@newcastle.edu.au](mailto:Meg.sherval@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Incorporating resource peripheries into the globalising economy**

Remoteness and distance have often been given as reasons for excluding particular places from playing an active role in the globalising economy and important decision-making. Frequently, however, these perceptions are stereotyped and bear little resemblance to the reality of these places on the ground, which more often than not, are very productive spaces. There remains a need for better understanding of remoteness as a concept so as to avoid the peripheralisation of places that continues today despite globalisation's claims to have created a 'border-less' world.

*Contact: Dr Meg Sherval*

*Phone: (02) 4921 6809*

*Email: [Meg.sherval@newcastle.edu.au](mailto:Meg.sherval@newcastle.edu.au)*

*Centre for Urban and Regional Studies (CURS)*

### **The effects of Climate Change on small Island states**

Climate change remains an ongoing global threat though its effects will be felt first by small island states. Understanding how these places adapt to stresses placed upon them by a changing climate and what strategies exist or need to be developed to help respond to these challenges will be an ongoing concern for researchers and governments alike.

*Contact: Dr Meg Sherval*

*Phone: (02) 49216809*

*Email: [Meg.Sherval@newcastle.edu.au](mailto:Meg.Sherval@newcastle.edu.au)*

*Centre for Urban and Regional Studies (CURS)*

### **The creation of green spaces through better environmental planning**

As population numbers continue to grow globally, as a consequence, more land is consumed often denuding our environment of 'green spaces'. Recently, however, there have been calls for better planning initiatives which promote and encourage developments which emphasise 'greening' the environment. Developments such as golf courses have recently been touted as a means for creating such spaces. Debates continue though as to whether this privileges the rich over the poor by controlling who has access to use these spaces and who is excluded and why.

*Contact: Dr Meg Sherval*

*Phone: (02) 4921 6809*

*Email: [Meg.sherval@newcastle.edu.au](mailto:Meg.sherval@newcastle.edu.au)*

*Centre for Urban and Regional Studies (CURS)*

**With any enquiries about these or any other potential Honours opportunities in Geography and Environmental Studies Honours and Development Studies Honours, please contact Honours Co-ordinator Dr Meg Sherval via email at: [Meg.Sherval@newcastle.edu.au](mailto:Meg.Sherval@newcastle.edu.au).**

# GEOGRAPHY & ENVIRONMENTAL STUDIES

---

## **Geographies of urban regeneration**

The regeneration of our cities in the face of growing environmental, social and population pressures will be a major challenge facing urban Australia over the coming decades. Both national and comparative research is needed on how we can imagine, govern and operationalise successful regeneration to have environmentally and socially acceptable outcomes. Research topics might include case study investigations of regeneration processes and outcomes, studies of community involvement in regeneration, studies of the politics of regeneration governance.

Contact: *Professor Pauline M<sup>c</sup>Guirk or Dr Kathy Mee*  
Phone: *(02) 4921 5097*  
Email: *[Pauline.McGuirk@newcastle.edu.au](mailto:Pauline.McGuirk@newcastle.edu.au)*  
*Centre for Urban and Regional Studies (CURS)*

## **Urban Carbon Governance**

Effective responses to climate change hinge on the capacity to govern carbon, especially in our growing cities. Australia's urban carbon governance framework has proved ineffective, and there is no systematic knowledge of it to inform improvement. This research project would contribute to a wider project aimed to document and analyse the 'who', 'how' and 'where' of urban carbon governance, and the related politics and spatiality. The project will provide empirical and theoretical knowledge to advance the capacity to govern carbon and enhance Australia's environment.

Contact: *Professor Pauline M<sup>c</sup>Guirk*  
Phone: *(02) 4921 5097*  
Email: *[Pauline.McGuirk@newcastle.edu.au](mailto:Pauline.McGuirk@newcastle.edu.au)*  
*Centre for Urban and Regional Studies (CURS)*

## **Urban social inclusion**

Cities have long been sites where the uneven distribution of resources and recognition is expressed. Recent policy initiatives have been framed around the notion of 'social excluded' places and people and the challenge of attaining 'social inclusion'. Yet we have relatively poor understandings of how social inclusion is both understood and experienced differentially across diverse communities and neighbourhoods with diverse levels of mobility and connectivity. Research topics in this field could address both urban spatial variations in the availability of resources and opportunities and the diverse understanding and experience of social inclusion.

*For these or other urban-related topics, please contact:*  
Contact: *Professor Pauline M<sup>c</sup>Guirk*  
Phone: *(02) 4921 5097*  
Email: *[Pauline.McGuirk@newcastle.edu.au](mailto:Pauline.McGuirk@newcastle.edu.au)*  
*Centre for Urban and Regional Studies (CURS)*

## **Geographies of home and home making**

Recent research in geography has investigated the homemaking as a dynamic process. Research in the field has investigated the home making practices of newly arrived migrants, new suburban residents, people living in medium density developments, public housing tenants, gay men, people with an intellectual impairment and the experiences of people living with animals as pets and pests. Other research has looked at practices of home-making that occur in gardens and neighbourhoods.

This honours research topic would further our knowledge of home making practices by examining one of the following:

- Home making on the Newcastle suburban fringe
- Home making in a retirement village
- Home making in share households
- The adoption of green domestic technologies and home making practices
- The role of food and cooking in homemaking.

Contact: *Dr Kathy Mee*  
Phone: (02) 4921 6451  
Email: [Kathy.Mee@newcastle.edu.au](mailto:Kathy.Mee@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Understanding Neighbourhood Dynamics**

Recent research on neighbourhood has emphasised that neighbourhoods cannot merely be understood as a set of socio-economic characteristics, but rather are brought into being through the actions of neighbourhood residents and other people who use the neighbourhood. At the cutting edge of urban research, this notion that neighbourhoods are performed, requires further investigation. Students could choose to investigate the role of social interactions in creating the neighbourhoods, the role of new developments or threatened developments in provoking the mobilisation of neighbourhood resources or the role of particular sorts of community assets such as schools and green spaces in developing neighbourhood. Potential topics include:

- Neighbourly relations and social capital in neighbourhoods
- Protest movements and neighbourhood development
- Schools as neighbourhood resources
- Green spaces as a neighbourhood resources

Contact: *Dr Kathy Mee*  
Phone: (02) 4921 6451  
Email: [Kathy.Mee@newcastle.edu.au](mailto:Kathy.Mee@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Geographies of mobility**

Issues of mobility and transport access are crucial to developing more sustainable cities. Recent geographical research has emphasised the importance of understanding flows of people around cities. While research on mobility in geography is growing, there is considerable scope to contribute to our understanding of mobility in Australia. Some potential research projects include:

- Cycling as a form of commuting in Newcastle
- Cycling activism as a form of urban intervention in Australian cities
- Public transport and mobility
- Transport access and neighbourhood development on the urban fringe
- Managing multiple demands in daily commuting
- The journey to university: transport choices amongst workers and students

Contact: *Dr Kathy Mee*  
Phone: (02) 4921 6451  
Email: [Kathy.Mee@newcastle.edu.au](mailto:Kathy.Mee@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Case Studies of community/mining company relations**

The minerals sector remains one of Australia's most important corporate players today influencing governmental decision-making at all scales. Its relations with communities, however, are not always as transparent as they could be and this can often lead to contestation over access to land and resources as well as concerns over possible environmental damage. These issues remain compelling ones for all sectors of society.

Contact: *Dr Meg Sherval*  
Phone: (02) 4921 6809  
Email: [Meg.sherval@newcastle.edu.au](mailto:Meg.sherval@newcastle.edu.au)  
Centre for Urban and Regional Studies (CURS)

### **Incorporating resource peripheries into the globalising economy**

Remoteness and distance have often been given as reasons for excluding particular places from playing an active role in the globalising economy and important decision-making. Frequently, however, these perceptions are stereotyped and bear little resemblance to the reality of these places on the ground, which more often than not, are very productive spaces. There remains a need for better understanding of remoteness as a concept so as to avoid the peripheralisation of places that continues today despite globalisation's claims to have created a 'border-less' world.

*Contact: Dr Meg Sherval*  
*Phone: (02) 4921 6809*  
*Email: [Meg.sherval@newcastle.edu.au](mailto:Meg.sherval@newcastle.edu.au)*  
*Centre for Urban and Regional Studies (CURS)*

### **The effects of Climate Change on small Island states**

Climate change remains an ongoing global threat though its effects will be felt first by small island states. Understanding how these places adapt to stresses placed upon them by a changing climate and what strategies exist or need to be developed to help respond to these challenges will be an ongoing concern for researchers and governments alike.

*Contact: Dr Meg Sherval*  
*Phone: (02) 49216809*  
*Email: [Meg.Sherval@newcastle.edu.au](mailto:Meg.Sherval@newcastle.edu.au)*  
*Centre for Urban and Regional Studies (CURS)*

### **The creation of green spaces through better environmental planning**

As population numbers continue to grow globally, as a consequence, more land is consumed often denuding our environment of 'green spaces'. Recently, however, there have been calls for better planning initiatives which promote and encourage developments which emphasise 'greening' the environment. Developments such as golf courses have recently been touted as a means for creating such spaces. Debates continue though as to whether this privileges the rich over the poor by controlling who has access to use these spaces and who is excluded and why.

*Contact: Dr Meg Sherval*  
*Phone: (02) 4921 6809*  
*Email: [Meg.sherval@newcastle.edu.au](mailto:Meg.sherval@newcastle.edu.au)*  
*Centre for Urban and Regional Studies (CURS)*

### **Analyses of particular development projects (in Australia and overseas)**

**Local impacts of global change**

**Environmental politics and social justice**

**Effects of neoliberal development on women**

**The constructions of "globalisations from below" by social movements**

**Migration to Newcastle and transnational communities**

**Sustainable agriculture and alternative agriculture networks**

**Indigenous tourism**

**Indigenous social enterprise**

*Contact: Dr Sarah Wright\*\**  
*Phone: (02) 4921 6809*  
*Email: [Sarah.Wright@newcastle.edu.au](mailto:Sarah.Wright@newcastle.edu.au)*  
*Centre for Urban and Regional Studies (CURS)*

\*\*Sarah's research interests are in development studies, sustainability, social movements and feminist theory, particularly women in development. She has done work in Southeast Asia, the Pacific, Australia and Latin America. She has also worked extensively with Indigenous people mostly in Arnhem Land. Honours

projects might involve a trip overseas but also could look at issues of development within Australia. The topics listed for Sarah are general ideas and would need to be refined with an appropriate case study or more specific topic in consultation her. Sarah is on maternity leave in 2010 but will be available for supervision in 2011.

### **Urban natures**

New visions of nature and the city are emerging with the recognition that nature is always already in the city – insects, air, pests, street trees, gardens, wastelands, pets, soil and so on. Urban nature is around us, in our homes, in our bodies and part of everyday urban lives. Students could investigate a range of topics including:

- Controversies over proposals to sell off urban parkland
- Relations and interactions with urban biodiversity
- Invasive species and weeds in urban public spaces
- Debates around the reintroduction of native vegetation in urban open space
- Human-plant relations in public parks and gardens
- Nature strips
- Urban political ecology

Contact: *Dr Lesley Instone*

Phone: (02) 4921 6637

Email: [Lesley.Instone@newcastle.edu.au](mailto:Lesley.Instone@newcastle.edu.au)

Centre for Urban and Regional Studies (CURS)

### **Animal geographies and human-animal relations**

Animal geographies sprung to prominence in the 1990s as a lively and innovative area exploring the human-nonhuman entanglements of places and spaces. Questions of animal agency, hybridity and representation animate these animal geographies in a range of urban, rural and 'wild' settings and across a range of scales. Topics could include:

- Companion species and new forms of consumption and waste
- Urban animal geographies of wildness and domesticity
- Climate change and animal lives and spaces
- The entanglement of humans and animals in daily life and at work
- Changing pet relations and sustainable pet ownership
- Living with pests/wildlife in the city

Contact: *Dr Lesley Instone*

Phone: (02) 4921 6637

Email: [Lesley.Instone@newcastle.edu.au](mailto:Lesley.Instone@newcastle.edu.au)

Centre for Urban and Regional Studies (CURS)

### **Socio-cultural studies of Australian environments and sustainability**

Cultural beliefs are everyday orientations that influence how we think about nature and how we frame questions about conservation and sustainability. How do ideas about nature influence on-the-ground practices? How do different groups appreciate and interact with the environment? What effects do attitudes and values have on modes of environmental management, regulation and sustainability? Topic areas include:

- Historical and contemporary attitudes to native grasses and grasslands
- Socio-cultural aspects of ecological restoration, renaturing and plant/animal reintroductions
- Conservation practices on private land
- Geographies of environmental legislation and regulation, e.g. biobanking and biodiversity
- Gender and sustainability

Contact: *Dr Lesley Instone*

Phone: (02) 4921 6637

Email: [Lesley.Instone@newcastle.edu.au](mailto:Lesley.Instone@newcastle.edu.au)

Centre for Urban and Regional Studies (CURS)

**With any enquiries about these or any other potential Honours opportunities in Geography and Environmental Studies Honours and Development Studies Honours, please contact Honours Co-ordinator Dr Meg Sherval via email at: [Meg.Sherval@newcastle.edu.au](mailto:Meg.Sherval@newcastle.edu.au).**

### MATHEMATICS

---

#### **Cycles and Symmetry in Graphs / Graph Theory**

The well-known Lovasz Problem (1969) asking whether every connected vertex-transitive graph has a Hamilton path has generated considerable research since it was posed. This project involves an examination of recent progress made on the general question.

