FACULTY OF SCIENCE

THE UNIVERSITY OF SYDNEY

# Biology News

ISSUE 23
JUNE 2013

## STEVE SIMPSON ELECTED TO THE ROYAL SOCIETY

Professor Steve Simpson has been announced as a new Fellow of the Royal Society. The honour sees him join a fellowship of the world's most eminent scientists, engineers and technologists from the United Kingdom and Commonwealth, including more than 80 Nobel Laureates.

The Society has acknowledged how Steve's "seminal work on locust swarming has provided a unifying framework, ranging from chemical events in nervous systems of individual insects to mass migration, using techniques from molecular biology, population genetics, neurophysiology, biochemistry, behaviour, biomathematics, statistical physics, computer science, engineering, robotics, evolutionary theory and landscape ecology."

royalsociety.org/people/stephen-simpson/

# NUTRITIONAL ECOLOGY PROFESSOR ARRIVES

Professor David Raubenheimer has taken up the Leonard P Ullmann Chair in Nutritional Ecology at the Charles Perkins Centre, the first of several chairs that will be funded by the proceeds of the 2011 sale of a Picasso donated to the University to raise funds for scientific research.

From an initial interest in cyanide-eating butterflies, David has been a pioneer in the field of nutritional ecology. "Nutrition influences just about every aspect of biology - reproduction, predator avoidance, population growth and decline, health, ecology - they are all underpinned by nutrition."

This often side-lined specialty has now come to the fore thanks to the work of David and his collaborator, Professor Steve Simpson. "Almost all other approaches to nutrition consider the effects of nutrients individually," said David. "But the geometric framework is a modelling approach that helps us to understand how nutrients interact in their effects on animals." [For more about the geometric framework read their book *The Nature of Nutrition*.]

David brings to the School his experience in studying the nutrition of insects, fish, birds, rats, mice, mink, dogs, cats, giant pandas, lemurs, monkeys, gorillas and humans! "The bit that excites me most," said David, explaining his move to Sydney, "is the application of nutritional ecology to help understand and solve problems, improving our own lives and those of animals for which we have responsibility."

David joins the University on a co-appointment between the School of Biological Sciences and the Faculty of Veterinary Science.

## IN THIS ISSUE



## DIARY DATES

WEDNESDAY 21 AUGUST
**Annual Murray Lecture by Dr Bruce Stillman**
**Eastern Avenue Auditorium**
**6pm-7pm**

FRIDAY 18 OCTOBER
**Back to the School**
**Annual biology alumni social**
**Macleay Building and Botany Lawn**
**4pm-7pm**

## EDITORIAL


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# HEADSPACE

This year the School is introducing its new second year curriculum of six fundamental units of study: Botany, Zoology, Cell Biology, Ecology and Conservation, Genetics and Genomics and Biology Experimental Design and Analysis.

These units of study have attracted a 70% increase in enrolments over previous years and I am delighted that so far both the students and staff have been enjoying them. This new second year program follows on from our very successful curriculum renewal in our flagship first year units of study last year. Most members of the School were involved in some way in the mammoth effort to renew these first year units. I am thrilled that the team of academic and technical staff charged with taking the School's vision and implementing the new programs have just been awarded the 2013 Faculty of Science *Teaching and Learning Award*. Congratulations to Dr Charlotte Taylor, Dr Will Figueira, Dr Danny Liu, Dr Matt Pye, Mr Matt Austin, Mr Hamlet Giragossyan and Dr Anne-Laure Markovina.

It was a delight to hear two of our talented alumnus talk to our current students about their careers in biology at a recent *Jumpstart your Science Career* event. Dr Samantha Ginn (PhD 1999 with Professor Skurray) shared her fascinating experiences as a researcher in gene therapies at the Children's Medical Research Institute. She told students that the fundamental training she received in the School in doing good careful science with excellent record keeping had been invaluable to her career success. Sam is the subject of the Alumni Profile (page 7) in this newsletter. Kirsten Proft (BSc(Adv)(Hons) 2011), a recent honours graduate and currently a biodiversity conservation officer at the National Parks Association of NSW, shared the joys and challenges of her work in the conservation area.