Contact: Dr Brian Alspach

Phone: (02) 4921 2026

Email: [Brian.Alspace@newcastle.edu.au](mailto:Brian.Alspace@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

#### **Graph Searching/Graph Theory**

An active area of current research in graph theory revolves around the basic idea of trying to determine whether an intruder is located somewhere in a graph, and designing strategies to capture an intruder. This project involves an examination of one or two models for graph searching and a possible exploration of an unsolved problem (of which there are many).

Contact: Dr Brian Alspach

Phone: (02) 4921 2026

Email: [Brian.Alspace@newcastle.edu.au](mailto:Brian.Alspace@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

#### **Radiation**

One of the major challenges of contemporary physics is the direct detection of gravitational radiation. (The slowing down of pulsars as accounted by Einstein's quadrupole formula is indirect evidence.) However, there isn't really a good definition of what exactly gravitational radiation is! (The usual definitions only apply to perturbations about some fixed spacetime background.) Although the electromagnetic case is much better understood (there are a number of exact solutions available) there are still many ambiguities in trying to give a precise definition of what radiation is. These have been discussed in the literature (largely over the last 40 years). Part of this project would be a literature review. A more specific topic to investigate would be the use of conformal transformations to relate the world line of an inertial charge to that of a uniformly accelerating charge, and to see what this tells us about the radiation of the latter. (This is not an original idea, but discussion of this topic can be found in fairly recent sources).

Contact: Dr Ian Benn

Phone: (02) 4921 5531

Email: [ian.benn@newcastle.edu.au](mailto:ian.benn@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

#### **Compressed Sensing/ Nonlinear Optimization**

To analyze optimization methods for finding sparse signals which reconstruct known measurements. Traditionally in signal or image reconstruction problems, the scientist recovers a signal and then compresses it using JPEG, wavelet or other methods of reducing the size of the data set to be stored. Recent exciting work performed by Australian Fields medallist Terry Tao among others has focussed on determining *ab initio* sparse reconstructions. The theory behind current methods for such *compressed sensing* is poorly understood and the project offers considerable room to make mathematical discoveries.

Contact: Laureate Professor Jon Borwein

Phone: (02) 4921 5535

Email: [Jonathan.Borwein@newcastle.edu.au](mailto:Jonathan.Borwein@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Computer assisted discovery and proof / Experimental Mathematics**

To work on the implementation and design of methods to assist with the discovery and or proof of analytic objects, such as inequalities in one and more variables, identification of values of series and integrals and much more. One goal is to provide 'intelligent agents' to allow human researchers to quickly validate or falsify conjectured inequalities and in the former case to provide automated proofs whenever possible. This project will provide also an opportunity to learn a great deal about modern computer algebra systems.

Contact: Laureate Professor Jon Borwein

Phone: (02) 4921 5535

Email: [Jonathan.Borwein@newcastle.edu.au](mailto:Jonathan.Borwein@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **High Precision Integration / Computational Mathematics**

To work on the implementation and analysis of algorithms to compute physically meaningful integrals to at least double precision in more than two dimensions. Such integrals arise in statistical mechanics, quantum field theory, geosciences, mathematical finance and many other places; and their accurate evaluation is one of the central challenges of modern numerical and symbolic computer analysis.

Contact: Laureate Professor Jon Borwein

Phone: (02) 4921 5535

Email: [Jonathan.Borwein@newcastle.edu.au](mailto:Jonathan.Borwein@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Cost-based bounding techniques for solving resource constrained shortest path problems**

The problem of finding the shortest path between two points in a network is well known and there exists a plethora of algorithms to solve these problems. When in addition to finding the shortest path, certain additional resource constraints are imposed, the resulting problem can be extremely difficult to solve. Although an interesting problem in itself, the resulting *resource constrained shortest path problem* (RCSP) appears as a sub problem to many large scale combinatorial and integer optimisation problems including vehicle routing, crew scheduling, aircraft routing, network design etc. This project aims to develop and investigate the use of relaxation based bounding techniques within dynamic, integer, and/or constraint programming methods for RCSP.

Contact: Dr Faramroze Engineer

Phone: (02) 4921 6683

Email: [Faramroze.Engineer@newcastle.edu.au](mailto:Faramroze.Engineer@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Optimizing preparedness plans for pandemic outbreaks**

Many experts believe that a pandemic influenza will hit the world in the near future that is much more devastating than the H1N1 (swine flu) outbreak the world is currently experiencing. Governments and nongovernmental organizations prepare response plans, but most preparation has focused on developing vaccine manufacturing. From managing the inventory of vaccines, to distribution and transportation strategies, to general strategies for public quarantine, this project aims to address some of the more logistical problems that can become obstacles to an effective response plan. This project will develop an understanding of the key models and techniques in mathematical optimisation including using simulation techniques as part of the optimisation or to validate the quality of solutions.

Contact: Dr Faramroze Engineer

Phone: (02) 4921 6683

Email: [Faramroze.Engineer@newcastle.edu.au](mailto:Faramroze.Engineer@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Optimizing the procurement, distribution, and delivery of childhood immunization**

Childhood immunization programs are one of the most successful and cost effective ways of preventing vaccine preventable diseases among children. A successful immunization program requires not only the careful planning and design of vaccination schedules that reflect the best possible coverage for a child but also, procurement and distribution strategies that can meet the demand for vaccines in a cost effective way. With a growing list of vaccines and the introduction of new combination vaccines, this decision making process has become ever more complex. This project will aim to develop and solve optimisation models for a range of decision making activities necessary for a successful immunization program. From strategic level decision making in which the goals of the immunization program are set out, to tactical level decisions where the schedules are designed and vaccines are procured, to the day-to-day scheduling of vaccines for individual children who fall behind the recommended schedule. In addition to exposing the student to problems in the real world (public health in this case), this project will develop an understanding of the key models and techniques in mathematical optimization, investigate the effectiveness of integer and dynamic programming techniques, and explore alternative approaches.

*Contact: Dr Faramroze Engineer*

*Phone: (02) 4921 6683*

*Email: [Faramroze.Engineer@newcastle.edu.au](mailto:Faramroze.Engineer@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

### **Uncertainty relations for Multi-channel signals and Clifford algebra**

In recent years, mathematicians and electrical engineers have developed Fourier-type integral operators for the analysis and processing of multi-channel signals, such as colour images. The kernels of these operators are similar in nature to the classical Fourier kernel, but also have important differences. In particular, these kernels (and the signals themselves) take values in an appropriate Clifford algebra where multiplication is non-commutative. Here we explore the uncertainty relations satisfied by these new operators and also their applications in colour image processing. This project will require some programming in MATLAB.

*Contact: Dr Jeff Hogan*

*Phone: (02) 4921 7235*

*Email: [Jeff.Hogan@newcastle.edu.au](mailto:Jeff.Hogan@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

### **Applications of biorthogonal systems in approximating higher order derivatives**

Finite element methods based on biorthogonal systems are proved to be very effective in solving partial differential equations with a weak constraint. Weak constraints can be used to reduce the order of derivatives in numerical approximation. Higher order derivatives occur frequently in data smoothing, image processing and binary mixtures. The aim of the project is to analyse the performance of biorthogonal systems in approximating higher order derivatives. Programming skill in MATLAB is required to complete the project.

*Contact: Dr Bishnu Lamichhane*

*Phone: (02) 4921 5529*

*Email: [Bishnu.Lamichhane@newcastle.edu.au](mailto:Bishnu.Lamichhane@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

### **Variational approach in image processing**

The finite element method has become a very powerful and popular tool to solve boundary value problems coming from science and engineering. This project is concerned with applying finite element method in image processing. One example is to remove the mixture of impulsive and Gaussian noise from an image. Programming skill preferably in MATLAB is required to complete the project.

*Contact: Dr Bishnu Lamichhane*

*Phone: (02) 4921 5529*

*Email: [Bishnu.Lamichhane@newcastle.edu.au](mailto:Bishnu.Lamichhane@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

### **Applying finite element method for solving applied partial differential equations**

Finite element method is a powerful tool to approximate partial differential equations. This project is concerned with applying the finite element method to solve partial differential equations like heat and reaction-diffusion equations. This is an applied project and involves a lot of programming.

Contact: *Dr Bishnu Lamichhane*

Phone: (02) 4921 5529

Email: [Bishnu.Lamichhane@newcastle.edu.au](mailto:Bishnu.Lamichhane@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Nonlinear Analysis and Fixed Point Theory**

Many problems in the behavioural, communication, computational, economic, life and physical sciences and in engineering and technology translate into problems concerning fixed points of certain mappings. For instance; equilibria of discrete and continuous dynamical systems correspond to fixed points of nonlinear maps on infinite dimensional function spaces. The solution of nonlinear optimization and control problems lead to variational inequalities and thence to the search for fixed points of related nonlinear operators.

Nonexpansive maps arise when modelling conservative or dissipative situations and their fixed point theory presents a tantalizing intermediary between the classical theorems of Banach and Brouwer which has led to a fertile interplay between metric geometry and fixed point theory.

A principal goal is to further our understanding of nonexpansive and related types of mappings, with an emphasis on identifying widely applicable, easily verifiable conditions on Banach, and more generally metric, spaces that ensure the existence of fixed points for all nonexpansive self-mappings of appropriate nonempty domains such as closed bounded, convex and possibly weakly compact subsets of a Banach space. Special emphasis is given to the more difficult cases, where the underlying space lacks the nice geometric structure of, for example, a Hilbert space, or situations where there is no natural linear structure. Recently such situations have arisen in robotics and models of cognition.

Alternating projection algorithms, first considered by von Neumann in 1932, and variants of them have become standard tools for handling inverse and signal/image reconstruction problems, where one seeks a feasible point in the intersection of a family of constraint sets. When all of the constraint sets are convex subsets of a Hilbert space these iterative schemes for approximating fixed points of an appropriate map have rigorous theoretical under-pinnings. However, despite the absence of any sound theoretical justification, for more than three decades the same algorithms have been routinely and successfully employed solve real world problems involving non-convex constraints. We seek to provide theoretical foundations in such situations and in spaces other than Hilbert space. These investigations lead to a variety of potential projects.

Contact: *A/Professor Brailey Sims*

Phone: (02) 4921 5540

Email: [brailey.sims@newcastle.edu.au](mailto:brailey.sims@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Learning and Pricing: Uncensoring Lost Demand**

We consider a capacity provider who offers a new product to a new market. The provider is uncertain about two elements: the value of the product and the size of the market. The information is revealed during the sales period by the market response. A method has been developed to update the provider's prior belief based on market responses, and update the price to maximize expected revenues over a rolling horizon. However, the method assumes the provider can observe the lost demand, an assumption which is not valid in some settings. We want to extend the method to be able to uncensor the lost demand.

Contact: *Dr Masoud Talebian*

Phone: (02) 4921 5525

Email: [Masoud.Talebian@newcastle.edu.au](mailto:Masoud.Talebian@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Bottleneck assignment problem**

A graph admits a perfect matching if there exists a subset of the edges such that each vertex is incident to exactly one matching edge. In a bipartite graph where each edge has an associated weight, the minimum weight perfect matching problem, or assignment problem as it is often called, is to find a perfect matching with minimum total weight. The bottleneck assignment problem is to find a perfect matching such that the edge with maximum weight in the matching is minimized. This project will investigate improvements to an efficient polynomial time threshold algorithm for solving the bottleneck assignment problem with the view of extending this methodology to mathematical programs with minimax objective functions which commonly arise in practice. The student will be required to develop, implement and benchmark these algorithms.

Contact: Dr Hamish Waterer

Phone: (02) 4921 5951

Email: [Hamish.Waterer@newcastle.edu.au](mailto:Hamish.Waterer@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Maximum weight b-matching with fixed costs**

A graph admits a b-matching if there exists a subset, possibly a multiset, of the edges such that each vertex is incident to at most b edges. In a graph where each edge has an associated weight, the maximum weight b-matching problem is to find a b-matching with maximum total weight. This problem can be solved efficiently in polynomial time. This project considers the extension in which there is a fixed cost associated with each edge. This cost is only incurred the first time the edge is included in the b-matching. The fixed cost b-matching problem is to find a b-matching that maximises the total weight less the total fixed cost incurred. The student will be required to develop algorithms to solve this problem. This problem is a subproblem in an integer programming model for curriculum-based course timetabling. Consequently integer programming formulations of the problem will be investigated with the view to identifying strong valid inequalities for the convex hull of feasible solutions.

Contact: Dr Hamish Waterer

Phone: (02) 4921 5951

Email: [Hamish.Waterer@newcastle.edu.au](mailto:Hamish.Waterer@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Maximum weight matching subject to a linear ordering of the vertices**

A graph admits a matching if there exists a subset of the edges such that each vertex is incident to at most one matching edge. In a graph where each edge has an associated weight, the maximum weight matching problem is to find a matching with maximum total weight. This problem can be solved efficiently in polynomial time using the Blossum Algorithm. This project considers the extension in which there exists a linear ordering on the set of vertices. A matching is considered feasible if it satisfies the additional requirement that if a vertex is incident to a matching edge, then all vertices of lower order must also be incident to an edge in the matching. The student will be required to show that this problem can also be solved efficiently in polynomial time by extending the Blossum Algorithm. This problem is a subproblem in a multi-stage stochastic integer programming model for hydrogeological optimization. Consequently integer programming formulations of the problem will be investigated with the view to providing a complete description of the convex hull of feasible solutions.

Contact: Dr Hamish Waterer

Phone: (02) 4921 5951

Email: [Hamish.Waterer@newcastle.edu.au](mailto:Hamish.Waterer@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Classify simple totally disconnected groups.**

The simple connected groups have been completely classified since the middle of the 20th century but until recently there was no prospect of such a classification for totally disconnected groups. However the structure theory currently being developed is beginning to provide tools and structural invariants that might be used in a classification. Making a complete classification would be an enormous program of research but there are many sub-projects that will contribute, including some of the previous ones.

Contact: Professor George Willis

Phone: (02) 4921 5666

Email: [George.Willis@newcastle.edu.au](mailto:George.Willis@newcastle.edu.au)

Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)

### **Invariant subspaces of shift operators**

Shift operators are easily described and have some obvious invariant subspaces. In some cases, it is known that the obvious invariant subspaces are the only ones but in others it is not. This project aims to understand these other cases.

*Contact: Professor George Willis*

*Phone: (02) 4921 5666*

*Email: [George.Willis@newcastle.edu.au](mailto:George.Willis@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

### **Simple subgroups of the automorphism group of a tree**

Many examples of simple automorphism groups of trees are known. The aim is to develop our understanding of these groups to be more than a set of examples.

*Contact: Professor George Willis*

*Phone: (02) 4921 5666*

*Email: [George.Willis@newcastle.edu.au](mailto:George.Willis@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

### **Symmetry groups of graphs and complexes**

The project aims to relate properties of the automorphism group of a graph or simplicial complex to properties of the graph.

*Contact: Professor George Willis*

*Phone: (02) 4921 5666*

*Email: [George.Willis@newcastle.edu.au](mailto:George.Willis@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

### **Number theory and special functions**

Investigate arithmetic and analytic properties of special functions (including modular and hypergeometric functions) and their values, discover and prove identities for them.

*Contact: Associate Professor Wadim Zudilin*

*Phone: (02) 4921 5530*

*Email: [Wadim.Zudilin@newcastle.edu.au](mailto:Wadim.Zudilin@newcastle.edu.au)*

*Priority Research Centre for Computer Assisted Research in Mathematics and its Applications (CARMA)*

# PHYSICS

---

## **Determination of Magnetic Topology Using Ultra Low Frequency Waves Recorded in Antarctica**

Quasi-sinusoidal, mHz frequency variations of the geomagnetic field at high latitudes are associated with local field line resonances. The resonant frequency depends on magnetospheric dimensions and hence solar wind conditions. In this project magnetohydrodynamic theory will be used in combination with geomagnetic field and plasma density models to determine the expected resonance frequencies and compare these to observations from four closely spaced magnetometers near Davis station, Antarctica.

Contact: *Dr Sean Ables*  
Phone: (02) 4921 6824  
Email: [sean.ables@newcastle.edu.au](mailto:sean.ables@newcastle.edu.au)  
Centre for Space Physics

## **The Ionospheric Alfvén Resonator**

The Earth's ionosphere acts as a resonant cavity for electromagnetic plasma waves. This project will involve numerically solving the time dependent Maxwell wave equations in 2D to explore the properties of this cavity, and compare with experimental data. The model is unique in combining realistic descriptions of the conductivity and geomagnetic field.

Contact: *Dr Murray Sciffer*  
Phone: (02) 4921 5800  
Email: [Murray.Sciffer@newcastle.edu.au](mailto:Murray.Sciffer@newcastle.edu.au)  
Centre for Space Physics

## **Tracing Ionised Particle Trajectories in Space**

High energy electrons exist in near-Earth space. One of the proposed energisation mechanisms involves plasma wave to particle energy transfer. Using existing 2-D computer models, this project will advance understanding of the trajectories and energies of particles in near-Earth space.

Contact: *Dr Murray Sciffer*  
Phone: (02) 4921 5800  
Email: [Murray.Sciffer@newcastle.edu.au](mailto:Murray.Sciffer@newcastle.edu.au)  
Centre for Space Physics

## **Numerical Simulations in Space Physics**

This project will teach you how to solve differential equations that describe fully charged, magnetised fluids. Using existing 2-D models, this project will add extra code to include pressure and temperature dependent waves and the relationship with other wave modes. Simulation results will be compared with experimental satellite and ground data.

Contact: *Dr Murray Sciffer*  
Phone: (02) 4921 5800  
Email: [Murray.Sciffer@newcastle.edu.au](mailto:Murray.Sciffer@newcastle.edu.au)  
Centre for Space Physics

## **Numerical Simulations in Ionosphere Physics**

This project will teach you how to solve differential equations that describe mixtures of neutral and charged magnetised fluids. This involves a conductivity tensor. The project applies to the Earth's ionosphere and will extend our existing 1-D simulations into 2-D using a formulation that is Fourier analysed in time ( $e^{-i\omega t}$ ). The solution will involve teaching you to use tri-diagonal, sparse matrix solvers in Fortran on multi-processor computers.

Contact: *Dr Murray Sciffer, A/Prof C. Waters*  
Phone: (02) 4921 5800  
Email: [Murray.Sciffer@newcastle.edu.au](mailto:Murray.Sciffer@newcastle.edu.au)  
Centre for Space Physics

### **Radar Signatures of the Plasmapause**

An important dynamic structure in the inner magnetosphere is the plasmapause. Modeling work suggests that ULF wave energy transfer from the auroral regions to Australian latitudes critically depends on the structure and location of this boundary. Observations of ULF wave signatures using our HF radars in Tasmania and New Zealand have shown a distinct localized band of enhanced ULF power. Are these the signature of wave growth associated with a well formed plasmapause? This project will use existing methods for locating the plasmapause, (EUV instrument onboard the IMAGE spacecraft, ground magnetometer data, GPS data) to identify the radar signature of this structure. This will be excellent training in the operation and data returned from multi-pulsed HF radar instrumentation, similar to those use in defence surveillance.

*Contact: A/Prof Colin Waters  
Phone: (02) 4921 5421/2005  
Email: [Colin.Waters@newcastle.edu.au](mailto:Colin.Waters@newcastle.edu.au)  
Centre for Space Physics*

### **Remote Sensing of ULF Waves in Geospace Plasma Using SuperDARN Radars**

This project uses HF radars in Tasmania and New Zealand to study the signatures of ULF plasma waves in the high latitude ionosphere. The project focuses on advanced analysis techniques used in geophysics, including spectral and correlation algorithms, to elucidate the spatio-temporal and spectral structure of ULF waves and obtain new information on their generation and propagation mechanisms.

*Contact: A/Prof Colin Waters  
Phone: (02) 4921 5421  
Email: [Colin.Waters@newcastle.edu.au](mailto:Colin.Waters@newcastle.edu.au)  
Centre for Space Physics*

### **Remote sensing killer electron energisation electric fields in space**

Ground magnetometers detect small variations in the geomagnetic field which are caused by magnetised plasma wave energy in near-Earth space. The associated electric fields energise electrons to high energies which pose a threat to spacecraft operations. This project will develop the link between the recorded ground magnetic signals and the electric fields in space and compare these with spacecraft data.

*Contact: A/Prof Colin Waters  
Phone: (02) 4921 5421  
Email: [Colin.Waters@newcastle.edu.au](mailto:Colin.Waters@newcastle.edu.au)  
Centre for Space Physics*

### **Spatial Properties of ULF Resonance structures**

Low frequency variations in the plasma of near-Earth space are enhanced at various resonances. These are important for remote sensing various properties above 5000 km altitude. This project will use magnetic field variation data and high frequency (HF) Doppler returns data from Scandinavia to determine the differences in the remote sensed parameters using these different data sets.

*Contact: A/Prof Colin Waters  
Phone: (02) 4921 5421  
Email: [Colin.Waters@newcastle.edu.au](mailto:Colin.Waters@newcastle.edu.au)  
Centre for Space Physics*

### **Substorm signatures in over-the-horizon radars**

Large releases of energy in near-Earth space result in almost daily 'substorms' that cause auroras and damaging effects on technological systems. A characteristic magnetic field perturbation, called Pi2, is produced at substorm onset. Pi2 have mostly been studied using ground magnetometer arrays. We have developed techniques to more directly and precisely identify and image Pi2 using over-the-horizon radars such as those that form the backbone of Australia's defence surveillance. This project will use our own HF radars to image the substorm ionosphere and identify the dual (2-D) radar signature of Pi2, characterise the properties of these, and explain causative the physical mechanism. This will bring new understanding to this most important topic.

Contact: A/Prof Colin Waters  
Phone: (02) 4921 5421/2005  
Email: [Colin.Waters@newcastle.edu.au](mailto:Colin.Waters@newcastle.edu.au)  
Centre for Space Physics

### **Drivers of High Energy Radiation Arriving into the Atmosphere**

Very high energy particles precipitate from the Earth's radiation belts into the atmosphere and may cause significant damage to mobile electronics including low-Earth orbiting spacecraft. The physics driving this process is largely unknown. This project will investigate what effect ultra-low frequency plasma waves propagating through near-Earth space have on the precipitation process. The project will involve collaboration with the British Antarctic Survey, Cambridge, and the University of Otago, New Zealand, using a new world-wide network of Very Low Frequency (VLF) radio sounders to monitor the arrival of high energy particles in the atmosphere, and the TIGER and Unwin SuperDARN over-the-horizon radars operated jointly by Newcastle and LaTrobe Universities.

Contact: Professor Fred Menk  
Phone: (02) 4921 2005  
Email: [Fred.Menk@newcastle.edu.au](mailto:Fred.Menk@newcastle.edu.au)  
Centre for Space Physics

### **How Does Solar Wind Energy get to the Nightside?**

The Earth's magnetic field lines extend a considerable distance into space and influence the motion of ions and electrons. Variations in solar wind pressure cause changes in the shape and position of field lines and particle motions on the dayside. How we get a response on the nightside, and the form of that response, is an open but important question. This project will involve collaboration with the British Antarctic Survey, Cambridge, using remote sensing techniques based on VLF radio and ground magnetometer measurements, over-the-horizon radar measurements, and in situ spacecraft data, to investigate the effects of solar wind variations and magnetic substorms on field lines in the nightside.