For our alumni and friends in Tamworth, Parkes or Wagga Wagga, watch out for our school outreach program that will be heading to these rural centres as part of *Kickstart on the Road*. Dr Cecily Oakley, our wonderful science communicator and a team of our postgraduate research students, will be on tour with some biology hands-on experiences specifically targeted to enrich the NSW HSC School syllabus. They will be in Tamworth on June 17-18, Parkes on July 22-23 and Wagga Wagga on July 25-26. At each location there will also be an evening event for the public (6-9pm on June 18, July 23 and July 26 at the respective locations) – I am sure our team would love to have our alumni drop by.

Finally, it is my pleasure to congratulate Professor Steve Simpson on his recent election to the Royal Society for his work on locust swarming. Steve is currently the academic director of the Charles Perkins Research Centre, the University's exciting major initiative to tackle the burden of obesity, diabetes and cardiovascular disease. It is wonderful that the leader of this multi-disciplinary centre is a biologist!

Best wishes

Robyn Overall

# RESEARCH SPOTLIGHT: ROBYN OVERALL

We don't know their structure, how they work or how they are regulated...and for this reason plasmodesmata continue to fascinate Professor Robyn Overall.

"I imagine the structure," said Robyn. "I see the plasmodesmata function, but it's an hallucination." Plasmodesmata, the microscopic cytoplasmic channels that connect adjacent plant cells, have been slow in giving up their secrets. But we do have a few clues about their structure and function.

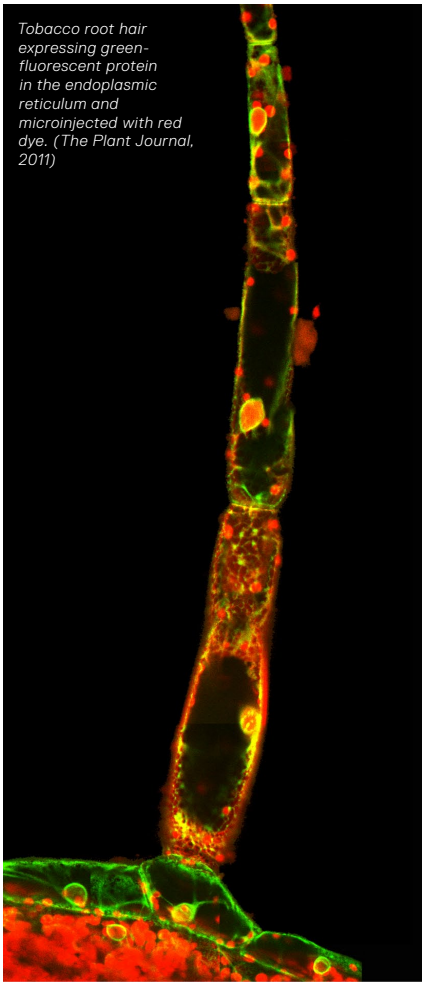
"Plasmodesmata pass water, mineral ions, proteins, RNA and viruses from one cell to another," explained Robyn. "But we don't know if individual plasmodestmata in a cell wall are all the same, or if the channels have specificity."

Plasmodesmata channels, which are lined by the plasma membrane, connect the cytoplasm of neighbouring cells. Most plasmodesmata also have a central tube of endoplasmic reticulum going through the channel. "It was generally accepted that transport occurred via the cytoplasmic pathway. But we were able to show that there was also transport down the endoplasmic reticulum."

"We injected fluorescent dye into individual cells. If the dye goes to the neighbouring cell we know it goes through the channel," said Robyn, patiently explaining ten years worth of experiments. "We saw the dye go into this mesh-work and then rapidly travel into the nuclei of neighbouring cells."

Unsure of exactly what they were seeing, the Overall lab began a series of very fiddly experiments to prove that this 'mesh work' and the endoplasmic reticulum were one and the same. "We expressed green-fluorescent protein in the endoplasmic reticulum and microinjected a red dye into the mesh-work – and they were in the same place. We were away!"

But why do cells have both cytoplasmic and endoplasmic pathways? "The endoplasmic reticulum might be part of a quick signalling mechanism," said Robyn. "Imagine the cytoplasm is a field and the endoplasmic reticulum is a road going through it. It is more efficient for the molecules moving from cell to cell to go on the road, because they move more quickly and arrive at a higher concentration."