Contact: Professor Fred Menk  
Phone: (02) 4921 2005  
Email: [Fred.Menk@newcastle.edu.au](mailto:Fred.Menk@newcastle.edu.au)  
Centre for Space Physics

### **Mapping the Radio Sky at Southern Polar Latitudes**

We have operated an imaging riometer at the Australian Antarctic station Davis for some years. This space weather instrument measures variations in radio noise reaching the ground from the sky. This project will involve collaboration with IPS Radio and Space Services, Bureau of Meteorology, to (a) determine whether individual radio stars or galaxies are detected; (b) use such discrete sources to check the calibration of the antenna beam pattern and sensitivity; and (c) investigate scintillation effects. This has not been done before and will provide new information on the performance of these instruments.

Contact: Professor Fred Menk  
Phone: (02) 4921 2005  
Email: [Fred.Menk@newcastle.edu.au](mailto:Fred.Menk@newcastle.edu.au)  
Centre for Space Physics

### **Microscale Fluctuations in GPS Signals**

Many navigation and aircraft landing systems rely upon precise radio signals transmitted from GPS spacecraft at 20,200 km altitude. These signals suffer amplitude and phase perturbations due to plasma density irregularities along the transmission path. This project will involve collaboration with IPS Radio and Space Services, Bureau of Meteorology, and use high time resolution GPS data and ground magnetometer observations from the Australian sector to investigate whether such perturbations are caused by ULF (few mHz) plasma waves propagating through space. Such waves occur for hours every day at all locations, and their presence in GPS data may have important implications for precise navigation systems.

Contact: Professor Fred Menk  
Phone: (02) 4921 2005  
Email: [Fred.Menk@newcastle.edu.au](mailto:Fred.Menk@newcastle.edu.au)  
Centre for Space Physics

### **MRI-based treatment guidance for cancer treatment**

Combinations of magnetic resonance imaging (MRI) scanners and linear-accelerators for radiation therapy treatment are currently under development. A proposal for an installation at Liverpool Hospital in Sydney is under development. The Mater Hospital is also soon to install a state-of-the-art 3T MRI scanner. These next-generation devices will enable high contrast real-time MRI images to be used to guide the treatment dose to the tumour while avoiding normal tissues. The aim of this project is to acquire multiple MRI images for a group of patients and develop and test methods to use these scans to plan and guide radiation therapy treatments.

Contact: A/Prof Peter Greer  
Phone: (02) 4921 1892  
Email: [peter.greer@newcastle.edu.au](mailto:peter.greer@newcastle.edu.au)  
Medical Physics Group / Priority Research Centre for Information Based Medicine

### **Real-time image-based dosimetry for radiation therapy**

Flat-panel Imaging devices can record dose from high energy modulated radiation beams in real-time during cancer treatment. These measurements could be combined with a dose calculation model to calculate dose to the imager in real-time. This would be compared with the expected dose in real-time. This could ensure that treatments are accurate and that errors in treatment are detected and avoided.

This project will investigate methods to measure the dose in real-time with the imaging device including investigating a new imaging system design. Methods for fast comparison of expected and measured dose will be developed potentially with GPU devices. This would be the first system to verify patient dose distribution delivery in real-time with imaging devices.

Contact: A/Prof Peter Greer  
Phone: (02) 4921 1892  
Email: [peter.greer@newcastle.edu.au](mailto:peter.greer@newcastle.edu.au)  
Medical Physics Group / Priority Research Centre for Information Based Medicine

### **A dual imaging/dosimetry system for radiation therapy**

Current flat-panel imaging devices in radiation oncology are designed for high quality imaging and have severe limitations as dosimeters to verify accurate dose delivery. We have developed a novel design for an imaging system that performs extremely well for dosimetry but less well for imaging. The aim of this project is to develop methods to adapt this design to perform as a dual-mode imager enabling both high quality imaging and high quality dosimetry. This work could facilitate the development of a new device for radiation therapy verification.

Contact: A/Prof Peter Greer  
Phone: (02) 4921 1892  
Email: [peter.greer@newcastle.edu.au](mailto:peter.greer@newcastle.edu.au)  
Medical Physics Group / Priority Research Centre for Information Based Medicine

### **Automatic prostate segmentation using MRI for improved accuracy of prostate radiation therapy**

For prostate radiation therapy a radiation oncologist manually delineates (segments) the border of the prostate on a planning magnetic resonance imaging (MRI) scan to define the target high dose region and to limit the doses to surrounding normal tissues. However for the same patient there are differences in the borders of the prostate outlined by different clinicians (inter-observer variability) which produces uncertainties in the prostate location. This project is a collaboration with CSIRO and will develop advanced methods to automatically segment the prostate on MRI scans using our expertise in advanced atlas-based image segmentation. This project has the potential reduce the uncertainties and margins in prostate treatment leading to lower normal tissue doses and improved quality of life following treatment.

Contact: A/Prof Peter Greer  
Phone: (02) 4921 1892  
Email: [peter.greer@newcastle.edu.au](mailto:peter.greer@newcastle.edu.au)  
Medical Physics Group / Priority Research Centre for Information Based Medicine

### **Does the initial treatment plan predict doses delivered to normal tissues during prostate radiation therapy?**

Increasing the dose to the prostate (dose escalation) in radiation therapy has been shown to increase local control for medium and high risk patients with five year survival rates now very high. However increasing the dose increases the risk of long-term bladder, rectal and other toxicity which can reduce the quality of life for these patients. At present we use a computed tomography (CT) scan acquired prior to the treatment course to predict these doses. However changes in bladder and rectum size and shape and beam positioning changes occur during the nearly forty daily treatment deliveries. This could change the doses received by these organs and our initial prediction of the dose may not be a good estimate. In this project we will determine actual delivered doses to these organs using daily on-treatment CT scans to capture the anatomical shape and size at each treatment, combined with calculation of delivered dose on each on-treatment scan. We will then determine whether the initial treatment plan is predictive of delivered doses to the rectum and bladder. This will allow us to determine the uncertainties in these current treatment plan predicted doses. The results will lead to development of better methods to determine actual delivered doses to improve patient treatments.

Contact: A/Prof Peter Greer  
Phone: (02) 4921 1892  
Email: [peter.greer@newcastle.edu.au](mailto:peter.greer@newcastle.edu.au)  
Medical Physics Group / Priority Research Centre for Information Based Medicine

### **Three-dimensional real-time patient dosimetry for radiation therapy**

Flat-panel Imaging devices can record dose from high energy modulated radiation beams in real-time during cancer treatment. These measurements could be combined with a dose calculation model to calculate dose to the patient in real-time. This would be compared with the expected dose in real-time. This could ensure that treatments are accurate and that errors in treatment are detected and avoided. The calculation of dose within a patient in real-time from transit dose images requires very fast calculations. The aim of this project would be to develop graphical processor units (GPU) based physics models for real-time patient dose verification in radiation therapy treatment.

Contact: A/Prof Peter Greer  
Phone: (02) 4921 1892  
Email: [peter.greer@newcastle.edu.au](mailto:peter.greer@newcastle.edu.au)  
Medical Physics Group / Priority Research Centre for Information Based Medicine

### **Biosensors from Plastic Electronics**

Current state-of-the-art biosensor fabrication involves assembling complex molecular structures on hard conventional semiconductor materials such as silicon. Our aim is to demonstrate that low cost biosensors can be fabricated by simply incorporating bioactive materials into organic field effect transistors. Using soft electronic polymers as the matrix for the bioactive material eliminates the need for complex molecular surface assembly. Previous work at the University of Newcastle has clearly demonstrated that prototype sensors can be built using OFETs. This project will involve building and characterising OFETs and is focussed on understanding the device physics of these electronic components. The long term goal of this project is the development of flexible and inexpensive biosensors for a variety of applications.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Developing a Helium Beam Microscope**

Scanning helium microscopy offers the tantalizing possibility of using the wave-particle nature of helium atoms to image the structure of delicate surfaces with unprecedented resolution. This project will involve developing the new ARC-funded helium beam microscope at Newcastle and producing preliminary images. This project will involve collaboration with the Cavendish Laboratory at the University of Cambridge.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Extending the Spectral Response of Organic Solar Cells**

State-of-the-art organic solar cells are limited by the wavelength response of the active semi-conducting polymer layer since these materials typically only photogenerate charges below 500 – 550 nm. In the natural world, plants use a range of porphyrin-based molecules (such as chlorophyll) to allow photosynthesis to occur across the solar spectrum. This project aims to develop photovoltaic devices containing artificial porphyrin light harvesting molecules. The goal of this project is to develop, for the first time, plastic solar cells that generate electricity from the entire solar spectrum.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Field Ionisation He Detection using Carbon Nanotubes**

Scanning helium microscopy is an emerging imaging technology that uses low energy (<50 meV) helium atom beams as a completely non-perturbing probe of nanoscale structure. However, this exciting new technology is currently limited by the lack of an effective 2D imaging system for neutral He atoms. Carbon nanotubes (CNTs) offer the possibility of acting as effective field ionisation tips for He atoms thus allowing them to be detected. This project will aim to grow CNT arrays using a new state-of-the-art chemical vapour deposition (CVD) system in the Centre for Organic Electronics.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Large Area Printing of Organic Solar Cells**

The development of new sources of renewable energy is urgently required if the worst effects of man-made climate change are to be avoided. This project will build on the recent exciting advances made by the Centre for Organic Electronics (COE) in device fabrication to develop new methods for printing large photovoltaic arrays based on semi-conducting polymers. This project will make use of the new state-of-the-art ink jet printer that has been recently purchased by the COE for developing organic electronic circuits.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Novel Electrodes for Organic Solar Cells**

The capability of organic solar cells to provide large scale global sustainable energy solutions will be limited by the current high costs and supply issues associated with the current electrode materials. This project will explore novel inverse architectures and transparent conducting materials to address the issue of developing low cost electrode structures for these exciting new devices.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Novel Encapsulants for Organic Solar Cells**

State-of-the-art organic solar cells are limited by the durability and lifetime of the active layer materials in these blended devices. This project will study the role of new encapsulant materials and structures to extend the lifetime of these devices.

Contact: Prof Paul Dastoor

Phone: (02) 4921 5426

Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)

Priority Research Centre for Organic Electronics

### **Phase Contrast Mechanisms in Scanning Helium Microscopy**

The aim of this multinational collaborative research project is to develop the world's first imaging detector for neutral helium atoms for use in a new surface-imaging instrument – the scanning helium microscope. Scanning helium microscopy is an emerging imaging technology that uses low energy (<50 meV) helium atom beams as a completely non-perturbing probe of nanoscale structure. Currently, there is little understanding of the mechanisms that would provide contrast in this microscopy. The ultimate goal of this project is to understand the phase contrast mechanisms that would operate in scanning helium microscopy and is motivated by recent research by Dr Dastoor and colleagues at the University of Cambridge. This project will involve modelling work with the goal of understanding the phase contrast processes.

Contact: Prof Paul Dastoor

Phone: (02) 4921 5426

Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)

Priority Research Centre for Organic Electronics

### **Photocurrent Mapping of Organic Solar Cells**

State-of-the-art organic solar cells are limited the complex morphology and structure of these blended devices. This project will use a Near-Field Photocurrent Microscopy (NSPM) to simultaneously map the photocurrent and the morphology of organic solar cells. NSPM is a new technique that has been recently developed at the University of Newcastle and is the first technique that is capable of directly measuring the photocurrent from organic solar devices. This project will apply NSPM to the study of P3HT/PCBM blend structures, which are the most efficient blend materials currently available.

Contact: Prof Paul Dastoor

Phone: (02) 4921 5426

Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)

Priority Research Centre for Organic Electronics

### **Printing of Electronic Arrays using State-of-the-art Ink Jet Printing**

The Centre for Organic Electronics has recently purchased a new state-of-the-art ink jet printer for developing organic electronic circuits. This project will involve developing organic thin film transistor arrays for a variety of sensor applications. The project will involve developing an understanding of the device physics of these transistor arrays.

Contact: Prof Paul Dastoor

Phone: (02) 4921 5426

Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)

Priority Research Centre for Organic Electronics

### **Structure and Morphology of Conducting Polymer Blends**

Conducting polymer blends underpin all of the activities of the Centre for Organic Electronics, especially in the areas of organic solar cells and biosensors based on organic transistors. This project will study the role of structure and morphology in these blend materials as characterised by advanced synchrotron based techniques. The successful Honours student will be required to travel to use the new synchrotron facilities in Melbourne and may be required also to undertake experiments at the Advanced Light Source, Berkeley, USA.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **Ultra-fast Laser Spectroscopy of Organic Electronic Materials**

The charge generation and charge conduction mechanisms involved in organic electronic devices occur on extremely short timescales and as such are not well understood. This project will aim to use a state-of-the-art femtosecond laser spectroscopy system to probe these mechanisms using pump-probe spectroscopy.

Contact: Prof Paul Dastoor  
Phone: (02) 4921 5426  
Email: [phpd@alinga.newcastle.edu.au](mailto:phpd@alinga.newcastle.edu.au)  
Priority Research Centre for Organic Electronics

### **A new approach for imaging in the transmission electron microscope.**

Imaging is almost always based upon the measurement of intensities. We have recently been using new methods to measure the phase of electron beams instead. Initial results suggest that very interesting effects can be observed when we consider the phase changes of inelastic scattering. The aim of this project is to explore and develop this new technique, both from a theoretical and experimental standpoint.

Contact: Dr Vicki Keast  
Phone: (02) 4921 6653  
Email: [vicki.keast@newcastle.edu.au](mailto:vicki.keast@newcastle.edu.au)  
Surface and Nanoscience Group

### **Predicting optical properties of materials.**

Predicting and understanding the optical properties of materials from first principles can be considered as one of the "last frontiers" in solid state physics. The challenge lies in the fact that the optical properties are related to the excited electron states within the material. This project will use and develop a range of techniques for the quantum mechanical calculations of optical properties. In particular, the extension to nanostructured materials will be particularly challenging.

Contact: Dr Vicki Keast  
Phone: (02) 4921 6653  
Email: [vicki.keast@newcastle.edu.au](mailto:vicki.keast@newcastle.edu.au)  
Surface and Nanoscience Group

### **Surface plasmons: beyond gold and silver.**

Surface plasmons are collective excitations of valence electrons that propagate along a surface. They are currently of enormous technological interest for applications such as single molecule detection, sub-wavelength optics and even tumour therapy. However, to date, all materials have been based on either gold or silver. This project will explore the possibility of improving and designing the plasmon response using new metal alloys.

Contact: Dr Vicki Keast  
Phone: (02) 4921 6653  
Email: [vicki.keast@newcastle.edu.au](mailto:vicki.keast@newcastle.edu.au)  
Surface and Nanoscience Group

### **Secondary Ion Mass Spectrometry of Implant Diffusion in Silicon**

In the NASA Genesis mission, a spacecraft orbited the sun for 3 years collecting atoms given off by the sun, the so-called solar wind, into silicon wafers. The spacecraft returned to Earth and the wafers are now being analysed. During the collection phase, the samples were at a temperature of 200 degrees C so solar wind atoms implanted into the silicon diffused. In this project the diffusion of solar wind elements in silicon wafers

will be measured by secondary ion mass spectrometry to understand the atomic motion in the original Genesis samples.

Contact: Prof Bruce King  
Phone: (02) 4921 5548  
Email: [Bruce.King@newcastle.edu.au](mailto:Bruce.King@newcastle.edu.au)  
Surface and Nanoscience Group

### **Radiation Damage in MAX Phase materials**

MAX phase materials have the capacity to operate in extreme environments and may be candidates for high temperature and high radiation environments. One particular environment is as a construction material in a fusion reactor where it would experience significant radiation damage. This project would involve the investigation of ability of MAX phase materials to withstand exceptionally high levels of radiation damage while retaining key physical properties. The experiments will involved accelerated radiation damage with ion implantation, RBS, SIMS and XRD.

Contact: Prof John O'Connor  
Phone: (02) 4921 5439  
Email: [john.oconnor@newcastle.edu.au](mailto:john.oconnor@newcastle.edu.au)  
Surface and Nanoscience Group

### **Control Systems for Low Dose Surface Analysis using Low Energy Ion Scattering**

New equipment has been purchased which will allow the automated control of a low energy accelerator and data acquisition system. The goal in this project is to bring the key elements together in a Labview application which has considerable flexibility to maintain a broad range of experiments while also minimising radiation damage to the surface under analysis.

Contact: Prof John O'Connor  
Phone: (02) 4921 5439  
Email: [john.oconnor@newcastle.edu.au](mailto:john.oconnor@newcastle.edu.au)  
Surface and Nanoscience Group

### **Computational Single Molecule Molecular Electronics**

One of the major theoretical endeavours of the Surface and Nanoscience Group is to contribute to the development of the new field of molecular electronics by modelling processes which will allow control of the positioning and functionality of individual atoms on silicon and germanium surfaces. This project builds on past successes in describing the interaction of acetone [(CH<sub>3</sub>)<sub>2</sub>CO], water, and phosphine (PH<sub>3</sub>) molecules with the Si(001) surface and will employ a theoretical modelling based on ab initio techniques.

Contact: A/Prof Marian Radny  
Phone: (02) 4921 5447  
Email: [Marian.Radny@newcastle.edu.au](mailto:Marian.Radny@newcastle.edu.au)  
Priority Research Centre for Energy / Surface and Nanoscience Group

### **Experimental Single Molecule Molecular Electronics**

One of the major experimental endeavours of the Surface and Nanoscience Group is to contribute to the development of the new field of molecular electronics. By using a scanning tunnelling microscopy (STM), this project involves a fundamental understanding on the interactions between organic molecules and silicon surfaces at an atomic level. The formed structures will be used to make organic silicon hybrid devices for single molecule molecular electronics.

Contact: A/Prof Marian Radny  
Phone: (02) 4921 5447  
Email: [Marian.Radny@newcastle.edu.au](mailto:Marian.Radny@newcastle.edu.au)  
Priority Research Centre for Energy / Surface and Nanoscience Group

### **Reaction energetics of dioxins with copper surfaces**

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/F's) are among the most harmful pollutants to health and the environment. Despite the enormous amount of research on PCDD/F's in the last two decades, driven largely by their high toxicity, their formation mechanisms are not yet understood in sufficient detail. This project will explore the role copper and copper oxides in the catalytic formation of PCDD/F's using first principles density functional theory calculations will be performed.

*Contact: A/Prof Marian Radny*

*Phone: (02) 4921 5447*

*Email: [Marian.Radny@newcastle.edu.au](mailto:Marian.Radny@newcastle.edu.au)*

*Priority Research Centre for Energy*

### **Ultra-fast Laser Continuum Generation**

Supercontinuum generation in optical materials is widely used in ultra-fast spectroscopy. This project will use a state-of-the-art femtosecond laser spectroscopy system to generate and analyse continua in microstructured optical fibre.

*Contact: Dr John Holdsworth*

*Phone: (02) 4921 5436*

*Email: [John.Holdsworth@newcastle.edu.au](mailto:John.Holdsworth@newcastle.edu.au)*

*Priority Research Centre for Organic Electronics*

### **Laser Processing**

This project will use a state-of-the-art femtosecond laser, continuous diode laser and nanosecond pulsed lasers to investigate annealing and welding of materials in organic solar cell development.

*Contact: Dr John Holdsworth*

*Phone: (02) 4921 5436*

*Email: [John.Holdsworth@newcastle.edu.au](mailto:John.Holdsworth@newcastle.edu.au)*

*Priority Research Centre for Organic Electronics*

### **Two-Photon Microscopy**

Two-Photon Microscopy allows deep imaging of live tissues. The optical arrangement and optimisation of a two-photon microscope incorporating a novel scan engine will be the topic of this work.

*Contact: Dr John Holdsworth*

*Phone: (02) 4921 5436*

*Email: [John.Holdsworth@newcastle.edu.au](mailto:John.Holdsworth@newcastle.edu.au)*

*Priority Research Centre for Organic Electronics*

# STATISTICS

---

## **Correspondence analysis - its theory and application**

Correspondence analysis is a graphical statistical technique that provides a visual perspective to understanding the nature of the association within a contingency table. It provides a graphical understanding of conclusions obtained from the traditional chi-squared test of independence and correlation. This project will explore the statistical development of correspondence analysis and consider the various ways in which the association between categorical variables may be visualised.

*Contact: A/Prof Eric Beh  
Phone: (02) 4921 6503  
Email: [Eric.Beh@newcastle.edu.au](mailto:Eric.Beh@newcastle.edu.au)  
Statistics Research Group*

## **Understanding the Duckworth-Lewis method for one-day international cricket**

The Duckworth-Lewis method is designed to provide a means of resetting a target for a one-day international (and domestic) cricket match in the event of a rain (or other) interruption. This project will investigate the statistical processes underlying this method (including aspects of the model used) and will make use of international cricket data provided by Tony Lewis (one of the founders) covering 331 international cricket matches.

*Contact: A/Prof Eric Beh  
Phone: (02) 4921 6503  
Email: [Eric.Beh@newcastle.edu.au](mailto:Eric.Beh@newcastle.edu.au)  
Statistics Research Group*

## **Bayesian Hierarchical Modelling**

Bayesian techniques have increasingly been used in the analysis and reporting of performance measures in health care, education and industry. This project will explore the effects of various Bayesian models on parameter estimation and/or methods for monitoring processes, with a focus on the model's use in organisational quality improvement. The methods may be applied to health care, education or industry.

*Contact: Dr Peter Howley  
Phone: (02) 4921 5518  
Email: [Peter.Howley@newcastle.edu.au](mailto:Peter.Howley@newcastle.edu.au)  
Statistics Research Group*

## **Estimation methods for flexibly shaped statistical distributions**

Investigating the process of estimation of the parameters of statistical distributions that can take on a wide variety of shapes contributes to our understanding of distributional shape. Such distributions are of particular interest to psychologists and physical environmental scientists. This project could either focus on analytical approaches, or be based on simulation studies of different methods.

*Contact: Dr Robert King  
Phone: (02) 4921 5548  
Email: [Robert.King@newcastle.edu.au](mailto:Robert.King@newcastle.edu.au)  
Statistics Research Group*

## **Functional data analysis for spectra**

Functional data analysis works on entire functions of the real line. This project will work on time-varying spectral data from physics and/or chemistry.

*Contact: Dr Robert King  
Phone: (02) 4921 5548  
Email: [Robert.King@newcastle.edu.au](mailto:Robert.King@newcastle.edu.au)  
Statistics Research Group*

### **Image analysis for robot location**

This project involves work with the University of Newcastle's robot soccer team, the NUBots. The robots find where they are on the field (localise) using information from the picture taken by the camera in their head. This project will work on improving the image analysis module.

Contact: Dr Robert King  
Phone: (02) 4921 5548  
Email: [Robert.King@newcastle.edu.au](mailto:Robert.King@newcastle.edu.au)  
Statistics Research Group

### **Statistical Design for strategy assessment in robot soccer**

This project involves work with the University of Newcastle's robot soccer team, the NUBots. The robot software is overseen by a "behaviour" module that decides what the robot should do. This project will design a series of tests for candidate strategies.

Contact: Dr Robert King  
Phone: (02) 4921 5548  
Email: [Robert.King@newcastle.edu.au](mailto:Robert.King@newcastle.edu.au)  
Statistics Research Group

### **Socio-spatial statistics: Boundary effects**

The spatial pattern of disadvantage shows different features at different geographic levels. This project will consider the role of geographic level, particularly the effects of different types of boundaries, and investigate social statistics of areas in the Hunter region. This project would ideally suit a student with a background in both statistics and geography.

Contact: Dr Robert King  
Phone: (02) 4921 5548  
Email: [Robert.King@newcastle.edu.au](mailto:Robert.King@newcastle.edu.au)  
Statistics Research Group

### **Adaptive estimation in Threshold AR models**

The Threshold Autoregressive (TAR) model is one class of nonlinear times series models that has been applied in many areas, from Finance to Ecology. The aim of the project is to explore the adaptive estimation of TAR models by weakening the assumption on the distribution of the errors. For example, if the error follows a t-distribution, then under some conditions, we should be able to obtain the efficient estimates as when it was normally distributed. This project will include understanding the established theory in the literature, a bit of programming and their applications.