*Tobacco root hair expressing green-fluorescent protein in the endoplasmic reticulum and microinjected with red dye. (The Plant Journal, 2011)*

Plant derived molecules are not the only particles transported via plasmosdesmata. "Recently we've been working intensively with the Waterhouse lab looking at the molecular warfare between viruses and plants." Again utilising the power of fluorescent microscopy, the lab groups have been labelling both plant proteins and viruses and watching them interact.

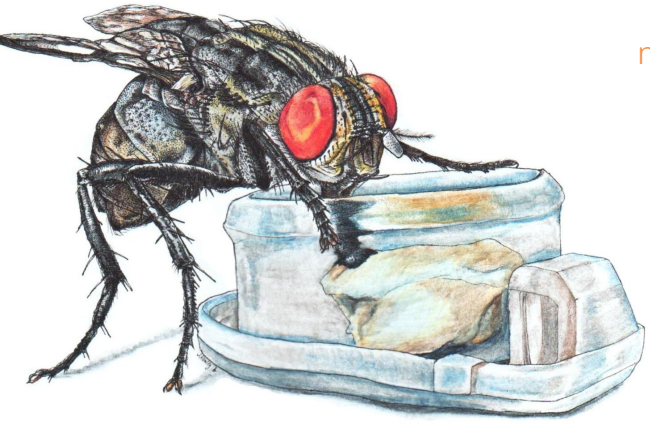
"We're able to do live cell imaging and see in real time the very first indication of a virus moving in to a cell," said Robyn, with obvious enthusiasm. "It's been exciting watching how the plants and viruses interact in terms of timing and place."

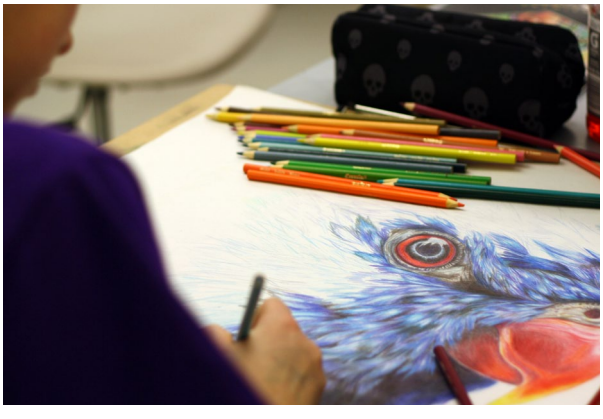
"The first indication that a virus is moving into a cell is the movement of a particular protein up to the wall adjacent to an infected cell, probably near our plasmodesmata." What this means is that the protein moves specifically to the wall adjacent to the infected cell, and not the other walls adjacent to un-infected cells. "It tells us that this cell knows there's a virus coming."

"We are planning to use correlative microscopy to investigate what physically happens when the virus first interacts with the plasmodesmata. If we can work out what component the viruses are interacting with, we might have a mechanism to stop viral transmission."

# PRACTICAL ART

How many times have you found yourself scribbling on a notepad or whiteboard (or the back of beer coster) trying to illustrate a scientific idea for a colleague or friend? We all use drawings as communication and education tools, but the illustrations that some biologists produce border on art. *Biology News* interviewed three talented biological illustrators for their views on biology as art in an age of digital-cameras.






*Top: colour painting of a male dottyback (Pseudochromis magnificus) by Tony Gill; Middle-top: illustration of a flesh fly (Sarcophaga crassipalpis) by Jesse Hawley; Middle-bottom: student drawing a rainbow lorikeet at James Madison University and Bottom: Alex Bannigan stands in front of works produced for an art-microscopy contest.*

"Photographs are certainly helpful, but they are very literal," says alumna Dr Alex Bannigan (PhD 2003). "A drawing or diagram allows for artistic licence that can emphasise what's important in the image you're looking at," she explained. "Or it can provide the 'typical' view so that it is more easily translated to different individual specimens."