Contact: Dr Darfiana Nur  
Phone: (02) 4921 5547  
Email: [Darfiana.Nur@newcastle.edu.au](mailto:Darfiana.Nur@newcastle.edu.au)  
Statistics Research Group

### **Markov models in DNA sequences modelling**

Many genome sequences display heterogeneity in base composition in the form of segments with similar structure. Early evidence of segmental genomic structure was noticed early on that in the salivary glands of *Drosophila melanogaster* whereas the problem of statistically segmenting DNA sequence has a history about four decades. One approach describes DNA sequence structure by a hidden Markov model (HMM). This project focuses on the various change-point identification of a Bayesian hidden Markov model describing homogeneous segments of DNA sequences.

Contact: Dr Darfiana Nur  
Phone: (02) 4921 5547  
Email: [Darfiana.Nur@newcastle.edu.au](mailto:Darfiana.Nur@newcastle.edu.au)  
Statistics Research Group

### **Psychosocial effects of Cancer**

The death rate from colorectal cancer has declined in recent years due to improved screening methods and advances in treatment. Hence a growing population of people are living with a history of colon cancer. This project will assess the psychosocial outcomes of longer term survivors using structural equation modelling, a multivariate technique. Bayesian approaches will be implemented to account for some of the data characteristics (non-normality for example) within this modelling framework.

*Contact: Dr Elizabeth Stojanovski*

*Phone: (02) 4921 5346*

*Email: [Elizabeth.Stojanovski@newcastle.edu.au](mailto:Elizabeth.Stojanovski@newcastle.edu.au)*

*Statistics Research Group*

### **Bayesian inference - noninformative priors**

An advantage of the Bayesian approach is the possible inclusion of prior information/knowledge. However, it is desirable, for the purpose of scientific communication and sensitivity analysis, always to base inference on "noninformative" priors also. The currently recommended methodology to obtain such priors is reference analysis, but our research indicates that this methodology is incomplete. When dealing with extreme data, reference priors can be shown to be too informative for the binomial and Poisson parameters, for example. Possible research topics include the identification of alternative criteria when reference analysis fails in this manner, and the study of appropriate noninformative priors in related applications such as logistic and Poisson regression.

*Contact: Dr Frank Tuijl*

*Phone: (02) 4921 8854*

*Email: [Frank.Tuijl@newcastle.edu.au](mailto:Frank.Tuijl@newcastle.edu.au)*

*Statistics Research Group*

### PSYCHOLOGY

---

#### **Exploring obesity and negative stereotyping: potential implications for childrens' socialisation**

Contact: A/Prof Jenny Bowman

Phone: (02) 4921 5958

Email: [Jenny.Bowman@newcastle.edu.au](mailto:Jenny.Bowman@newcastle.edu.au)

Clinical and Health Psychology Group

#### **Addressing smoking for people with mental illness**

Contact: A/Prof Jenny Bowman

Phone: (02) 4921 5958

Email: [Jenny.Bowman@newcastle.edu.au](mailto:Jenny.Bowman@newcastle.edu.au)

Clinical and Health Psychology Group

#### **Harm perception of cannabis versus other drug use among people with psychotic disorders**

Contact: Rev Dr Martin Johnson

Phone: (02) 4921 8864

Email: [Martin.Johnson@newcastle.edu.au](mailto:Martin.Johnson@newcastle.edu.au)

Clinical and Health Psychology Group

#### **Role of Fear Appeals in changing health behaviour**

Contact: Rev Dr Martin Johnson

Phone: (02) 4921 8864

Email: [Martin.Johnson@newcastle.edu.au](mailto:Martin.Johnson@newcastle.edu.au)

Clinical and Health Psychology Group

#### **'What doesn't kill me will only make me stronger' is this stress-related growth?**

Contact: Rev Dr Martin Johnson

Phone: (02) 4921 8864

Email: [Martin.Johnson@newcastle.edu.au](mailto:Martin.Johnson@newcastle.edu.au)

Clinical and Health Psychology Group

#### **A Modern Take on a Textbook Classic: Hick's Law**

When people have to make decisions, they take longer if there are more alternatives to choose between. The slow-down is logarithmic with the number of choices, and this has been known as "Hick's Law" for more than 50 years. Despite being written about in every introductory textbook, there are no good theories for why Hick's Law arises. We will run some experiments and develop mathematical theories for the law.

Contact: Dr Scott Brown

Phone: (02) 4921 5760

Email: [Scott.Brown@newcastle.edu.au](mailto:Scott.Brown@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group

#### **Fast, or Careful?**

When making decisions, we are constantly faced with the need to trade speed for accuracy: we can make lots of decisions quickly, but with lots of errors; or we can make a few decisions slowly, but accurately. There are comprehensive mathematical theories for how this tradeoff occurs, and these theories have been well accepted by the scientific community for decades. However, some of the basic assumptions of those theories have never been tested – we will conduct experiments to find out which assumptions hold up to closer scrutiny.

Contact: Dr Scott Brown  
Phone: (02) 4921 5760  
Email: [Scott.Brown@newcastle.edu.au](mailto:Scott.Brown@newcastle.edu.au)  
Human Experimental and Applied Dynamics (HEAD) Group

### **Human faces as evolved signalers**

Human faces convey information about age, sex, health, fertility, etc. and movements of the face operate as complex social signals. Any project investigating people's sensitivity to these signals. I am particularly interested in non-verbal dynamic signalling in a variety of social contexts and in the evolution of attractiveness cues.

Contact: Dr Darren Burke  
Phone: (02) 4348 4158  
Email: [Darren.burke@newcastle.edu.au](mailto:Darren.burke@newcastle.edu.au)  
Human Experimental and Applied Dynamics (HEAD) Group

### **Sex differences in spatial cognition**

To what extent can we understand human sex differences in spatial memory and navigational ability in terms of the different evolutionary selection pressures faced by males and females in our ancestral past?

Contact: Dr Darren Burke  
Phone: (02) 4348 4158  
Email: [Darren.burke@newcastle.edu.au](mailto:Darren.burke@newcastle.edu.au)  
Human Experimental and Applied Dynamics (HEAD) Group

### **Evolution of cognition: Spatial**

How has the ability of nectar feeding birds to remember locations in their environment been shaped by the spatial and temporal distribution of their food?

Contact: Dr Darren Burke  
Phone: (02) 4348 4158  
Email: [Darren.burke@newcastle.edu.au](mailto:Darren.burke@newcastle.edu.au)  
Human Experimental and Applied Dynamics (HEAD) Group

### **Avian visual cognition**

Birds inhabit very different visual ecologies to land-based mammals and have fundamentally different brains. How has this impacted on the way in which they process movement and depth information and recognise objects?

Contact: Dr Darren Burke  
Phone: (02) 4348 4158  
Email: [Darren.burke@newcastle.edu.au](mailto:Darren.burke@newcastle.edu.au)  
Human Experimental and Applied Dynamics (HEAD) Group

**Factors affecting performance on a visual source monitoring task** Source monitoring refers to the processes involved in determining the origin of a particular memory. The aim of this project is to investigate the effects of instruction and cue type on source monitoring ability.

Contact: Dr Kerry Chalmers  
Phone: (02) 4921 5757  
Email: [Kerry.Chalmers@newcastle.edu.au](mailto:Kerry.Chalmers@newcastle.edu.au)  
Human Experimental and Applied Dynamics (HEAD) Group

**Familiarity effects on memory as a function of test type**

The effect of the familiarity of to-be-remembered items (e.g., nonwords, words) on memory performance will be investigated using multiple memory paradigms (e.g., recall, recognition).

Contact: Dr Kerry Chalmers

Phone: (02) 4921 5757

Email: [Kerry.Chalmers@newcastle.edu.au](mailto:Kerry.Chalmers@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group

**Working memory, processing speed, and intelligence**

This project will investigate the effect of training on working memory and processing speed tasks and examine how this relates to measures of intelligence.

Contact: Dr Kerry Chalmers

Phone: (02) 4921 5757

Email: [Kerry.Chalmers@newcastle.edu.au](mailto:Kerry.Chalmers@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group

**Cognitive Psychology: Are human faces special?**

People are extremely efficient in recognizing other peoples' faces. We can recognize a familiar face from distance, in dim light, and even if the face is partially occluded. Contemporary theories of face processing argue that faces are special because different facial features (eyes, nose, mouth) are combined together to create a 'holistic' experience. We shall test this assertion using the well-known Garner paradigm.

Contact: Dr Ami Eidels

Phone: (02) 4921 7089

Email: [Ami.Eidels@newcastle.edu.au](mailto:Ami.Eidels@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group

**Cognitive Psychology: 'Hot Hand' in computer games.**

The 'Hot Hand' phenomenon in basketball (Kahneman & Tversky), or other sports, refers to one's ability to make a successful shot after a sequence of successful shots, compared to her or his chances of making the next shot after unsuccessful shot(s). Presumably, high confidence after a successful trial improves performance on subsequent trial(s). We shall test if the 'Hot Hand' phenomenon exists in computer games, and focus on whether or not gamers are willing to take higher risks after successful trials.

Contact: Dr Ami Eidels

Phone: (02) 4921 7089

Email: [Ami.Eidels@newcastle.edu.au](mailto:Ami.Eidels@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group

**Cognitive Psychology: Challenging the automaticity account of the Stroop phenomenon.**

In a Stroop task, participants are presented with colour names printed in colour and are asked to indicate the print colour, while ignoring the word. People are often slower in naming the colour of incongruent displays (such as the word GREEN printed in red) compared to naming the colour of congruent displays (RED printed in red). Presumably, this slowdown in performance (termed the Stroop effect) is due to the automatic nature of reading: when presented with words, people cannot ignore the words, which in turn slow them down on incongruent trials. We shall challenge this account and test whether is mandatory.

Contact: Dr Ami Eidels

Phone: (02) 4921 7089

Email: [Ami.Eidels@newcastle.edu.au](mailto:Ami.Eidels@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group

### **Being afraid of the other: Investigating aversive learning mechanisms and the role of prior contact in the development of inter-ethnic anxiety**

The aftermath of September 11 demonstrates that intergroup anxiety, the anxiety experienced during anticipated or actual interactions with individuals of other ethnicity, is a powerful predictor of intergroup prejudice and discriminatory behaviour in society. Contemporary intergroup research confirms this. This research project uses a controlled experimental paradigm to investigate how repeated aversive experiences with members of another ethnicity leads to the development of this form of anxiety and how individuals' (positive/negative) prior experience with members of these groups (or 'prior contact') might affect the anxiety learning mechanisms. The student will have the opportunity to work with Dr Paolini, a researcher in social cognition, and Dr Griffin, a researcher in learning and cognition (Dr Griffin), both internationally recognized experts in their fields and learn to use state-of-the art technology to measure psychophysiological responses of anxiety. This exciting new line of research has the potential to inform the design of individual-level treatments of anxiety, as well as group-level intervention programs aiming to reduce racial tension in society.

Contact: Dr Stefania Paolini

Phone: (02) 4921 5938

Email: [stefania.paolini@newcastle.edu.au](mailto:stefania.paolini@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group / Priority Research Centre for Brain and Mental Health Research

### **Investigating why intergroup interactions can be detrimental to the relations between rival social groups**

Fifty years ago, an influential social psychologist proposed that face-to-face interactions, or 'contact', between individuals of potentially rival groups may reduce prejudice, discrimination, and conflict and lead to more harmonious intergroup relations (Allport, 1954). Since then, this idea has inspired desegregation policies in Australia and around the world. Recent reviews of the intergroup contact literature have confirmed that intergroup contact typically improves intergroup relations. This optimistic view of the future, however, is at odds with a sharp increase in intergroup conflict that our multicultural society is experiencing. In the proposed research, we aim to clarify why intergroup conflict continues to be a key social issue in Australia and abroad despite increased contact between social groups. In particular, we use a variety of social psychological research methods (experiments, field-studies, surveys) and look into a variety of intergroup settings (inter-ethnic, inter-generational, cross-gender, etc. relations) to address the following critical questions:

- Does negative contact with outgroup members make people more aware of their respective group memberships than positive contact and does it have a greater long-lasting impact on group attitudes?
- Why and when might negative intergroup contact have a disproportionate impact on intergroup relations?

Contact: Dr Stefania Paolini

Phone: (02) 4921 5938

Email: [stefania.paolini@newcastle.edu.au](mailto:stefania.paolini@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group / Priority Research Centre for Brain and Mental Health Research

### **Investigating why intergroup interactions can be detrimental to the relations between rival social groups** *Area: Social stereotyping, prejudice, and discrimination*

Fifty years ago, Gordon Allport, an influential social psychologist, proposed that face-to-face interactions, or 'contact', between individuals of potentially rival groups may reduce prejudice, discrimination, and conflict and lead to more harmonious intergroup relations. Since then, this idea has inspired desegregation policies in Australia and around the world. Recent reviews of the intergroup contact literature have confirmed that positive contact with individuals of the 'other' group or 'outgroup' improves intergroup relations. This optimistic view of the future, however, is at odds with a sharp increase in intergroup conflict that our multicultural society is experiencing. In the proposed research, we aim to clarify why intergroup conflict continues to be a key social issue in Australia and abroad despite increased contact between social groups. In particular, we use a variety of social psychological research methods to address the following critical questions:

- Does negative (i.e., unpleasant) contact with outgroup members make people more aware of their respective group memberships than positive (i.e., pleasant) contact and does it have a greater impact on group attitudes?

- Why might negative intergroup contact have a disproportionate impact on intergroup relations?
- Are there conditions under which negative contact does *not* make people more aware of their group memberships and does *not* have a greater impact on group attitudes?

Contact: Dr Stefania Paolini

Phone: (02) 4921 5938

Email: [stefania.paolini@newcastle.edu.au](mailto:stefania.paolini@newcastle.edu.au)

Priority Research Centre for Brain and Mental Health Research

### **Predicting people's willingness to engage in intergroup contact and intergroup friendship**

Growing evidence indicates that intergroup friendship, the friendship between individuals of opposing groups (e.g., Anglo-ethnic individuals, straight and gay individuals, young-old people), is probably the most effective form of intergroup exchange able to diminish prejudiced attitudes towards entire discriminated groups. Willingness to engage in contact with people of different backgrounds naturally precede the formation of intergroup friendships, yet research investigating the determinants of people's seeking/avoidance of meaningful intergroup exchange is surprisingly scant. In the proposed research, we use a combination of natural observation, survey, and experimentation to investigate individual difference variables and contextual factors that affect this willingness to engage in intergroup relations. For example, ongoing work investigates two motivational-affective drives: *intergroup anxiety* (the anxiety experienced when engaging or anticipating and intergroup interaction; associated with avoidance; Stephan & Stephan, 1985) and *self-expansion* (the desire to expand the resources, perspectives, and identities of the self through the formation of close relationships with different others; associated with engagement, Wright, Aron & Tropp, 2002). The relative predictive powers of these and other critical factors, in their *trait* (i.e., individual differences) and *state* (i.e., contextual manifestations) forms, as well as their interactive effects, are investigated.

Contact: Dr Stefania Paolini

Phone: (02) 4921 5938

Email: [stefania.paolini@newcastle.edu.au](mailto:stefania.paolini@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Group / Priority Research Centre for Brain and Mental Health Research

### **Gender Differences in Spatial Cognition**

Investigates whether gender bias exists in test performance on spatial ability tasks. Research provides evidence that differences do exist. This study examines whether differences are still prevalent today. It investigates if changes in study, work and leisure activities which are currently more uniform across genders will show test performance to be similar. This study compares the performance of two groups (male and female) using a recently developed computer-based psychometric test of spatial ability.

Contact: Mr Ken Sutton

Phone: (02) 4921 6361

Email: [Ken.Sutton@newcastle.edu.au](mailto:Ken.Sutton@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Research Group

### **Improving 3D Understanding**

Investigates performance on a computer-based psychometric test of spatial ability after exposure to a set of interactive learning tasks designed to improve 3D understanding. Examines active exploration (learning by doing) as opposed to the conventional approach of passive learning. Compares test performance of a control group with an experimental group consisting of participants with no prior learning experience. Learning tasks will be selected from a set currently under development. Both male and female subgroups may be investigated.

Contact: Mr Ken Sutton

Phone: (02) 4921 6361

Email: [Ken.Sutton@newcastle.edu.au](mailto:Ken.Sutton@newcastle.edu.au)

Human Experimental and Applied Dynamics (HEAD) Research Group

### **Auditory Temporal Processing**

Natural sounds are transient in nature, containing rapid temporal variations in frequency, amplitude of the sound envelope. These transients carry important information necessary for accurate perception of speech, music and other environmental sounds. This research program seeks to better understand the neural basis of perception of the temporal characteristics of sound through examining the relationship between brain electrical responses (EEG/ERP methods) and perceptual sensitivity (psychoacoustic/psychophysical methods) to temporal variations in sound.

*Contact: Dr Bill Budd  
Phone: (02) 4348 4135  
Email: [Bill.Budd@newcastle.edu.au](mailto:Bill.Budd@newcastle.edu.au)  
Neuroscience Group*

### **Brain mechanisms in binaural hearing**

One of the most remarkable features of auditory perception is our ability to very small detect differences in the timing of sound arriving at each ear. This sensitivity to timing of sounds is an order of magnitude more precise than any other sensory modality and underlies our ability to localise sounds in space as well as to accurately perceive sounds in noisy environments. This research seeks to better understand the role of the auditory brain in the representation and analysis of binaural information using measures of brain electrical activity (EEG/ERP) and psychoacoustic methods.

*Contact: Dr Bill Budd  
Phone: (02) 4348 4135  
Email: [Bill.Budd@newcastle.edu.au](mailto:Bill.Budd@newcastle.edu.au)  
Neuroscience Group*

### **Neuroplasticity in somatosensory cortex.**

Previous EEG studies have shown that entrained neuroelectric activity of somatosensory cortex to prolonged or rapidly repeated tactile stimulation reflect the entrained neuroelectric activity of the responding a synchronously active neural population. Recent research has shown that this response is not static, reflecting only the hardwired connections to the skin, but modifies progressively and reversibly over short periods of time (seconds to minutes). This suggests that this measure of EEG activity may provide an important index of brain plasticity with applications in to clinical populations such as stroke.

*Contact: Dr Bill Budd  
Phone: (02) 4348 4135  
Email: [Bill.Budd@newcastle.edu.au](mailto:Bill.Budd@newcastle.edu.au)  
Neuroscience Group*

### **Tactile Sensitivity of the Hand**

Evaluating the sensory motor function of patients following stroke provides the clinician with a means to measure and monitor recovery of function during post-stroke recovery and rehabilitation. Currently a sensory glove has been developed to measure responses to sensory stimulation of the fingers. We now wish to measure responses in normal controls in order to establish baseline data before testing the glove with stroke patients.

*Contact: Dr Bill Budd  
Phone: (02) 4921 5953  
Email: [Bill.Budd@newcastle.edu.au](mailto:Bill.Budd@newcastle.edu.au)*

*Contact: A/Prof Mick Hunter  
Phone: (02) 4921 5953  
Email: [mick.hunter@newcastle.edu.au](mailto:mick.hunter@newcastle.edu.au)  
Neuroscience Group*

### **Behavioural and neural mechanisms of social learning in Indian mynahs (*Acridotheres tristis*)**

Social learning is a key learning process in which individuals acquire information about the environment by watching the behaviour of others, rather than through their own direct experience. Both humans, particularly children, and non human animals, rely heavily upon social learning, particularly when acquiring information about events that pose a threat to the organism. The present project will use an experimental approach to explore the behavioural and neural mechanisms underpinning social learning. To overcome limitations imposed by human research, the work will be carried out on an avian model, the highly social and opportunistic Indian mynah (*Acridotheres tristis*), and will build upon a body of empirical work in Dr Griffin's laboratory showing that this species learns readily about dangerous events from watching the alarm behaviour of social companions, hence avoiding any risk to themselves. Behavioural experiments on wild-caught captive birds will aim to determine the conditions under which social learning occurs, and its properties. A potential expansion into an analysis of the neural structures involved will aim to test a recent theoretical model of social learning, which has proposed that social learning of fear engages Pavlovian fear conditioning while recruiting additional cortical structures to modulate the effects of the social experience (Olsson & Phelps 2007; *Nature Neuroscience*). Elucidating behavioural and neural mechanisms underpinning social learning will be instrumental in addressing deficits in this essential learning process.

Contact: Dr Andrea Griffin

Phone: (02) 4921 7161 (both Callaghan and Ourimbah)

Email: [Andrea.Griffin@newcastle.edu.au](mailto:Andrea.Griffin@newcastle.edu.au)

Neuroscience Group / Priority Research Centre for Brain and Mental Health Research

### **Social learning in Indian mynahs (*Acridotheres tristis*)? (Ourimbah or Callaghan)**

Social learning is a learning process in which individuals learn about the environment by watching the behaviour of others, rather than through their own direct experience (individual learning). Such learning is a major route for acquiring information in both humans and non human animals, and is of particular importance when learning about events that pose a threat to the organism. For example, a child may become afraid of dogs because he/she observes his/her mother behaving fearfully towards dogs, even if he/she has never had a personal aversive interaction with dogs. Elucidating behaviour and neural mechanisms underpinning social learning is of prime importance to addressing deficits in these learning processes. The present project will employ an avian (bird) species, the highly social and opportunistic Indian mynah, and will build upon a body of empirical work in our laboratory showing that Indian mynahs learn readily about dangerous events from watching the behaviour of social companions, hence avoiding any risk to themselves. Behavioural experiments on wild-caught captive birds will aim to determine the conditions under which social learning occurs.

Contact: Dr Andrea Griffin

Phone: (02) 4921 7161

Email: [Andrea.Griffin@newcastle.edu.au](mailto:Andrea.Griffin@newcastle.edu.au)

Neuroscience Group / Priority Research Centre for Brain and Mental Health Research

### **What's in a face: An investigation on the learning mechanisms of inter-ethnic anxiety. . (Ourimbah or Callaghan)**

Intergroup anxiety, the anxiety experienced during anticipated or actual interactions with individuals of other ethnicity, is a powerful predictor of intergroup prejudice and discriminatory behaviour in society. The present project takes a systematic approach to explore the extent to which intergroup anxiety can be modified through both direct experience of an aversive interaction with ethnic faces, and observation of another person's (the 'demonstrator') aversive experience. The student will work under the supervision of a researcher in learning and cognition (Dr Griffin) and a researcher in social psychology (Dr Paolini), both internationally recognized experts in their fields and learn to use state-of-the art technology to measure psychophysiological responses of arousal. This exciting new line of research has the potential to inform the design of individual-level treatments of anxiety, as well as group-level intervention programs aiming to reduce racial tension in society.

Contact: Dr Andrea Griffin

Phone: (02) 4921 7161

Email: [Andrea.Griffin@newcastle.edu.au](mailto:Andrea.Griffin@newcastle.edu.au)

Contact: Dr Stefania Paolini (Co-Supervisor)

Phone: (02) 4921 5938

Email: [stefania.paolini@newcastl.edu.au](mailto:stefania.paolini@newcastl.edu.au)

Neuroscience Group / Priority Research Centre for Brain and Mental Health Research

### **What's in a face: An investigation on the learning mechanisms of inter-ethnic anxiety**

Intergroup anxiety, the anxiety experienced during anticipated or actual interactions with individuals of other ethnicity, is a powerful predictor of intergroup prejudice and discriminatory behaviour in society. The present project takes a systematic approach to explore the extent to which intergroup anxiety can be modified through both direct experience of an aversive interaction with ethnic faces, and observation of another person's (the 'demonstrator') aversive experience.

The student will work under the supervision of a researcher in learning and cognition (Dr Griffin) and a researcher in social psychology (Dr Paolini), both internationally recognized experts in their fields and learn to use state-of-the art technology to measure psychophysiological responses of arousal. This exciting new line of research has the potential to inform the design of individual-level treatments of anxiety, as well as group-level intervention programs aiming to reduce racial tension in society.

Contact: *Dr Andrea Griffin*

Phone: (02) 4921 7161 (both Callaghan and Ourimbah)

Email: [Andrea.Griffin@newcastle.edu.au](mailto:Andrea.Griffin@newcastle.edu.au)

Neuroscience Group / Priority Research Centre for Brain and Mental Health Research

### **Social learning about danger: the role of attribution (Ourimbah or Callaghan)**

Both humans, particularly children, and nonhumans rely heavily upon social information when learning about dangerous events because in doing so, they avoid any risk to themselves. One way of learning is to watch the fear reactions of another individual (the 'model') and to remember what elicited that fear response. But for learning to be accurate, observers need to identify correctly what caused the fear response in the model, a problem referred to as 'attribution'. The present project will use an experimental approach to determine to what extent attribution is important for social learning in a bird species, the Indian mynah (*Acridotheres tristis*). The project builds upon a body of empirical work in Dr Griffin's laboratory showing that this species learns readily about dangerous events from watching the alarm behaviour of social companions.