Alex has recently begun teaching an undergraduate course in biological illustration at James Madison University in Virginia, USA. "I am trying to get my students to use art as a communication tool. I ask them to do things like illustrate an organism's life cycle, or team up with a research lab in the department and illustrate a major concept in their research."

As well as a communication device there are additional benefits for the illustrator-scientist. Ichthyologist and Macleay Museum curator, Dr Tony Gill, draws to understand. "For me, the actual process of illustrating anatomical features is an integral part of my research. It forces me to see better. Drawing structures makes me study them more carefully to make sure my illustrations are accurate."

Alex agrees that there is a strong teaching and learning benefit. "Drawing something forces you to really look at it. If it's a dissection, for example, you might ask yourself, 'Well, what's this bit connected to, then?' so that you can draw it properly. It allows for deeper learning than just snapping a photograph does."

Honours student Jesse Hawley studied flesh flies for his final-year research project. "After spending a dozen hours drawing and analysing, I grew a great appreciation for how special flies are!" Jesse particularly advocates biological illustration for subjects that don't lend themselves to photography. "Until a real-life Doctor Hammond comes along, we won't be able to photograph dinosaurs or anything prehistoric, this advantage of illustration is particularly alluring to me."

But are biological illustrations art? "Art is commonly expressive," explains Jesse. "Since the advent of cameras, art has moved from presenting things as 'photo-realistic', to representing them however the artist intends. There's a spectrum of biological illustration, spanning works of photo-realism, to abstract representations of the subject. For me, I rarely use art as a medium for expression, but instead for purposes more practical." Hmmm, so maybe yes, but it is art with a purpose.

# KOALAS STRUGGLE TO LIVE WITH HUMANS

BY DORIS YAU (SENIOR BIOLOGY STUDENT)

A recent survey in Brisbane Water National Park put in doubt the assumption that the koala (*Phascolarctos cinereus*) is coexiting well with humans on the eastern coast of Australia.

In April, myself and another undergraduate biology student, volunteered to participate in a koala search in the Pearl Beach/Patonga area, organised by the National Parks and Wildlife Service. We were told to look out for scratches on the trees and koala scats on the ground (which looked like raisins and smelt like green tea).

Soon after we began the search, our leader spotted scratches on a eucalyptus tree and a stale scat on the ground - but no koala in the branches above. We pushed on for the another two hours with no further signs or sightings of koalas.

At our meeting point, our scat and scratch were hailed as the only evidence that at least one koala still lived in the area. This is a dire finding for the koala population. Indeed the last reliable sighting of the marsupial was back in 2005 and many locals have confirmed that there has been a lack of koala sightings in the area in recent years.

The survey raised concerns about koala numbers in the area. Koalas are listed as a threatened species nationally - their main threats include bush fires, habitat destruction and fatality by feral and domestic dogs.

So how do we help our furry friends? Moving koala populations has been deemed an unsustainable strategy. Koalas may be protected, but their habitats are not, so a re-introduction program would do them a disservice. Instead, conservation efforts may need to include a public education plan.

It would be a very great loss if koalas were confined to the zoo. Perhaps a more holistic approach is necessary to ensure the koala's future.

# SYNTHETIC BIOLOGY
## BASED ON STANDARD PARTS

BY ROBBIE OPPENHEIMER (SENIOR BIOLOGY STUDENT)

Eight undergraduates from eight different backgrounds - biology, biochemistry, chemistry, mathematics, medical science, information technology, economics and anthropology - have come together as the first University of Sydney team to compete at an international competition in synthetic biology.

The competition is iGEM, the international Genetically Engineered Machine. Student teams from around the globe are given a kit of biological parts from the 'Registry of Standard Biological Parts'. Working at our own institutions, we use these parts and new parts of our own design to build biological systems and operate them in living cells.

iGEM represents an online, international community of students from over 200 universities. This is an opportunity to build on the skills and knowledge we have acquired in our time at Sydney University, while connecting with like-minded students from around the world.

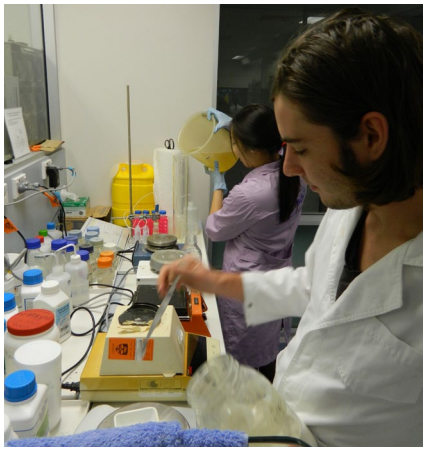
Dr Nick Coleman and Dr Peter Rutledge are supervising our attempt to modify a soil bacterium, *Pseudomonas stutzeri*, so that it can degrade dichloroethane. Dichloroethane is a suspected carcinogen, it is toxic to humans and it contaminates the groundwater at Botany Bay as a result of a long and complex history of industrial activity in the area. Our work represents an interesting application of Dr Coleman's research into naturally transformable bacteria, and we hope to produce publishable findings.

Further, some of the genetic material we characterise will be submitted to the rapidly growing Registry of Standardised Parts. The Registry is a global experiment to see whether DNA can become a reliable and predictable substrate for engineering through the collaborative effort of teams around the world.

Finally, in an attempt to get people thinking about synthetic biology, without forcing opinions and information upon them, we are creating a science writing competition for high-school students. We will host the competition on a website which provides an introduction to genetics, links to exciting current applications of synthetic biology, a quiz targeting common misconceptions, and more. Our aim is to promote an understanding of genetic technologies amongst the wider non-specialist community. This is important as the cost of sequencing and synthesising genomes plummets, and as genetic technology becomes more widely distributed.

We begin labwork tomorrow and we have just five months to complete our work! Thanks to the support of the Schools of Biological Sciences, Molecular Bioscience and Medical Sciences, the Dean of Science and the Deputy Vice Chancellors of Education and Research, our entire team will be able to attend the regional jamboree in Hong Kong this October.

2013.igem.org




*Ernst Haeckel's series on four main types of cleavage and gastrulation (1876). Ziegler Studio, Germany, 22 models in series. Macleay Museum: SC2001.32*

**sydney.edu.au/museums/events_exhibitions/macleay_exhibitions.shtml**

# TRUE TO FORM

The Macleay Museum continues to celebrate teaching and research in Biological Sciences this time looking further back in history at the foundations of teaching at Sydney.

*True to Form: models made for science* was curated by Jan Brazier (curator, history collections at the Macleay). It features wax models purchased by the University in its first years of teaching. The purchase of supplies seems an unpromising start to an exhibition but as Jan Brazier demonstrates, it is through these acquisitions that one can see how and what the University taught its first students.

In this excerpt from the exhibition text Jan Brazier tells the story of the University's beginnings in biological sciences.

*In 1882 William A. Haswell was appointed to the University of Sydney as demonstrator in comparative anatomy, and then in 1884, lecturer in zoology and comparative anatomy. His major area of research interest was marine zoology, particularly Australian crustaceans and polychaete annelids.*

*Haswell used models in teaching but also in his research, publishing illustrations of Ziegler models in his* Textbook of Zoology *(1897). Haswell established a collection of specimens and teaching materials still in use today in the Haswell Museum.*

# LITTLE PEOPLE, GIANT SCIENCE

Looks of horror turned to squeals of delight as year five and six primary students' hunted invertebrates in the leaf litter during a visit to the School of Biological Sciences.

"Are there *really* spiders in there?" they asked – not quite believing that they would be permitted to encounter such scary creepy crawlies. Not only were there spiders (mostly Woodlouse, *Dysdera spp*), but also centipedes, silverfish, earth worms and slaters.

These youthful scientists were visiting the University of Sydney as part of the *Giant Science* program. This outreach activity brings the wonders of science to primary school students and their teachers.

The School hosted 113 students over two days in April. The budding biologists learnt some basic microscope skills, as well as touching on ideas of animal classification and food webs.

The students, for the most part, did a great job of describing the invertebrates. 'Cylindrical, covered in mucus' for an earthworm; 'long body and inteners [sic]' for the symphylids; 'white spots on its butt' for one of the spiders. But the poor slater was described as being 'gross and disgusting' by one child. We can only hope that this student could at least appreciate the place of the slater in the leaf litter food web.