Contact: *Dr Andrea Griffin*

Phone: (02) 4921 7161 or (02) 4348 4393

Email: [Andrea.griffin@newcastle.edu.au](mailto:Andrea.griffin@newcastle.edu.au)

Neuroscience Group / Priority Research Centre for Brain and Mental Health Research

### **Perinatal programming of anxiety**

The role of the early life environment has become increasingly important in understanding the development of later life disease. The current study will assess the role of neonatal bacterial exposure on the predisposition to psychopathology using a rodent model. Rats will be administered bacterial endotoxin or saline control on days 3 and 5 of life; and will be assessed in adulthood for differences in behaviour using a battery of behavioural tests.

It is intended that this research project will provide greater insight into the neuroimmune mechanisms underlying psychopathology such as depression, anxiety and post-traumatic stress disorder.

Contact: *A/Prof Deborah Hodgson*

Phone: (02) 4921 6701

Email: [Deborah.Hodgson@newcastle.edu.au](mailto:Deborah.Hodgson@newcastle.edu.au)

Neuroscience Group / Priority Research Centre for Brain and Mental Health Research

### **Handedness and Magnetic Resonance Spectroscopy.**

Measuring the MR spectra of cortical brain regions during activation of the motor areas has yielded differences between measures from dominant and non-dominant cerebral hemispheres. These measures were taken using the 1.5T scanner at the John Hunter Hospital. We now wish to replicate the study using the 3T scanner that will provide better differentiation of metabolic compounds in the spectra.

Contact: *A/Prof Mick Hunter*

Phone: (02) 4921 5953

Email: [mick.hunter@newcastle.edu.au](mailto:mick.hunter@newcastle.edu.au)

Neuroscience Group

## **Judging facial emotions - accuracy and discriminability of emotion expression**

Contact: A/Prof Mick Hunter  
Phone: (02) 4921 5953  
Email: [mick.hunter@newcastle.edu.au](mailto:mick.hunter@newcastle.edu.au)  
Neuroscience Group

## **Maturation in the Chicken – changes in EEG power during the first 6 weeks of life**

Contact: A/Prof Mick Hunter  
Phone: (02) 4921 5953  
Email: [mick.hunter@newcastle.edu.au](mailto:mick.hunter@newcastle.edu.au)  
Neuroscience Group

## **Mind control - EEG mu rhythm neurofeedback and control of dynamic visual displays**

Contact: A/Prof Mick Hunter  
Phone: (02) 4921 5953  
Email: [mick.hunter@newcastle.edu.au](mailto:mick.hunter@newcastle.edu.au)  
Neuroscience Group

## **Developmental trajectories of cognitive control**

Executive control functions are amongst the last to mature – often not reaching peak function until early adulthood. Our research aims at defining maturational pathways of different aspects of cognitive control across childhood to early adulthood. We examine individual variability in developmental trajectories with a view to mapping specific patterns of executive function development to problem behaviours in childhood and adolescence.

Contact: Dr Frini Karayanidis  
Phone: (02) 4921 5457  
Email: [Frini.Karayanidis@newcastle.edu.au](mailto:Frini.Karayanidis@newcastle.edu.au)  
Neuroscience Group

## **Structural and functional organisation of cognitive control processes**

Our research program aims at understanding the cognitive and neural architecture of executive control processes. We use a range of paradigms that allow us to examine the role of voluntary mechanisms vs contextual factors that affect the way we control our intentions and actions. Our program integrates across mathematical models of behaviour and neuroimaging methods such as event-related potentials (ERP) and functional magnetic resonance imaging (fMRI) in order to develop integrative models of cognitive control.

Contact: Dr Frini Karayanidis  
Phone: (02) 4921 5457  
Email: [Frini.Karayanidis@newcastle.edu.au](mailto:Frini.Karayanidis@newcastle.edu.au)  
Neuroscience Group

## **The role of control processes in cognitive decline in normal ageing and psychopathology**

Executive dysfunction is associated with many clinical conditions and normal ageing. Our work aims to examine specific patterns of cognitive control decline in psychopathologies associated with frontal lobe dysfunction and develop cognitive remediation programs targeted to different clinical groups.

Contact: Dr Frini Karayanidis  
Phone: (02) 4921 5457  
Email: [Frini.Karayanidis@newcastle.edu.au](mailto:Frini.Karayanidis@newcastle.edu.au)  
Neuroscience Group

## **Global spatial perceptual processes as cues in coherent motion perception**

Contact: Dr Stuart Marlin  
Phone: (02) 4921 6323  
Email: [Stuart.Marlin@newcastle.edu.au](mailto:Stuart.Marlin@newcastle.edu.au)  
Neuroscience Group

## **Local temporal processes as cues in coherent motion perception**

Contact: Dr Stuart Marlin  
Phone: (02) 4921 6323  
Email: [Stuart.Marlin@newcastle.edu.au](mailto:Stuart.Marlin@newcastle.edu.au)  
Neuroscience Group

## **Vision Science - Making Illusory Objects in Motion Seem Stationary**

Attention normally improves and speeds performance on a wide variety of tasks. However, we have discovered an illusion in which attention interferes with our sense of motion. This project will study this phenomena in human subjects.

Contact: Dr Sally McFadden  
Phone: (02) 4921 5634  
Email: [Sally.McFadden@newcastle.edu.au](mailto:Sally.McFadden@newcastle.edu.au)  
Neuroscience Group

## **Vision Science - Mechanisms Underlying Myopia Inhibition**

Myopia (short-sightedness) is a leading cause of blindness in Asia and the incidence has risen dramatically within one generation. It is caused by aberrant visual input during development. This project involves developing ways to inhibit the development of myopia using optical methods. We have developed a mammalian animal model of myopia in which eyes which wear spectacle lenses compensate for the imposed blur of the spectacles becoming long or short-sighted. This compensatory response happens in both humans and animal models, but in the animal models, we can dial up an exact refractive error within one week of specialised spectacle lens exposure; and then test the effect of various methods of inhibiting myopia development. This work has direct relevance to the treatment of human myopia.

Suitable for any student who is enthusiastic about working with animals and is meticulous and caring in nature. No specific background is needed.

Contact: Dr Sally McFadden  
Phone: (02) 4921 5634  
Email: [Sally.McFadden@newcastle.edu.au](mailto:Sally.McFadden@newcastle.edu.au)  
Neuroscience Group

## **Vision Science - Neuronal Plasticity in the Retina**

For decades it was believed that adult neural systems were incapable of plasticity until several examples were discovered in the cortex. We have discovered new neuronal connections that are due to visual stimulation in the retina of the eye, which not only overturns the interpretation of how cortical plasticity might arise, but shows an amazing adaptability in this mini-neural system. This project will pinpoint the source, targets and causal neuronal factors underlying this plasticity using immunohistochemistry, pharmacology and optical experiments in young guinea pigs.

Contact: Dr Sally McFadden  
Phone: (02) 4921 5634  
Email: [Sally.McFadden@newcastle.edu.au](mailto:Sally.McFadden@newcastle.edu.au)  
Neuroscience Group

### **The role of associative learning in multimodal interactions**

The project aims to examine the role of learning in determining how stimuli in different sensory systems can be bound and subsequently influence one another. In particular, studies will be carried out that repeatedly pair arbitrary auditory/tactile and olfactory/colour qualities and examine whether the detectability or intensity of a stimulus quality can be enhanced when the previously paired stimulus is also present. The conditions under which such effects occur optimally will also be addressed.

Contact: A/Prof John Prescott  
Phone: (02) 4348 4121  
Email: [J.Prescott@newcastle.edu.au](mailto:J.Prescott@newcastle.edu.au)  
Neuroscience Group

### **Effects of trial sequence on brain markers of response inhibition and conflict**

Behavioural performance in many tasks is dependent on the sequence of trials preceding the current trial. For example, errors are likely when a participant has to perform response Y after a long run of performing response X. The project will examine effects of trial sequence on brain markers of inhibition and response conflict in the stop-signal task, the Eriksen flanker task, and/or the two-choice task.

Contact: Dr Janette Smith  
Phone: (02) 4348 4149  
Email: [Janette.Smith@newcastle.edu.au](mailto:Janette.Smith@newcastle.edu.au)  
Neuroscience Group

### **Effects of trial sequence on brain markers of response inhibition and conflict**

Behavioural performance in many tasks is dependent on the sequence of trials preceding the current trial. For example, errors are likely when a participant has to perform response Y after a long run of performing response X. The project will examine effects of trial sequence on brain markers of inhibition and response conflict in the stop-signal task, the Eriksen flanker task, and/or the two-choice task.

Contact: Dr Janette Smith  
Phone: (02) 4348 4149  
Email: [Janette.Smith@newcastle.edu.au](mailto:Janette.Smith@newcastle.edu.au)  
Neuroscience Group

### **Mind Pong**

Using a software package (bci2000) to measure electrical brain activity in the motor cortex and to integrate this with a visual presentation on a monitor of a moving ball, we have developed a game 'Mind Pong', in which participants learn to control the movement of the presented visual image. We wish to test the ability to control in a competitive configuration where participants play against each other.

Contact: Dr Janette Smith  
Phone: (02) 4348 4149  
Email: [Janette.Smith@newcastle.edu.au](mailto:Janette.Smith@newcastle.edu.au)

Contact: A/Prof Mick Hunter  
Phone: (02) 4921 5953  
Email: [Mick.Hunter@newcastle.edu.au](mailto:Mick.Hunter@newcastle.edu.au)  
Neuroscience Group

### **Perceptual overlap and the NoGo N2**

In the Go/NoGo task, participants respond to stimuli of one type (Go) and withhold the response to stimuli of another type (NoGo). Previous research has shown that brain markers of inhibition to NoGo stimuli (the 'NoGo N2') are difficult to observe with auditory stimuli. This study will examine the issue of perceptual overlap in auditory stimuli, and whether a strong NoGo N2 can be observed under conditions of high perceptual overlap between Go and NoGo stimuli.

*Contact: Dr Janette Smith  
Phone: (02) 4348 4149  
Email: [Janette.Smith@newcastle.edu.au](mailto:Janette.Smith@newcastle.edu.au)  
Neuroscience Group*

### **Defining contextual relevance in sound processing**

The brain automatically models patterns in sound activity in the environment. These models serve the function of representing a current context against which the relevance of subsequent sounds can be automatically evaluated outside of our awareness. This function contributes to the efficiency of attention and neural processing and is dysfunctional in certain clinical groups. Studies will be conducted using electrophysiological, psychophysical and/or neurocognitive measures to determine the parameters that define the boundaries of this context.

*Contact: Dr Juanita Todd  
Phone: (02) 4921 5977  
Email: [Juanita.Todd@newcastle.edu.au](mailto:Juanita.Todd@newcastle.edu.au)  
Neuroscience Group / Priority Research Centre for Brain and Mental Health Research*

### **Nicotine and Cognition in Schizophrenia**

Whilst nicotine use is declining in the general population (25-30%), it remains very high in individuals with schizophrenia (70-90%). Two hypotheses put forward to explain the high rates of nicotine use in schizophrenia include a focus on self-medication and addiction vulnerability. We are conducting studies to further explore some of the unique effects of nicotine on cognitive abilities in this group.

*Contact: Dr Juanita Todd  
Phone: (02) 49215977  
Email: [Juanita.Todd@newcastle.edu.au](mailto:Juanita.Todd@newcastle.edu.au)  
Neuroscience Group*

### **Processing time cues in sound – changes in central auditory processing associated with aging**

As we age, many individuals with intact audiograms (normal hearing sensitivity) will experience difficulty hearing speech in noisy environments. One hypothesis for why this occurs is that there is a decline in the ability to track important temporal/timing cue in the speech signal. Studies will be conducted using electrophysiological, psychophysical and/or neurocognitive measures to determine the pattern of temporal processing of age-related decline in central auditory processing.

*Contact: Dr Juanita Todd  
Phone: (02) 4921 5977  
Email: [Juanita.Todd@newcastle.edu.au](mailto:Juanita.Todd@newcastle.edu.au)  
Neuroscience Group / Priority Research Centre for Brain and Mental Health Research*