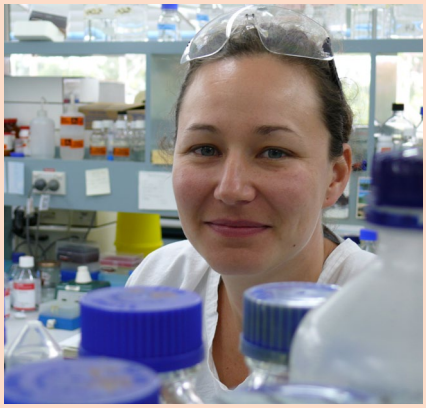
This program runs every two years, with the next *Giant Science* scheduled for 2015.

**sydney.edu.au/science/outreach/giant/**

*Photo courtesy of the Compass program* **sydney.edu.au/compass**

# ALUMNI PROFILE: SAMANTHA GINN

Dr Samantha (Sam) Ginn (PhD 1999) became hooked on molecular biology early in her career. Now a researcher into gene therapies, Sam works at the cutting edge of medicine.



**A love for chemistry saw Sam enroll in an undergraduate biotechnology degree at the University of Technology, Sydney. Her third year molecular biology subject sparked an interest in genetics that she pursued at the School of Biological Sciences for her PhD. Sam now uses those skills and her solid foundation in research to study gene therapies at the Children's Medical Research Institute.**

**What are your memories from your time at the School?**

I have such wonderful memories of my time at the School of Biological Sciences, both at a professional and personal level. My supervisors Ron Skurray and Melissa Brown, as well as Neville Firth, who was a post-doc in the lab at the time, provided me with excellent training, that I still carry with me today. I always had fun in the Skurray lab, and I still catch up with the members - I guess these people become like your second family.

**From a PhD in bacterial genetics, how did you move into medical research?**

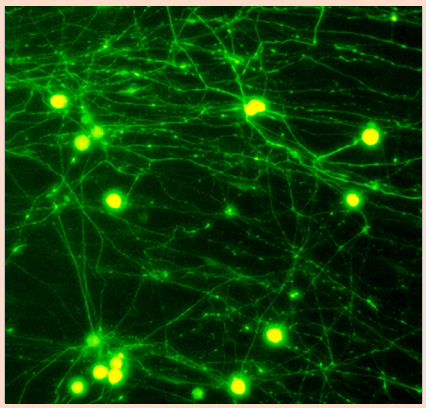
I had wanted to shift into medical research and originally applied unsuccessfully for a position in a cancer research lab. But they then put my name forward to the head of the gene therapy lab, Ian Alexander. I had a good skill set, even though there were many aspects to the position that were unfamiliar to me. I guess if you have good training and foundations, you can apply them to other areas of research.

**What is gene therapy?**

Gene therapy, as defined by the United Kingdom's Gene Therapy Advisory Committee, is '*the deliberate introduction of genetic material into human somatic cells for therapeutic, prophylactic or diagnostic purposes*'. In theory, the concept of gene therapy is simply based on the idea of using 'genes as medicine'. Of course this is much more complicated in practice. It was originally conceived as treatment for inherited monogenetic diseases but there is now a much broader appreciation of the scope of gene therapy.

**What are you working on now?**

At the moment I am developing lentiviral vector systems (based on HIV-1) to treat genetic immunodeficiency disorders that affect infants. These kids require bone marrow transplantation to have a functional immune system. This transplant carries some serious risks



*Peripheral nervous system neurons that Dr Samantha Ginn has genetically modified to express green-fluorescent protein. Sam has used these in her research into neurons as targets for gene transfer.*

(most commonly graft-versus-host disease). To generate essential pre-clinical data we model these diseases in the mouse, which is a really important way to test the efficacy and safety of potential gene therapy protocols.

I am also investigating whether cellular proliferation plays a role in lymphoma development when the haematopoietic compartment is reconstituted from small numbers of cells, which is like giving the mice a bone marrow transplant and then monitoring them to see if any problems develop.

**What are your career highlights?**

So far, I think it was being involved in a clinical trial for a rare disease known as X-linked severe combined immunodeficiency, sometimes referred to as 'boy-in-the-bubble' disease. Led by a group based in France, this was the first genetic disease to be treated successfully by gene therapy and was really a milestone, not only for the field of gene therapy, but also for medicine in general.

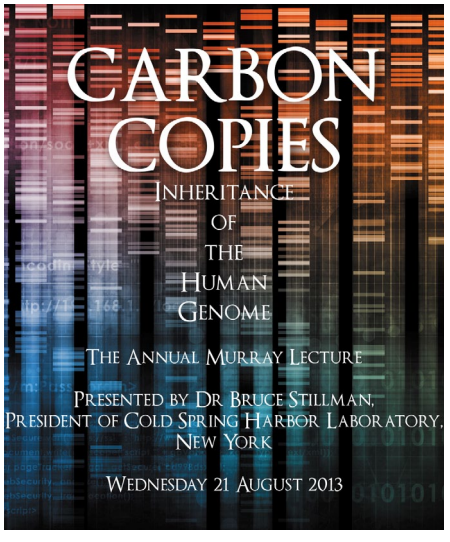
There is now a second iteration of this trial underway, with some improvements to vector safety, and it would be great to have the opportunity to be involved with that again.

**In addition to your research at the Children's Medical Research Institute, in what other ways are you involved with the scientific community?**

There are a few ways that I try to be involved with the scientific community. I am a reviewer for a scientific gene therapy journal, an external reviewer for the NHMRC and I also present my work at scientific conferences. I am also the secretary of the Australasian Gene Therapy Society, whose aim is to facilitate the growth and development of the field of gene therapy in Australia.

And from time-to-time I am asked to talk to interested science teachers and students, I find that very rewarding.

# EVENTS




## MURRAY LECTURE - WEDNESDAY 21 AUGUST

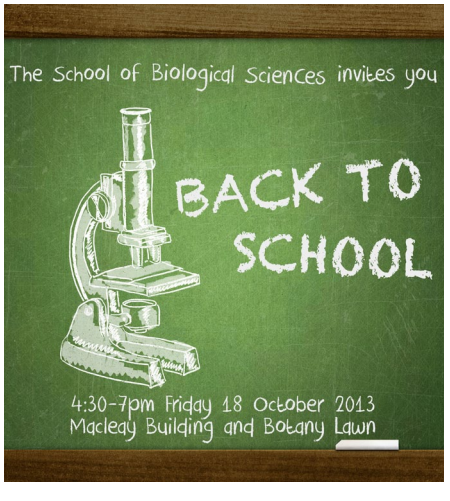
### Carbon Copies: Inheritance of the human genome

We take it for granted that our DNA replicates normally in our cells every day, but when these processes go wrong in our body's cells we can end up with abnormal cells, the wrong rate of cell replacement and even cancer.

In the annual Murray Lecture, **Dr Bruce Stillman**, President of Cold Spring Harbor Laboratory in New York, will discuss how the human genome is copied and inherited each time a cell divides. Dr Stillman's research has elucidated the mechanism of how a cycle of copying the DNA double helix is initiated and how it is coordinated with chromosome segregation during mitosis.

Delve deep into your cells and find out how important DNA replication is.

**VENUE** Eastern Avenue Auditorium, University of Sydney
**TIME** 5:45pm-6:45pm
**RSVP** via email to **science.forum@sydney.edu.au** or online booking at **sydney.edu.au/science/outreach/forum/lecture7.shtml**




## ANNUAL ALUMNI SOCIAL - FRIDAY 18 OCTOBER

### Come **Back to the School** of Biological Sciences - take a class, refresh your knowledge, run an experiment and then relax with a drink.

Do you remember the fun of dissections? The thrill of peering down the microscope? The buzz you get from grasping a new idea? Re-live your University days and join us in the lab for the annual alumni social. Bring along family and friends and share your experiences. Lab work is more fun when there are drinks at the end (and no exam)!

**VENUE** Macleay Building and Botany Lawn, University of Sydney
**TIME** 4:30pm-7:00pm
**RSVP** Please RSVP by Monday 14 October, via phone to 02 9351 4543 or email **biorsvp@sydney.edu.au**

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FACULTY OF SCIENCE

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